IIMT UNIVERSITY
MEERUT (U.P.)
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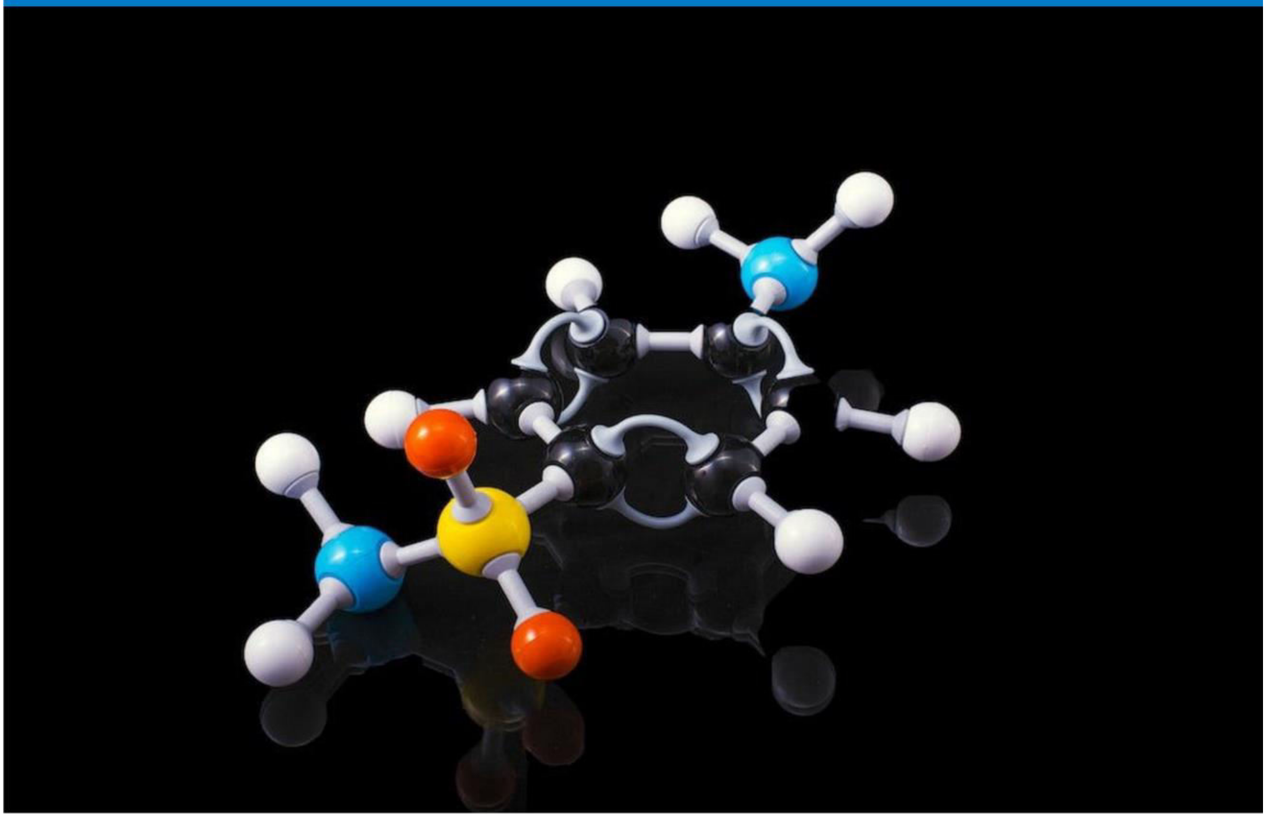
UGC Approved
Section 2f & 12B

# School of Basic Sciences

# ACADEMIC HAND BOOK



## ORDINANCE & ACADEMIC REGULATIONS
## BACHELOR OF SCIENCE
## PHYSICS/CHEMISTRY/MATHEMATICS
## PHYSICS/ STATISTICS/MATHEMATICS

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# 1. PREAMBLE

School of Basic Sciences and Technology was founded in 2017 with an aim to provide top-notch education in the fields of fundamental sciences and technology. The school started with the introduction of the undergraduate courses B.Sc. (PCM) and B.Sc. (PSM) in 2017, and then M.Sc. in Physics, Chemistry, Mathematics, and Statistics, as well as Doctoral programmes in Physics, Chemistry, Mathematics, and Statistics.

The goal of our school is to give intermediate and graduate students, who come from various educational boards/universities, a solid foundation that will help them succeed in various professional and educational programme. When students graduate from our programme, they will be ready for diverse academic professions and positions in industry.
The School of Basic Sciences and Technology supports research-based methodologies by harnessing the skills and capabilities of top-tier faculty members and cutting-edge buildings, enabling us to provide fascinating programme in both traditional and multidisciplinary fields of science and technology. The school currently features departments that are well-established, well equipped, and going forward with a strong team of highly trained and experienced faculty members.

Under the skilled guidance of subject professors and mentors, students enrolling in the School of Basic Sciences and Technology in a variety of disciplines succeed in achieving their individual academic objectives. Additionally, many seminars, conferences, workshops, and educational and professional tours are all encouraged for students to take part in.

To prepare students for many academic areas including competitive exams like NET, JRF, GATE, and PSUs, regular extracurricular activities and career development activities are offered. The institution provides PhD programmes in a number of fields, including chemistry, physics, mathematics, and statistics, in addition to U.G. and P.G. courses. Numerous career prospects are available after completing a PhD degree, including those in pharmaceutical synthesis, academic teaching, economic research, cutting-edge laboratories, and market research and development companies.

By offering students a superior educational opportunity and supporting all facets of teaching, learning, and research, the School of Basic Sciences and Technology contributes to the university's purpose of academic eminence in teaching, scholarship, and service.

# 2. DEFINITIONS

1. Student- a student registered for the undergraduate program for a full time study leading to Bachelor’s Degree.
2. Academic Council- the Academic Council of the University, as defined in the Statutes.
3. CGPA- The cumulative grade point average of a student.
4. Core Courses- courses which are considered mandatory to be taken by students at departmental level and must be passed by students to fulfill the degree requirement. The courses need to be repeated by students in case of “fail” grade.
5. Course- a subject or curricular component identified by a designated code number and a title.
6. Course Description- shall comprise details such as Curricular Content, Course Code, Course Title, Brief Syllabus, Course Learning Outcomes, Pre-requisites, if any, special teaching methodology, Evaluation Methodology etc.

7. Course Coordinator- a faculty member who shall have full responsibility for the course, coordinating the work of other faculty member(s) involved in that course, including setting up of course syllabus, timeline for conduct of various component of the course, Examinations and the award of grades. In case of any difficulty, the student is expected to approach the course coordinator for advice and clarification.
8. Curricula- the program structure duly filled with titles and code numbers of the courses in a program for a discipline.
9. Degree- Bachelor's degree viz. BSc and such other degrees of the University as may be approved by the Executive Council.
10. Elective Courses- courses subscribed by a student to have flexibility to pursue their interest in different areas of science. The elective courses are expected to help a student to gain deeper knowledge and skills in specific/chosen areas in science. They may be interchanged and shall not count as essential for the award of degree so long as credit and other requirements are fulfilled.
11. Equivalent Course(s)- wherever made applicable, through regulations or laid down in the curriculum for a given course an equivalent course(s) may be identified for any other course, which is being discontinued, or not done as essential part of curriculum to be completed by a student. Department may use the equivalent course(s) for meeting degree / pre-requisite requirement in special circumstances.
12. Executive Council- the Executive Council of the University, as defined in the Act.
13. Faculty Mentor- a faculty member nominated by the Department to advise / counsel/mentor a student on matters related to the academic program, of the student. He/she shall be responsible for acting as an interface between student, University and parents / guardians, as required.
14. Foundation Courses- courses aimed at building the foundation in the science Programs and are common across all the streams within the School. These courses are designed for providing basic conceptual knowledge and analytical tools. The courses need to be repeated by students in case of "fail" grade.
15. Pre-requisite- a course which a student must pass before taking another course which has it as a pre-requisite.
16. Program Structure- to be used for defining semester wise credits and contact hours (distribution allotted to various types of courses in a program) like Theory, Labs and Seminars etc. mentioning their status as core or elective).
17. SGPA- the semester grade point average.

## 3. VISION AND MISSION

We aim to help our students to develop the competencies and essential proficiency necessary for success and leadership in the emerging creative economy and to improve the conditions for communities in the field of science and technology.

At school of Basic sciences and Technology we have a mission to develop a strong research oriented scientific foundation to pursue an emerging carrier in the field of basic sciences and technology. We aim to develop a logical and analytical approach among the students to prepare them for future professional endeavors'.

## 4. PROGRAM EDUCATIONAL OBJECTIVES

- The students will have knowledge of fundamental laws and principles in a variety of areas along with their applications.
- The students will develop research skills which might include advanced laboratory

techniques, numerical techniques, computer algebra, computer interfacing.

- The students will become effective researcher who will be able to provide lucid summation of the scientific literature on a given topic of study.
- The students will develop the skill to plan, execute and report the results of an extended experimental or theoretical based project in a research environment.

**5. PROGRAM OUTCOMES:**

At the end of the programme the students will be able to:

- Apply theoretical knowledge of principles and concepts of subjects to practical problems.
- Demonstrate the ability to plan, undertake, and report on a programme of original work; including the planning and execution of experiments, the analysis and interpretation of experimental results.
- Assess the errors involved in an experimental work and make recommendations based on the results in an effective manner.
- Develop communication skills, both written and oral, for specialized and non-specialized audiences.

**6. PROGRAM SPECIFIC OUTCOMES**

Students graduating with the B.Sc. Physical Science degree should be able to acquire

- Ability to demonstrate a broad knowledge of the B.Sc. Program.
- The ability to employ critical thinking in understanding concepts in each area of the BSc. PCM program.
- Ability to analyze results and apply them to a variety of problems.
- Develop a sense of research to predict cause-and-effect relationships
- Ability to solve problems using research-based knowledge and research methods.
- Knowledge of the values and beliefs of multiple cultures and a global perspective, and the ability to effectively engage in a multicultural society and interact respectfully with diverse groups.
- This program will also help the students to enhance their employability for jobs in various sectors.

**7. ADMISSION**

- Candidate seeking admission in Bachelor of Sciences courses must have passed basic eligibility criteria i.e. 10 + 2 with minimum 40% marks and 50% marks respectively or its equivalent from any recognized Central / State Board with any stream. Further,
- Candidate appeared in the qualifying examination and awaiting the result may also apply and may be admitted provisionally.
- The admission shall be confirmed only after the declaration of the result and passing the examination and fulfilling the admission eligibility criteria within 30 days of admission.

**8. ELIGIBILITY**

Students who want to enrollment in the B.Sc. (PCM/PSM) programme will be eligible to take admission as per eligibility criteria of NEP 2020.

**9. CURRICULUM**

The curriculum of B.Sc. (PCM/PSM) programme allows students to choose elective courses from a set of courses with contemporary relevance, thereby offering students the flexibility to prepare for careers in academia, law, management, journalism, government, and many other fields. The programme is consistent with global standards in the different discipline. IIMT University, Meerut hopes that the LOCF approach of the B.Sc. (PCM/PSM) programme will help students in making an informed decision regarding the goals that they wish to pursue in further education and life.

**10. MEDIUM OF INSTRUCTION:**

The medium of instructions will be English.

**11. CHOICE BASE CREDIT SYSTEM (CBCS)/LOCF/OBE**

**a.** The course curriculum and syllabus of B.Sc. (PCM/PSM) programme shall be developed by the concerned School Board of Studies/Department Board of Studies / Board of Under-Graduate Studies of the University and they shall be implemented after obtaining approval from the Academic Council.

**b.** IIMT University, Meerut offers a number of choices for the papers under Generic Elective Courses (GEC), Discipline Specific Elective (DSE) courses, Skill Enhancement Courses (SEC) and Value Addition Courses (VAC), as per the availability of the courses and faculty.

**c.** The University may evolve a system/policy about Extra Curricular Activities/ General Interest and Hobby Courses/Sports/NCC/NSS/Vocational courses/related courses, for adding them under Value Addition Courses (VAC).

**d.** Dissertation/Project Work/Internship is optional and it may be offered in lieu of a discipline specific elective paper in 6th Semester.

**e.** The curriculum of B.Sc. (PCM/PSM) programme shall be in conformity with the University Grants Commission's Guidelines for the Learning Outcomes- based Curriculum Framework (LOCF) under the Choice Based Credit System (CBCS).

**The following mechanism shall be adopted for computation of work-load as per the credit system for theory and practicals both.**

**(a)** 1Credit =1Theory period of one hour duration/week/semester;
**(b)** 1Credit =1Tutorial period of one hour duration/week/semester;
**(c)** 1Credit =1Practical period of two hours duration/week/semester;
**(d)** 1Credit = Internship of 1 week/semester.

**REGISTRATION FOR COURSE IN A SEMESTER**

- The students can register themselves by filling the application form available at the IIMT University reception or through online mode.
- To register online, a registration fee is payable at the time of registration. The payment can be made through paytm, bank draft, NEFT and other online payment services.
- The application form should be duly filled and complete in all aspects. The completed application form can be submitted online. The Candidate can also send the hard copy of the downloaded filled application form along with the bank draft or the proof of

payment (if paid through any other mode) to the University address.

- The candidates are shortlisted based on the eligibility criteria of the course applied for and called for a Personal Interview (PI).
- Admission is granted based on the final evaluation done by the PI team that includes members from the respective programs as well.

**12. Attendance**

A regular student shall not be permitted to appear in semester examination, unless he/she has regularly attended not less than 75% classes held in aggregate of all subjects. The university however may, condone the shortage in attendance up to 10% in each subject for any of the following reasons.

- Participation in NCC/ NSS Camps.
- Participation in University/ Inter-university/ State-level Games.
- Participation in other extra-curricular activities at University/ Inter-university/ State level.
- Prolonged Illness

**13.1 Condonation of medical cases**

The condonation on medical grounds shall be granted only when the student is incapacitated, such that he/she cannot attend classes. IIMT University, Meerut shall verify the same. No condonation will be granted if the doctor/hospital fails to certify such illness.

**13.2 Additional Condonation**

Additional Condonation may be given as per the term and condition of the students. Competent authority will look after the entire process of attendance.

**13. Assessment procedure**

**14.1 Internal Assessment (IA)**

Internal Assessment is done by conducting minimum two Sessional Examinations and practical. Class test, assignment and presentation are also key part of the internal assessment.

**External Assessment (EA)**

The external assessment is done by conducting the End term Examinations as per evaluation scheme. After this proper evaluation will be done by the external examiners.

**14.2 Practical Assessment**

Practical Assessment plays a pivotal role in Academics. The school conducts Practical on internal and external basis as per the evaluation scheme.

**Internal Assessment (IA)**

The internal assessment is done on the basis of files and presentation.

**External Assessment (EA)**

The external assessment is done on the basis of files, presentation and viva-voice assessed by the external examiners.

**14. Research Project/Semester project Assessment Criteria**

In School of Basic Sciences & Technology particular research project are not including in the Curriculum.

**15. Internship-Research/Industrial Internship**

In School of Basic sciences & Technology particular Internship-Research/Industrial Internship are not the part of Curriculum. Still research activities related to the subjects may be conducted by the School of Basic sciences & Technology time to time.

**16. For Non-Credit Course/Audit Course**

Candidates will be offered noncredit course in all semesters. It will be non-credit course.

1. Physical education and Yoga/Sports
2. Sports/Physical education

**17. Credit Weightage**

Candidates will be offered Credits for Core Courses, Ability Enhancement Compulsory Course (AECC), Skill Enhancement Course (SEC), Discipline Specific Elective (DSE), Generic Elective (GE) SWAYAM/MOOCs/NCC. The credits are well defined in the evaluation scheme as per the weightage of the course.

**18. Maximum Duration of Progrmame/Promotion Policy**

(i) A candidate shall have to pass all the six semesters examinations within a maximum period of Five Years of his/her admission to the first semester of B.Sc. programme respectively failing which he/she will be deemed to be unfit for the programme.

(ii) If a candidate, who has passed the second semester examination, but could not continue his studies, for legitimate and justified reasons, may be permitted to join third semester within two years of his passing the second semester examination.

(iii) The Internal Assessment awards of a candidate, who fails in any external exam, would be awarded the same marks as he/she has obtained when he/she was there in the semester.

**19. Maximum gaps between semester/year**

It is usually a constructive 24 month break taken from study or work in order for the individual to pursue other interests, generally markedly different from their regular life or line of work. At least two years gap may be considered as per the norms of IIMT University, Meerut.

**20. Credit System & grading CGPA/SGPA**

**Credit:** Credit defines the quantum of work-load for a course. Generally, one hour of theory or one hour of tutorial or two hours of laboratory work, per week for duration of a semester result in the award of one credit. Credits for internship shall be one credit per one week of internship, subject to a maximum of six credits.

**Credit Point:** It is the product of grade point and number of credits for a Course.

**Semester Grade Point Average (SGPA):** It is a measure of performance of work done in a semester. It is ratio of total credit points secured by a student in various courses registered in a semester to the total course credits taken during that semester. It shall be expressed up to two decimal places.

**Cumulative Grade Point Average (CGPA):** It is a measure of overall cumulative performance of a student over all semesters. The CGPA is the ratio of total credit points secured by a student in various courses in all semesters to the sum of the total credits of all courses in all the semesters. It is expressed up to two decimal places.

**Transcript or Grade Card or Certificate**: Based on the grades earned, a grade certificate shall be issued to all the registered students after every semester. The grade certificate will display the course details (code, title, number of credits, grade secured) along with SGPA of that semester and CGPA earned till that semester.

**21. Class/Division**

Class/Division may be done as per the choice of subjects by the students. Subject may be classified as per the evaluation scheme for preparing the subject combination list according to the division.

**22. Transfer of Credit/Academic Credit Bank**

A candidate who has earned the minimum number of credits prescribed in the concerned Syllabi and Scheme of Teaching and Examination, either entirely from the School of Basic Sciences & Technology, IIMT University, Meerut credits which have been transferred after earning them for one semester/ semesters from any other University operating in and outside India and with which MoU has been entered by the IIMT University, shall be declared to have passed the programme, and shall be eligible for the award of the relevant degree. The Syllabi and Scheme of Teaching and Examination shall clearly specify the minimum credits to be earned to qualify for a degree in Bachelor of Science. The credits included in the Syllabi and Scheme of Teaching and Examination of a programme shall generally be 5 – 10% more than such minimum specified credits, subject to prescribed guidelines of the concerned authority of IIMT University, Meerut.

**23. Change of Discipline**

After taking the admission in any course Students can change the discipline as per own choice under the rules and regulation of IIMT University, Meerut. Change of Discipline is the right of Students as per the law of NEP 2020.

**24. Use of technological Intervention**

- SoBST has been currently using technology for teaching the students, conducting the regular classes, scheduling meeting, organizing webinars, and conducting all academic and cultural activities.
- All the students have been taught through various technological apps such as Google classroom, Zoom, Google Meet, Microsoft team etc.
- Faculty as well as Students have been given regular training to acquaint with technology, its use and functions to work in a friendly manner.
- We are also promoting students for online courses like NPTEL/SWAYAM/MOOCS.
- Students have been trained for giving presentations through technology.

**25. Student Discipline**

School of Basic sciences & Technology believes in providing professional education with human values. Ragging is form of brutality that can never be tolerated in an educational institution with ethics. It is the practice of the faculty members as well as the Proctorial board to guide the Students about the disciplined activities In – Campus and out Side Campus.

**26. Student Welfare**

School of Basic Sciences & Technology believes in providing a healthy learning atmosphere where students can generate, enable and progress inspiration. Students are also supported for everything that works well for their welfare. Our Vision is to follow and provide professionalism, Positive Attitude towards Growth and Enablement of the Students besides anticipated reaching 100 percent Placement with the support of advanced way of learning.

**27. Ragging**

School of Basic Sciences & Technology provides learning in ragging free atmosphere to our Students as ragging is strictly prohibited in the campus. The Students follow the guidelines properly regarding the same.

**28. Power of modify**

School of Basic Sciences & Technology of IIMT University, Meerut has the power to modify the syllabus/Curriculum as per the guidelines of Academic counsel instruction of the competent authority as per the need to modify the same.

**29. Exit Point**

Students can exit after one year with a certificate, after two years with a diploma and a Bachelor's degree after three years and Bachelor's with research after 4 years.

**30. NC/Credit Course**

Candidates will be offered NC course all semesters. It will be non-credit course.

1. Physical education and Yoga/Sports
2. Sports/Physical education

   Candidates will be offered Credits for Core Courses, Ability Enhancement Compulsory Course (AECC), Skill Enhancement Course (SEC), Discipline Specific Elective (DSE), Generic Elective (GE) SWAYAM/MOOCs/ NCC. The credits are well defined in the evaluation scheme as per the weightage of the course.

**NOTE:** Any dispute arising on account of implementation of this ordinance shall be referred to a committee of three members to be appointed by the Vice-Chancellor and its decision shall be final and binding on all.

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# EVALUATION SCHEME

| B.Sc. (PCM)<br>Semester: I | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **S. No.** | **Course Code** | **Course Name** | **Course Category** | **Periods** | | | **Evaluation Scheme** | | | **Credit** |
| | | | | **L** | **T** | **P** | **IA** | **EA** | **Total** | |
| 1 | NHU-112/122 | Environmental Studies | AECC-1 | 3 | 0 | 0 | 15 | 35 | 50 | 3 |
| 2 | BSPH-111 | Mathematical Physics & Newtonian Mechanics | Core Theory-1 | 4 | 0 | 0 | 25 | 75 | 100 | 4 |
| 3 | BSCH-111 | Fundamentals of Chemistry | Core Theory-2 | 4 | 0 | 0 | 25 | 75 | 100 | 4 |
| 4 | BSMT-111 | Differential Calculus and Integral Calculus | Core Theory-3 | 4 | 0 | 0 | 25 | 75 | 100 | 4 |
| 5 | BSPH-111P | Mechanical Properties of Matter | Core Lab-1 | 0 | 0 | 4 | 20 | 30 | 50 | 2 |
| 6 | BSCH-111P | Quantitative Analysis | Core Lab-2 | 0 | 0 | 4 | 20 | 30 | 50 | 2 |
| 7 | BSMT-111P | Differential Calculus and Integral Calculus Tutorial | Core Lab-3 | 0 | 0 | 4 | 20 | 30 | 50 | 2 |
| 8 | SEC-111 | Moocs/ Swayam | SEC-1 | | | 2 | 25 | 0 | 25 | 1 |
| 9 | SEC-112 | NCC/USR | SEC-2 | | | 2 | 25 | 0 | 25 | 1 |
| 10 | | From any Department | GE-1* | 6 | | | 25 | 75 | 100 | 6 |
| | | **TOTAL** | | **21** | **0** | **16** | | | **650** | **29** |
| L-Lecture, T-Tutorials, P-Practical (Labs), IA-Internal Assessment (Class Test, Assignments, Tutorials etc.), EA-External Assessment | | | | | | | | | | |
| Note: Generic Elective Course (GE) is depend upon the Department which offeres the credit and it may be 4/5/6. | | | | | | | | | | |

| B.Sc. (PCM)<br>Semester: II | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **S. No.** | **Course Code** | **Course Name** | **Course Category** | **Periods** | | | **Evaluation Scheme** | | | **Credit** |
| | | | | **L** | **T** | **P** | **IA** | **EA** | **Total** | |
| 1 | NHU-111/121 | English | AECC-2 | 3 | 0 | 0 | 15 | 35 | 50 | 3 |
| 2 | BSPH-121 | Thermal Physics & Semiconductor Devices | Core Theory-4 | 4 | 0 | 0 | 25 | 75 | 100 | 4 |
| 3 | BSCH-121 | Bioorganic and Medicinal | Core Theory-5 | 4 | 0 | 0 | 25 | 75 | 100 | 4 |
| 4 | BSMT-121 | Matrices and Differential Equations & Geometry | Core Theory-6 | 4 | 0 | 0 | 25 | 75 | 100 | 4 |
| 5 | BSPH-121P | Thermal Properties of Matter & Electronic Circuits | Core Lab-4 | 0 | 0 | 4 | 20 | 30 | 50 | 2 |
| 6 | BSCH-121P | Biochemical Analysis | Core Lab-5 | 0 | 0 | 4 | 20 | 30 | 50 | 2 |
| 7 | BSMT-121T | Matrices and Differential Equations & Geometry Tutorial | Core Lab-6 | 0 | 2 | 0 | 50 | 0 | 50 | 2 |
| 8 | SEC-121 | Moocs/ Swayam | SEC-3 | | | 2 | 25 | 0 | 25 | 1 |
| 9 | SEC-123 | NCC/USR | SEC-4 | | | 2 | 25 | 0 | 25 | 1 |
| | | **TOTAL** | | **15** | **2** | **12** | | | **550** | **23** |
| L-Lecture, T-Tutorials, P-Practical (Labs), IA-Internal Assessment (Class Test, Assignments, Tutorials etc.), EA-External Assessment, NC- Non Credit Course, ECC-Extra Curricular Courses | | | | | | | | | | |

**B.Sc. (PCM)**
**Semester: III**

| S. No. | Course Code | Course Name | Course Category | Periods | | | Evaluation Scheme | | | Credit |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | IA | EA | Total | |
| 1 | | Computer skills | AECC-3 | 3 | 0 | 0 | 15 | 35 | 50 | 3 |
| 2 | BSPH-231 | Electromagnetic Theory & Modern Optics | Core Theory-7 | 4 | 0 | 0 | 25 | 75 | 100 | 4 |
| 3 | BSCH-231 | Chemical Dynamics & Coordination Chemistry | Core Theory-8 | 4 | 0 | 0 | 25 | 75 | 100 | 4 |
| 4 | BSMT-231 | Algebra & Mathematical Methods | Core Theory-9 | 4 | 0 | 0 | 25 | 75 | 100 | 4 |
| 5 | BSPH-231P | Demonstrative Aspects of Electricity & Magnetism | Core Lab-7 | 0 | 0 | 4 | 20 | 30 | 50 | 2 |
| 6 | BSCH-231P | Physical Analysis | Core Lab-8 | 0 | 0 | 4 | 20 | 30 | 50 | 2 |
| 7 | BSMT-231T | Algebra & Mathematical Methods tutorial | Core Lab-9 | 0 | 2 | 0 | 50 | 0 | 50 | 2 |
| 8 | SEC-231 | Moocs/ Swayam | SEC-5 | | | 2 | 25 | 0 | 25 | 1 |
| 9 | SEC-232 | NCC/USR | SEC-6 | | | 2 | 25 | 0 | 25 | 1 |
| 10 | | From any Department | GE-2* | 6 | | | 25 | 75 | 100 | 6 |
| | | **TOTAL** | | **21** | **2** | **12** | | | **650** | **29** |

L-Lecture, T-Tutorials, P-Practical (Labs), IA-Internal Assessment (Class Test, Assignments, Tutorials etc.), EA-External Assessmen

**Note:** Generic Elective Course (GE) is depend upon the Department which offeres the credit and it may be 4/5/6.

**B.Sc. (PCM)**
**Semester: IV**

| S. No. | Course Code | Course Name | Course Category | Periods | | | Evaluation Scheme | | | Credit |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | IA | EA | Total | |
| 1 | | Leadership Managemant | AECC-4 | 3 | 0 | 0 | 15 | 35 | 50 | 3 |
| 2 | BSPH-241 | Perspectives of Modern Physics & Modern Optics | Core Theory-10 | 4 | 0 | 0 | 25 | 75 | 100 | 4 |
| 3 | BSCH-241 | Quantum Mechanics and Analytical Techniques | Core Theory-11 | 4 | 0 | 0 | 25 | 75 | 100 | 4 |
| 4 | BSMT-241 | Differential Equation & Mechanics | Core Theory-12 | 4 | 0 | 0 | 25 | 75 | 100 | 4 |
| 5 | BSPH-241P | Basic Electronics Instrumentation | Core Lab-10 | 0 | 0 | 4 | 20 | 30 | 50 | 2 |
| 6 | BSCH-241P | Instrumental Analysis | Core Lab-11 | 0 | 0 | 4 | 20 | 30 | 50 | 2 |
| 7 | BSMT-241T | Differential Equation & Mechanics Tutorial | Core Lab-12 | 0 | 2 | 0 | 50 | 0 | 50 | 2 |
| 8 | UVE-401 | Universal Human Values | AECC | 3 | 0 | 0 | 15 | 35 | 50 | 3 |
| 9 | SEC-241 | Moocs/ Swayam | SEC-7 | | | 2 | 25 | 0 | 25 | 1 |
| 10 | SEC-242 | NCC/USR | SEC-8 | | | 2 | 25 | 0 | 25 | 1 |
| | | **TOTAL** | | **18** | **2** | **12** | | | **600** | **26** |

L-Lecture, T-Tutorials, P-Practical (Labs), IA-Internal Assessment (Class Test, Assignments, Tutorials etc.), EA-External Assessment

***Note: Universal Human Values Course is mandatory to all the students. 50 Marks (15 Marks Internal Assessment & 35 Marks External Assessment). May be added in III/IV/VI Semester. It will be the choice to select this paper in any one semester as mentioned above.**

| B.Sc. (PCM)<br>Semester: V | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **S. No.** | **Course Code** | **Course Name** | **Course Category** | **Periods** | | | **Evaluation Scheme** | | | **Credit** |
| | | | | **L** | **T** | **P** | **IA** | **EA** | **Total** | |
| 1 | BSPH-351 | Classical & Statistical Mechanics | Core Theory (Physics) | 4 | 0 | 0 | 25 | 75 | 100 | 4 |
| | BSPH-352 | Quantum Mechanicsand Spectroscopy | | | | | | | | |
| | BSPH-351P | Demonstrative Aspects of Optics and Laser | Core Lab (Physics) | 0 | 0 | 4 | 20 | 30 | 50 | 2 |
| 2 | BSCH-351 | Organic Synthesis-A | DSE Theory (Chemistry) | 4 | 0 | 0 | 25 | 75 | 100 | 4 |
| | BSCH-352 | Rearrangements and Chemistry of Group Elements | | | | | | | | |
| | BSCH-351P | Qualitative analysis | DSE Lab (Chemistry) | 0 | 0 | 4 | 20 | 30 | 50 | 2 |
| 3 | BSMT-351 | Group, ring theory and linear algebra | Core Theory (Maths) | 4 | 0 | 0 | 25 | 75 | 100 | 4 |
| | BSMT-352 | Number Theory and Cryptography & Discrete Mathematics | | | | | | | | |
| | BSMT-351T | Group, ring theory and linear algebra tutorial | Core Lab (Maths) | 0 | 2 | 0 | 50 | 0 | 50 | 2 |
| | BSMT-352T | Number Theory and Cryptography & Discrete Mathematics Tutorial | | | | | | | | |
| 4 | SEC-351 | Moocs/ Swayam | SEC-9 | | | 2 | 25 | 0 | 25 | 1 |
| 5 | SEC-352 | NCC/USR | SEC-10 | | | 2 | 25 | 0 | 25 | 1 |
| 6 | RP-001 | | Research Project | | | 4 | 50 | 0 | 50 | |
| | | **TOTAL** | | **12** | **2** | **16** | | | **550** | **20** |
| L-Lecture, T-Tutorials, P-Practical (Labs), IA-Internal Assessment (Class Test, Assignments, Tutorials etc.), EA-External Assessment | | | | | | | | | | |

| B.Sc. (PCM)<br>Semester: VI | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **S. No.** | **Course Code** | **Course Name** | **Course Category** | **Periods** | | | **Evaluation Scheme** | | | **Credit** |
| | | | | **L** | **T** | **P** | **IA** | **EA** | **Total** | |
| 1 | BSPH-361 | Solid State & Nuclear Physics | Core Theory (Physics) | 4 | 0 | 0 | 25 | 75 | 100 | 4 |
| | BSPH-362 | Anlog & Digital Priniciples and applicatios | | | | | | | | |
| | BSPH-361P | Anlog & Digital Circuits | Core Lab (Physics) | 2 | 0 | 0 | 20 | 30 | 50 | 2 |
| 2 | BSCH-361 | Organic Synthesis-B | Core Theory (Chemistry) | 4 | 0 | 0 | 25 | 75 | 100 | 4 |
| | BSCH-362 | Chemical Energetics and Radiochemistry | | | | | | | | |
| | BSCH-361P | Analytical Methods | Core Lab (Chemistry) | 0 | 0 | 4 | 20 | 30 | 50 | 2 |
| 3 | BSMT-361 | Metric Space & Complex Analysis | DSE Theory (Maths) | 4 | 0 | 0 | 25 | 75 | 100 | 4 |
| | BSMT-362 | Numerical Analysis & Operations Research | | | | | | | | |
| | BSMT-362P | Numerical Analysis & Operations Research Lab | DSE Lab (Maths) | 0 | 2 | 0 | 20 | 30 | 50 | 2 |
| 4 | SEC-361 | Moocs/ Swayam | SEC-11 | | | 2 | 25 | 0 | 25 | 1 |
| 5 | SEC-362 | NCC/USR | SEC-12 | | | 2 | 25 | 0 | 25 | 1 |
| 6 | RP-002 | | Research Project | | | 4 | 50 | 0 | 50 | |
| | | **TOTAL** | | **8** | **2** | **12** | | | **550** | **22** |
| L-Lecture, T-Tutorials, P-Practical (Labs), IA-Internal Assessment (Class Test, Assignments, Tutorials etc.) | | | | | | | | | | |

| B.Sc. (PCM)<br>Semester: I | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| S. No. | Course Code | Course Name | Course Category | Periods | | | Evaluation Scheme | | | Credit |
| | | | | L | T | P | IA | EA | Total | |
| 1 | NHU-112/122 | Environmental Studies | AECC-1 | 3 | 0 | 0 | 15 | 35 | 50 | 3 |
| 2 | BSPH-111 | Mathematical Physics & Newtonian Mechanics | Core Theory-1 | 4 | 0 | 0 | 25 | 75 | 100 | 4 |
| 3 | BSCH-111 | Fundamentals of Chemistry | Core Theory-2 | 4 | 0 | 0 | 25 | 75 | 100 | 4 |
| 4 | BSMT-111 | Differential Calculus and Integral Calculus | Core Theory-3 | 4 | 0 | 0 | 25 | 75 | 100 | 4 |
| 5 | BSPH-111P | Mechanical Properties of Matter | Core Lab-1 | 0 | 0 | 4 | 20 | 30 | 50 | 2 |
| 6 | BSCH-111P | Quantitative Analysis | Core Lab-2 | 0 | 0 | 4 | 20 | 30 | 50 | 2 |
| 7 | BSMT-111P | Differential Calculus and Integral Calculus Tutorial | Core Lab-3 | 0 | 0 | 4 | 20 | 30 | 50 | 2 |
| 8 | SEC-111 | Moocs/ Swayam | SEC-1 | | | 2 | 25 | 0 | 25 | 1 |
| 9 | SEC-112 | NCC/USR | SEC-2 | | | 2 | 25 | 0 | 25 | 1 |
| 10 | | From any Department | GE-1* | 6 | | | 25 | 75 | 100 | 6 |
| | | **TOTAL** | | **21** | **0** | **16** | | | **650** | **29** |
| L-Lecture, T-Tutorials, P-Practical (Labs), IA-Internal Assessment (Class Test, Assignments, Tutorials etc.), EA-External Assessment | | | | | | | | | | |
| Note: Generic Elective Course (GE) is depend upon the Department which offeres the credit and it may be 4/5/6. | | | | | | | | | | |

IIMT UNIVERSITY
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Transforming Education System, Transforming Lives

UGC Approved
Section 2f & 12B

| B.Sc. (PCM)<br>Semester: II | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **S. No.** | **Course Code** | **Course Name** | **Course Category** | **Periods** | | | **Evaluation Scheme** | | | **Credit** |
| | | | | **L** | **T** | **P** | **IA** | **EA** | **Total** | |
| 1 | NHU-111/121 | English | AECC-2 | 3 | 0 | 0 | 15 | 35 | 50 | 3 |
| 2 | BSPH-121 | Thermal Physics & Semiconductor Devices | Core Theory-4 | 4 | 0 | 0 | 25 | 75 | 100 | 4 |
| 3 | BSCH-121 | Bioorganic and Medicinal | Core Theory-5 | 4 | 0 | 0 | 25 | 75 | 100 | 4 |
| 4 | BSMT-121 | Matrices and Differential Equations & Geometry | Core Theory-6 | 4 | 0 | 0 | 25 | 75 | 100 | 4 |
| 5 | BSPH-121P | Thermal Properties of Matter & Electronic Circuits | Core Lab-4 | 0 | 0 | 4 | 20 | 30 | 50 | 2 |
| 6 | BSCH-121P | Biochemical Analysis | Core Lab-5 | 0 | 0 | 4 | 20 | 30 | 50 | 2 |
| 7 | BSMT-121T | Matrices and Differential Equations & Geometry Tutorial | Core Lab-6 | 0 | 2 | 0 | 50 | 0 | 50 | 2 |
| 8 | SEC-121 | Moocs/ Swayam | SEC-3 | | | 2 | 25 | 0 | 25 | 1 |
| 9 | SEC-123 | NCC/USR | SEC-4 | | | 2 | 25 | 0 | 25 | 1 |
| | | **TOTAL** | | **15** | **2** | **12** | | | **550** | **23** |
| L-Lecture, T-Tutorials, P-Practical (Labs), IA-Internal Assessment (Class Test, Assignments, Tutorials etc.), EA-External Assessment, NC- Non Credit Course, ECC-Extra Curricular Courses | | | | | | | | | | |

| B.Sc. (PCM)<br>Semester: III | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **S. No.** | **Course Code** | **Course Name** | **Course Category** | **Periods** | | | **Evaluation Scheme** | | | **Credit** |
| | | | | **L** | **T** | **P** | **IA** | **EA** | **Total** | |
| 1 | | Computer skills | AECC-3 | 3 | 0 | 0 | 15 | 35 | 50 | 3 |
| 2 | BSPH-231 | Electromagnetic Theory & Modern Optics | Core Theory-7 | 4 | 0 | 0 | 25 | 75 | 100 | 4 |
| 3 | BSCH-231 | Chemical Dynamics & Coordination Chemistry | Core Theory-8 | 4 | 0 | 0 | 25 | 75 | 100 | 4 |
| 4 | BSMT-231 | Algebra & Mathematical Methods | Core Theory-9 | 4 | 0 | 0 | 25 | 75 | 100 | 4 |
| 5 | BSPH-231P | Demonstrative Aspects of Electricity & Magnetism | Core Lab-7 | 0 | 0 | 4 | 20 | 30 | 50 | 2 |
| 6 | BSCH-231P | Physical Analysis | Core Lab-8 | 0 | 0 | 4 | 20 | 30 | 50 | 2 |
| 7 | BSMT-231T | Algebra & Mathematical Methods tutorial | Core Lab-9 | 0 | 2 | 0 | 50 | 0 | 50 | 2 |
| 8 | SEC-231 | Moocs/ Swayam | SEC-5 | | | 2 | 25 | 0 | 25 | 1 |
| 9 | SEC-232 | NCC/USR | SEC-6 | | | 2 | 25 | 0 | 25 | 1 |
| 10 | | From any Department | GE-2* | 6 | | | 25 | 75 | 100 | 6 |
| | | **TOTAL** | | **21** | **2** | **12** | | | **650** | **29** |
| L-Lecture, T-Tutorials, P-Practical (Labs), IA-Internal Assessment (Class Test, Assignments, Tutorials etc.), EA-External Assessmen | | | | | | | | | | |
| **Note:** Generic Elective Course (GE) is depend upon the Department which offeres the credit and it may be 4/5/6. | | | | | | | | | | |

| B.Sc. (PCM)<br>Semester: IV | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **S. No.** | **Course Code** | **Course Name** | **Course Category** | **Periods** | | | **Evaluation Scheme** | | | **Credit** |
| | | | | **L** | **T** | **P** | **IA** | **EA** | **Total** | |
| 1 | | Leadership Managemant | AECC-4 | 3 | 0 | 0 | 15 | 35 | 50 | 3 |
| 2 | BSPH-241 | Perspectives of Modern Physics & Modern Optics | Core Theory-10 | 4 | 0 | 0 | 25 | 75 | 100 | 4 |
| 3 | BSCH-241 | Quantum Mechanics and Analytical Techniques | Core Theory-11 | 4 | 0 | 0 | 25 | 75 | 100 | 4 |
| 4 | BSMT-241 | Differential Equation & Mechanics | Core Theory-12 | 4 | 0 | 0 | 25 | 75 | 100 | 4 |
| 5 | BSPH-241P | Basic Electronics Instrumentation | Core Lab-10 | 0 | 0 | 4 | 20 | 30 | 50 | 2 |
| 6 | BSCH-241P | Instrumental Analysis | Core Lab-11 | 0 | 0 | 4 | 20 | 30 | 50 | 2 |
| 7 | BSMT-241T | Differential Equation & Mechanics Tutorial | Core Lab-12 | 0 | 2 | 0 | 50 | 0 | 50 | 2 |
| 8 | UVE-401 | Universal Human Values | AECC | 3 | 0 | 0 | 15 | 35 | 50 | 3 |
| 9 | SEC-241 | Moocs/ Swayam | SEC-7 | | | 2 | 25 | 0 | 25 | 1 |
| 10 | SEC-242 | NCC/USR | SEC-8 | | | 2 | 25 | 0 | 25 | 1 |
| | | **TOTAL** | | **18** | **2** | **12** | | | **600** | **26** |
| L-Lecture, T-Tutorials, P-Practical (Labs), IA-Internal Assessment (Class Test, Assignments, Tutorials etc.), EA-External Assessment | | | | | | | | | | |
| ***Note: Universal Human Values Course is mandatory to all the students. 50 Marks (15 Marks Internal Assessment & 35 Marks External Assessment). May be added in III/IV/VI Semester. It will be the choice to select this paper in any one semester as mentioned above.** | | | | | | | | | | |

**B.Sc. (PCM)**
**Semester: V**

| S. No. | Course Code | Course Name | Course Category | Periods | | | Evaluation Scheme | | | Credit |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | IA | EA | Total | |
| 1 | BSPH-351 | Classical & Statistical Mechanics | Core Theory (Physics) | 4 | 0 | 0 | 25 | 75 | 100 | 4 |
| | BSPH-352 | Quantum Mechanicsand Spectroscopy | | | | | | | | |
| | BSPH-351P | Demonstrative Aspects of Optics and Laser | Core Lab (Physics) | 0 | 0 | 4 | 20 | 30 | 50 | 2 |
| 2 | BSCH-351 | Organic Synthesis-A | DSE Theory (Chemistry) | 4 | 0 | 0 | 25 | 75 | 100 | 4 |
| | BSCH-352 | Rearrangements and Chemistry of Group Elements | | | | | | | | |
| | BSCH-351P | Qualitative analysis | DSE Lab (Chemistry) | 0 | 0 | 4 | 20 | 30 | 50 | 2 |
| 3 | BSMT-351 | Group, ring theory and linear algebra | Core Theory (Maths) | 4 | 0 | 0 | 25 | 75 | 100 | 4 |
| | BSMT-352 | Number Theory and Cryptography & Discrete Mathematics | | | | | | | | |
| | BSMT-351T | Group, ring theory and linear algebra tutorial | Core Lab (Maths) | 0 | 2 | 0 | 50 | 0 | 50 | 2 |
| | BSMT-352T | Number Theory and Cryptography & Discrete Mathematics Tutorial | | | | | | | | |
| 4 | SEC-351 | Moocs/ Swayam | SEC-9 | | | 2 | 25 | 0 | 25 | 1 |
| 5 | SEC-352 | NCC/USR | SEC-10 | | | 2 | 25 | 0 | 25 | 1 |
| 6 | RP-001 | | Research Project | | | 4 | 50 | 0 | 50 | |
| | | **TOTAL** | | **12** | **2** | **16** | | | **550** | **20** |

L-Lecture, T-Tutorials, P-Practical (Labs), IA-Internal Assessment (Class Test, Assignments, Tutorials etc.), EA-External Assessment

## B.Sc. (PCM)
## Semester: VI

| S. No. | Course Code | Course Name | Course Category | Periods | | | Evaluation Scheme | | | Credit |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | IA | EA | Total | |
| 1 | BSPH-361 | Solid State & Nuclear Physics | Core Theory (Physics) | 4 | 0 | 0 | 25 | 75 | 100 | 4 |
| | BSPH-362 | Anlog & Digital Prinicipiles and applicatios | | | | | | | | |
| | BSPH-361P | Anlog & Digital Circuits | Core Lab (Physics) | 2 | 0 | 0 | 20 | 30 | 50 | 2 |
| 2 | BSCH-361 | Organic Synthesis-B | Core Theory (Chemistry) | 4 | 0 | 0 | 25 | 75 | 100 | 4 |
| | BSCH-362 | Chemical Energetics and Radiochemistry | | | | | | | | |
| | BSCH-361P | Analytical Methods | Core Lab (Chemistry) | 0 | 0 | 4 | 20 | 30 | 50 | 2 |
| 3 | BSMT-361 | Metric Space & Complex Analysis | DSE Theory (Maths) | 4 | 0 | 0 | 25 | 75 | 100 | 4 |
| | BSMT-362 | Numerical Analysis & Operations Research | | | | | | | | |
| | BSMT-362P | Numerical Analysis & Operations Research Lab | DSE Lab (Maths) | 0 | 2 | 0 | 20 | 30 | 50 | 2 |
| 4 | SEC-361 | Moocs/ Swayam | SEC-11 | | | 2 | 25 | 0 | 25 | 1 |
| 5 | SEC-362 | NCC/USR | SEC-12 | | | 2 | 25 | 0 | 25 | 1 |
| 6 | RP-002 | | Research Project | | | 4 | 50 | 0 | 50 | |
| | | **TOTAL** | | **8** | **2** | **12** | | | **550** | **22** |

L-Lecture, T-Tutorials, P-Practical (Labs), IA-Internal Assessment (Class Test, Assignments, Tutorials etc.)

# FORMAT – 1

**Format-1**

## IIMTU-NEP IMPLEMENTATION
## CBCS: Statement of Credit distribution

| | |
|---|---|
| College/School: School of Basic Sciences & Technology<br>Programme: B.Sc.(PCM/PSM)<br>Duration:3 Years Annual/Semester: Semester | Credit range: 132-144<br>(suggested by<br>CBCS Committee) |

***Attached guidelines to be followed:***

| | | Sem. | Core Course/ Foundation Course Th (6 cr) or | Ability Enhancement Compulsory Course (AECC) | Skill Enhancment Course (SEC) | Discipline Specific Elective (DSE) | Generic Elective (GE) (From other Faculty) | Research Project (RP) | Prerequisite |
|---|---|---|---|---|---|---|---|---|---|
| Course Names as per UGC | Cr. | Sample | C-1 (4 Credit)+ P-1 (2 Credit)/T-1 (1 Cr.) FC-1 (3 Credit) 3/4/5/**6** Cr. | AECC-1 (Credit) **3** Cr./Each | SEC-1 (Credit) **2** Cr./Each | DSE-1 (Credit) 3 or 4/5/**6** Cr. | GE-1 (Credit) 3 or 4/5/6 Cr. **4 Cr./6 Cr.** | Industry Training/ Internship Survey (**4**Cr.) | |
| Course Names as per Higher Education (HE) | | | MAJOR-1 4/5/6 Cr. | Vocational 3 Cr. | Co-Curricular 2 Cr. | MAJOR-2 4/5/6 Cr. | MAJOR-3 4/5/6 Cr. | 4 Cr. | |
| Decided Credits for implementation | | | 6 Cr. | 3 Cr. | 2 Cr. | 6 Cr. | 4/6 Cr. | 4 Cr. | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Certificate (46) | 46 + 6 Cr. | I | C1: Chem./Stats.(Th. 4 Cr. + P 2Cr.) C2: Phy. (Th. 4 Cr. + P 2Cr.) C3: Math. (Th. 4 Cr. + P 2Cr.) | AECC-1 EVS. | SEC-1 NPTEL/USR | | GE1 (Mandatory) (6 Cr.) | | |
| | | II | C4: Chem./Stats. (Th. 4 Cr. + P 2Cr.) C5: Math. (Th. 4 Cr. + T 2Cr.) C6:Phy. (Th. 4 Cr. + P 2Cr.) | AECC-2 Eng. English Communication | SEC-2 NPTEL/USR | | | | |
| **Provision to change the stream** | | | | | | | | | |
| Diploma (92)<br><br>**Note:**6 Cr. More in semester I and Semster III | 46 + 6 Cr | III | C7: Chem./Stats. (Th. 4 Cr. + P 2Cr.) C8: Phy. (Th. 4 Cr. + P 2Cr.) C9: Math. (Th. 4 Cr. + T 2Cr.) | AECC-3 Computer Skills. | SEC-3 NPTEL/USR | | GE2 (Mandatory) (6 Cr.) NCC | | |
| | | IV | C10: Chem/Stats (Th. 4 Cr. + P 2Cr.) C11: Math (Th. 4 Cr. + T 2Cr.) C12:Phy. (Th. 4 Cr. + P 2Cr.) | AECC-4 Leadership Management. | SEC-4 NPTEL/USR | | | | |

| Provision to change the Core Papers (Main Subject) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| UG (132) | 40<br>. | V | C13: Phys (Th. 4 Cr. + P 2Cr.)<br>C14: Math (Th. 4 Cr. + T 2Cr.) | | SEC-5 NPTEL/USR | DSE1: Chem./Stats. (Th. 4 Cr. + P 2Cr.) | GE3 (Optional) (3/4/5/6 Cr.) | RP1 (NC audit): Seminar1 | |
| | | VI | C15: Chem/Stat (Th.4 Cr. + P 2Cr.)<br>C16 Phys (Th. 4 Cr. + P 2Cr.) | | SEC-6 NPTEL/USR | DSE2: Math. (Th. 4 Cr. + P 2Cr.) | | RP2 (NC audit): Seminar2 | |

**Note:**

**1.** 6 extra credit in semester I.

**2.** 6 extra credit in semester III.

**Therefore 12 extra credits add the end of semester VI.**

# FORMAT – 2

Format-2

## IIMTU-NEP Implementation: Exit Points.

| Programme | Year | Semester (15 weeks) | Paper | Credit | Periods per Week | Periods (Hours) per Semester | Paper Title | Unit (Periods per semester) | Prerequisite | Elective (For other faculty) |
|---|---|---|---|---|---|---|---|---|---|---|
| CERTIFICATE COURSES ------------- B.Sc.(PCM/PSM) | FIRST YEAR | SEMESTER -I | i) C1: Chem./Stats. (Th.4 Cr.+ P1 Cr.2)<br>ii) AECC-1: EVS.<br>iii) SEC-1: NPTEL/USR<br>iv) C2: Phy. (Th. 4 Cr.+P 2Cr.)<br>v) C3: Math.(Th.4 Cr.+ P2Cr).<br>vi) GE1(Mandatory) (6 Cr.) | 6<br>3<br>2<br>6<br>6<br>6 | 4+4<br>2+1<br>4<br>4+4<br>4+4<br>6 | 120<br>45<br>60<br>120<br>120<br>90 | C1:Fundamentals of Chemistry /Descriptive Statistics (Univariate) and Theory of Probability<br>C2: Newtonian Mechanics & Wave Motion<br>C3: Differential Calculus & Integral Calculus | C1:8(60)/ 8(60)<br>C2:8(60)<br>C3: 8(60) | 12th in PCM | C1:Yes/Yes<br>C2: Yes<br>C3: Yes |
| | | | **Total Credit/Periods per week/hours per semester** | **29** | **38** | **555** | | | | |
| | | SEMESTER - II | i) C4: Chem./Stats. (Th. 4 Cr. + P 2Cr.)<br>ii) AECC-2: English Communication<br>iii) SEC-2: NPTEL/USR<br>iv) C5: Math.(Th. 4 Cr. + T 2Cr.)<br>v) C6: Phy.(Th. 4Cr.+P 2Cr.) | 6<br>3<br>2<br>6<br>6 | 4+4<br>2+1<br>4<br>4+2<br>4+4 | 120<br>45<br>60<br>120<br>90 | C4:Bioorganic and Medicinal Chemistry /Descriptive Statistics (Bivariate) and Probability Distributions<br>C5: Matrices and Differential Equations& Geometry<br>C6: Thermal Physics & Semiconductor Devices | C4:8(60)/ 8(60)<br>C5:8(60)<br>C6: 8(60) | C4: Chemistry in 12th /Math. in12th<br>C5: 12th Mathematics, basic of calculus.<br>C6: Physics and Mathematics in 12th | C4:Yes/Yes<br>C5:Yes<br>C6: Yes |
| | | | **Total Credit/Periods per week/hours per semester** | **23** | **29** | **435** | | | | |

| Programme Outcome: | Programme Specific Outcome: |
| --- | --- |
| $PO_1$: Development of Scientific Temperament<br><br>$PO_2$: Core Competency<br><br>$PO_3$: Critical Thinking<br><br>$PO_4$: Digital Literacy<br><br><br>$PO_{5:}$ Employability | $PSO_1$: To impart proper knowledge of science and technology related to subjects to the graduates.<br>$PSO_2$: To enhance the skills of the graduates with the ability to implement the scientific concepts as per the societal need.<br>$PSO_{3:}$ To prepare the graduates to understand physical system and processes to address social and scientific challenges.<br>$PSO_{4:}$ To enhance the employability of graduates in various sectors both in public and private in addition to enhancing self-employability and entrepreneurship characteristics. |

| Programme | Year | Semester (15 weeks) | Paper | Credit | Periods per Week | Periods (Hours) per Semester | Paper Title | Unit (Periods per semester) | Prerequisite | Elective (For other faculty) |
|---|---|---|---|---|---|---|---|---|---|---|
| DIPLOMA COURSE (92 Credits) ------------ | SECOND YEAR | SEMESTER -III | i) C7: Chem./Stats. (Th. 4 Cr. + P 2Cr.)<br>ii) AECC-3 Computer Skill<br>iii) SEC-3: NPTEL/USR<br>iv) C8:Phy. (Th. 4 Cr. + P 2Cr.)<br>v) GE2(Mandatory): | 6<br>3<br>2<br>6<br>6 | 4+4<br>2+1<br>4<br>4+4<br>6 | 120<br>45<br>60<br>120<br>90 | C7:Chemical Dynamics & Coordination Chemistry/Theory of Estimation and Sampling Survey<br>C8: Electromagnetic Theory & Modern Optics<br>C9: Algebra & Mathematical Methods | C7:8(60)/ 8(60)<br>C8:8(60)<br>C9: 8(60) | C7: Basic Knowledge of Chem. In preceding sem. / Basic Knowledge of Stats. In preceding sem.<br>C8: Certificate course in Math<br>C9:12th Certificate course in Math. | C7:Yes/No<br>C8:Yes<br>C9: Yes |
| | | | v) C9: Math.(Th. 4 Cr.+T 2Cr.) | 6 | 4+2 | 90 | | | | |
| | | | **Total Credit/Periods per week/hours per semester** | **29** | **35** | **525** | | | | |
| | | SEMESTER – IV | i) C10: Chem./Stats. (Th. 4 Cr. + P 2Cr.)<br>ii) AECC-4 Leadership Management<br>iii) SEC4: NPTEL/USR<br>iv) C11: Math (Th. 4 Cr. + T 2Cr.) | 6<br>3<br>2<br>6 | 4+4<br>2+1<br>4<br>4+2 | 120<br>30<br>60<br>120 | C10:Quantum Mechanics and Analytical Techniques /Testing of Hypothesis and Applied Statistics<br>C11: Differential Equations & Mechanics | C10:8(60)/ 8(60)<br>C11:8(60) | C10: Basic Knowledge of Chem. In preceding sem. / Basic Knowledge of Stats. In preceding sem.<br>C11: Certificate course in Math. | C10:Yes/Yes<br>C11: Yes |
| | | | iv) C12: Phy. (Th. 4 Cr. + P 2Cr.) | 6 | 4+4 | 90 | C12: Perspectives of Modern Physics & Basic Electronics | C12: 8(60) | C12 Certificate course in Phy. | C12:Yes |
| | | | **Total Credit/Periods per week/hours per semester** | **23** | **29** | **420** | | | | |

| **Programme Outcome:** | **Programme Specific Outcome:** |
|---|---|
| $PO_1$: Development of Scientific Temperament | $PSO_1$: To impart proper knowledge of science and technology related to subjects to the graduates. |
| $PO_2$: Core Competency | $PSO_2$: To enhance the skills of the graduates with the ability to implement the scientific concepts as per the societal need. |
| $PO_3$: Critical Thinking | |
| $PO_4$: Digital Literacy | $PSO_{3:}$ To prepare the graduates to understand physical system and processes to address social and scientific challenges. |
| $PO_{5:}$ Employability | $PSO_{4:}$ To enhance the employability of graduates in various sectors both in public and private in addition to enhancing self-employability and entrepreneurship characteristics. |

| Programme | Year | Semester (15 weeks) | Paper | Credit | Periods per Week | Periods (Hours) per Semester | Paper Title | Unit (Periods per semester) | Prerequisite | Elective (For other faculty) |
|---|---|---|---|---|---|---|---|---|---|---|
| UNDER GRADUATE DEGREE (132 Credits) | THIRD YEAR | SEMESTER –V | i) SEC5: NPTEL/USR<br>ii) DSE1: Chem./Stats. (Th. 4 Cr. + P 2Cr.)<br>iii) C13: Phy. (Th. 4 Cr. + P 2Cr.)<br>iv)C14: Math. (Th. 4 Cr. + T 2Cr.)<br>v) RP1 (NC-audit): Seminar1 | 2<br>6<br>6<br>6 | 4<br>4+4<br>4+4<br>4+2 | 60<br>120<br>120<br>90 | **DSE1**:i) Organic Synthesis A<br>ii) Rearrangements and Chemistry of group elements<br>/i) Multivariate Analysis and Non-parametric Methods<br>ii): Analysis of Variance and Design of Experiment<br>**C13**: i) Classical & Statistical Mechanics<br>ii) Quantum Mechanics & Spectroscopy<br>**C14**: i) Group and Ring Theory & Linear Algebra<br>ii) Number Theory and Cryptography & Discrete Mathematics | **DSE1**<br>i):8(60)/ 8(60)<br>ii) 8(60)/8(60)<br>**C13**:i)8(60)<br>ii) 8(60)<br>**C14**: i) 8(60)<br>ii)8(60) | **DSE1**:i) Basic Knowledge of Chem. In preceding sem. / Basic Knowledge of Stats. In preceding sem.<br>ii): Basic Knowledge of Chem. In preceding sem. / Basic Knowledge of Stats. In preceding sem.<br>**C13**: i) Diploma in Phy.<br>ii) Diploma in Phy.<br>**C14**: i) Diploma in Math.<br>ii) Diploma in Math. | DSE1:i)Yes/ No<br>ii) Yes/Yes<br>**C13**:i)Yes<br>ii) Yes<br>**C14**:i)Yes<br>ii) Yes |
| | | | | | | | | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | **Total Credit/Periods per week/hours per sem** | **20** | **26** | **390** | | | | |
| | | SEMESTER - VI | i) SEC6: NPTEL/USR<br>ii) C15: Chem./Stats. (Th. 4 Cr. + P 2Cr.)<br>iii)C16: Phy. (Th. 4 Cr. + P 2Cr.)<br>iv)DSE2: Math. (Th. 4 Cr. + T 2Cr.)<br>v) RP2(NC-audit): Seminar2 | 2<br>6<br>6<br>6 | 4<br>4+4<br>4+4<br>4+2 | 60<br>120<br>120<br>120 | **C15**:i) Organic Synthesis B<br>ii) Chemical Energetic & Radio Chemistry<br>/i) Statistical Computing and Introduction to Statistical Software<br>ii): Operations Research<br>**C16**: i) Solid State & Nuclear Physics<br>ii) Analog & Digital Principles & Applications<br>**DSE2: i**) Metric Spaces & Complex Analysis<br>ii) Numerical Analysis & Operations Research | **C15**:i):8(60)/ 8(60)<br>ii) 8(60)/8(60)<br>**C16**: :i)8(60)<br>ii) 8(60)<br>**DSE2**: :i)8(60)<br>ii) 8(60) | **C15**:i) Basic Knowledge of Chem. In preceding sem. / Basic Knowledge of Stats. In preceding sem.<br>ii): Basic Knowledge of Chem. In preceding sem. / Basic Knowledge of Stats. In preceding sem.<br>**C16**: i) Diploma in Phy.<br>ii) Diploma in Phy.<br>**DSE2**: i) Diploma in Math.<br>ii) Diploma in Math. | **C15**:i) Yes/ Yes<br>ii) Yes/Yes<br>**C16**: i)Yes<br>ii) Yes<br>DSE2: i)Yes<br>ii) Yes |
| | | | | | | | | | | |
| | | | **Total Credit/Periods per week/hours per semester** | **20** | **28** | **420** | | | | |

*Research Topic may be selected from any one of 02 core papers.

| **Programme Outcome:** | **Programme Specific Outcome:** |
|---|---|
| $PO_1$: Development of Scientific Temperament | $PSO_1$: To impart proper knowledge of science and technology related to subjects to the graduates. |
| $PO_2$: Core Competency | $PSO_2$: To enhance the skills of the graduates with the ability to implement the scientific concepts as per the societal need. |
| $PO_3$: Critical Thinking | $PSO_{3:}$ To prepare the graduates to understand physical system and processes to address social and scientific challenges. |
| $PO_4$: Digital Literacy | $PSO_{4:}$ To enhance the employability of graduates in various sectors both in public and private in addition to enhancing self-employability and entrepreneurship characteristics. |
| $PO_{5:}$ Employability | |

**Legends:** Th = Theory, P = Practical, T = Tutorial.

# FORMAT–3

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: I / Semester: I**

<table>
<tr><td colspan="2">Programme: Certificate/Diploma/Degree/ UG(R)/PG/Ph.D.<br>Class: B.Sc. (PCM/PSM)</td><td colspan="2">Year: I<br><br>Semester: I</td></tr>
<tr><td colspan="2">Credits: 04<br>Theory: 04<br>Practical:</td><td colspan="2">Subject: Physics</td></tr>
<tr><td colspan="2">Course Code:BSPH-111</td><td colspan="2">Title: Mathematical Physics & Newtonian Mechanics</td></tr>
<tr><td colspan="4">Course Objectives:<br>The purpose of the undergraduate Physics program at the university level is to provide the key knowledge of the fact of science understanding of the law of physics and laboratory resources to prepare students for careers as professionals in various industries and research in situations.</td></tr>
<tr><td colspan="4">Nature of Paper: Core</td></tr>
<tr><td colspan="4">Minimum Passing Marks/Credits:40% Marks</td></tr>
<tr><td colspan="4">L: 04<br>T: 00<br>P: 00(In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)</td></tr>
<tr><td>Unit</td><td colspan="2">Contents</td><td>No. of Lectures Allotted</td></tr>
<tr><td colspan="4">Part A: Basic Mathematical Physics</td></tr>
<tr><td>I</td><td colspan="2">Introduction to Indian ancient Physics and contribution of Indian Physicists, in context with the holistic development of modern science and technology, should be included under Continuous Internal Evaluation (CIE).<br>Vector Algebra:<br>Basis for defining scalars, vectors, Component form in 2D. Geometrical and physical interpretation of addition, subtraction, dot product, cross product and triple product of vectors. Position.</td><td>09</td></tr>
<tr><td>II</td><td colspan="2">Geometrical and physical interpretation of vector differentiation, Gradient, Divergence and Curl and their significance. Vector integration, Line, Surface (flux) and Volume integrals of vector fields. Gauss-divergence theorem, Stoke-curl theorem.</td><td>08</td></tr>
<tr><td>III</td><td colspan="2">Coordinate Systems:<br>2D & 3D Cartesian, coordinate systems, basis vectors, transformation equations. Expressions for displacement vector. Components of velocity and acceleration in different coordinate systems. Examples of non-inertial coordinate system.</td><td>07</td></tr>
<tr><td>IV</td><td colspan="2">Introduction to Tensors:<br>Principle of invariance of physical laws w.r.t. different coordinate systems as the basis for defining tensors. Symmetric and skew</td><td>06</td></tr>
</table>

| | | |
|---|---|---|
| | symmetric tensors. Invariant tensors. | |
| | **PART B : Newtonian Mechanics & Wave Motion** | |
| V | **Dynamics of a System of Particles:** Review of historical development of mechanics up to Newton. Dynamics of a system of particles, centre of mass motion, and conservation laws & their deductions. Rotating frames of reference, general derivation of origin of pseudo forces (centrifugal) in rotating frame | **08** |
| VI | **Dynamics of a Rigid Body:** Angular momentum, Torque, Rotational energy. Rotational inertia for simple bodies (ring, disk, rod, solid and hollow sphere). The combined translational and rotational motion of a rigid body on horizontal and inclined planes. Elasticity, relations between elastic constants. | **08** |
| VII | **Motion of Planets & Satellites:** Two particle central force problem, reduced mass, relative and centre of mass motion. Newton's law of gravitation, gravitational field and gravitational potential. Kepler's laws of planetary motion | **06** |
| VIII | **Wave Motion:** Differential equation of simple harmonic motion and its solution, damped and forced oscillations, Quality factor. Composition of simple harmonic motion, Lissajous figures. Differential equation of wave motion. Plane progressive waves in fluid media, reflection of waves and phase change, pressure and energy distribution. Principle of superposition of waves, stationary waves, phase and group velocity. | **08** |

**Reference / Text Books:**

**PART A**


1. Murray Spiegel, Seymour Lipschutz, Dennis Spellman, "Schaum's Outline Series: Vector Analysis", McGraw Hill, 2017
2. Shanti Narayan, P.K. Mittal, "A Text Book of Vector Analysis", S. Chand Publishing, 2010
3. Shanti Narayan, P.K. Mittal, "A Text Book of Vector Calculus", S. Chand Publishing, 1987


**PART B**


1. Charles Kittel, Walter D. Knight, Malvin A. Ruderman, Carl A. Helmholz, Burton J. Moyer, "Mechanics (In SI Units): Berkeley Physics Course Vol 1", McGraw Hill, 2017
2. Richard P. Feynman, Robert B. Leighton, Matthew Sands, "The Feynman Lectures on Physics - Vol. 1", Pearson Education Limited, 2012
3. Hugh D. Young and Roger A. Freedman, "Sears & Zemansky's University Physics with Modern Physics", Pearson Education Limited, 2017
4. D.S. Mathur, P.S. Hemne, "Mechanics", S. Chand Publishing, 1981


If the course is available as Generic Elective then the students of following departments may opt it.

1. Yes Open to all

| Evaluation/Assessment Methodology | |
|---|---|
| | **Max. Marks** |
| 1. Class tasks/ Sessional Examination<br>2. Assignments<br>3. ESE | 10 + 10<br>5<br>75 |
| **Total:** | **100** |
| Prerequisites for the course: Physics and Mathematics in 12th | |

**Course Learning Outcomes:**

- Recognize the difference between scalars, vectors, pseudo-scalars and pseudo-vectors.
- Understand the physical interpretation of gradient, divergence and curl.
- Comprehend the difference and connection between Cartesian, spherical and cylindrical coordinate systems.
- Know the meaning of 4-vectors, Kronecker delta and Epsilon (Levi Civita) tensors.
- Study the origin of pseudo forces in rotating frame.
- Study the response of the classical systems to external forces and their elastic deformation.
- Understand the dynamics of planetary motion and the working of Global Positioning System (GPS).
- Comprehend the different features of Simple Harmonic Motion (SHM) and wave propagation.

**IIMTU-NEP IMPLEMENTATION**
**Year: I / Semester: I**

| | |
|---|---|
| **Programme: Certificate/Diploma/Degree/ UG(R)/PG/Ph.D.**<br>**Class: B.Sc (PCM/PSM)** | **Year: I**<br><br>**Semester: I** |
| **Credits: 02**<br>**Theory:**<br>**Practical:02** | **Subject: Physics** |
| **Course Code:BSPH-111P** | **Title: Mechanical Properties of Matter** |

**Course Objectives:**
The purpose of the undergraduate Physics program at the university level is to provide the key knowledge of the fact of science understanding of the law of physics and laboratory resources to prepare students for careers as professionals in various industries and research institutions.

Nature of Paper: **Core**

**Minimum Passing Marks/Credits: 50% Marks**

L: 00
T: 00
P: 04 (In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| | **Lab Experiment List** | |
| I | 1. Moment of inertia of a flywheel<br>2. Moment of inertia of an irregular body by inertia table.<br>3. Modulus of rigidity by statistical method (Barton's apparatus).<br>4. Modulus of rigidity by dynamical method (sphere / disc / Maxwell's needle)<br>5. Young's modulus by bending of beam.<br>6. Young's modulus and Poisson's ratio by Searle's method.<br>7. Poisson's ratio of rubber by rubber tubing.<br>8. Surface tension of water by capillary rise method.<br>9. Surface tension of water by Jaeger's method.<br>10. Coefficient of viscosity of water by Poiseuille's method.<br>11. Acceleration due to gravity by bar pendulum.<br>12. Frequency of AC mains by Sonometer<br>13. Height of a building by Sextant.<br>14. Study the wave form of an electrically maintained tuning fork / alternating current source with the help of cathode ray oscilloscope. | **20** |

**Reference / Text Books:**

**PART A**

1. Murray Spiegel, Seymour Lipschutz, Dennis Spellman, "Schaum's Outline Series: Vector Analysis", McGraw Hill, 2017
2. Shanti Narayan, P.K. Mittal, "A Text Book of Vector Analysis", S. Chand Publishing, 2010
3. Shanti Narayan, P.K. Mittal, "A Text Book of Vector Calculus", S. Chand Publishing, 1987

**PART B**

1. Charles Kittel, Walter D. Knight, Malvin A. Ruderman, Carl A. Helmholz, Burton J. Moyer, "Mechanics (In SI Units): Berkeley Physics Course Vol 1", McGraw Hill, 2017
2. Richard P. Feynman, Robert B. Leighton, Matthew Sands, "The Feynman Lectures on Physics - Vol. 1", Pearson Education Limited, 2012
3. Hugh D. Young and Roger A. Freedman, "Sears & Zemansky's University Physics with Modern Physics", Pearson Education Limited, 2017
4. D.S. Mathur, P.S. Hemne, "Mechanics", S. Chand Publishing, 1981

If the course is available as Generic Elective then the students of following departments may opt it.

1. Yes Botany/Chem./Comp. Sc./Maths/Stat./Zool.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1. Record File | 15 |
| 2. Viva Voce | 5 |
| 3. Class Interaction | 10 |
| **Total:** | **30** |

Prerequisites for the course:

- The course can be opted by Botany / Chemistry / Computer Science / Mathematics / Statistics / Zoology
- **PREREQUISITE:** Opted / Passed Semester I, Theory Paper-1 (**BSPH-111P**)

**Course Learning Outcomes:**

- Experimental physics has the most striking impact on the industry wherever the instruments are used to determine the mechanical properties.
- Measurement precision and perfection is achieved through Lab Experiments.
- Online Virtual Lab Experiments give an insight in simulation techniques and provide a basis for modeling.

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: I / Semester: I**

| | |
|---|---|
| **Programme: Certificate/Diploma/Degree/ UG(R)/PG/Ph.D.<br>Class:B.Sc. (PCM/PSM)** | **Year: I**<br><br>**Semester: I** |
| **Credits 04<br>Theory: 04<br>Practical:** | **Subject: Mathematics** |
| **Course Code: BSMT-111** | **Title: Differential Calculus & Integral Calculus** |

**Course Objectives:**

1. The primary objective of this course is to gain proficiency in differential calculus, and introduce the basic tools of matrices and complex numbers which are used to solve application problems in a variety of settings ranging from chemistry and physics to business and economics.
2. Differential calculus develops the concepts of limit, continuity and derivative, and is fundamental for many fields of mathematics.

**Nature of Paper:** Core

**Minimum Passing Marks/Credits : 40% Marks**

L: 4
T:
P: (In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- Hrs.= Credit (Hrs./Week=Credits)

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | **Indian Ancient Mathematics and Mathematicians**<br>Definition of a sequence, theorems on limits of sequences, bounded and monotonic sequences, Cauchy's convergence criterion, limit superior and limit inferior of a sequence, subsequence, Series of non-negative terms, convergence and divergence, Comparison tests, tests for convergence, alternating series, absolute and conditional convergence. | 9 |
| II | Limit, continuity and differentiability of function of single variable, Cauchy's definition, Uniform continuity, Borel's theorem, boundedness theorem, Bolzano's theorem, Intermediate value theorem, extreme value theorem, Chain rule, indeterminate forms. | 7 |
| III | Rolle's theorem, Mean value theorems, mean value theorems of higher order, Taylor's theorem with variousforms of remainders, Maclaurin's and Taylor's series, Partial differentiation, Euler'stheorem on homogeneous function. | 7 |
| IV | Tangent and normals, Asymptotes, Curvature, Tests for concavity and convexity, Points of inflexion, Multiple points, Parametric representation of curves, Tracing of curves in Cartesian and Polar forms. | 7 |

| | | |
|---|---|---|
| V | Definite integrals as limit of the sum, Riemann integral, Integrability of continuous and monotonic functions, Fundamental theorem of integral calculus, Mean value theorems of integral calculus, Differentiation under the sign of Integration. | 9 |
| VI | Improper integrals, convergence tests, Beta and Gamma functions. | 7 |
| VII | Volumes and Surfaces of Solid of revolution, Multiple integrals, change of order of double integration, Dirichlet's theorem, Liouville's theorem for multiple integrals. | 7 |
| VIII | Vector Differentiation, Gradient, Divergence and Curl, Directional Derivative, Vector Integration, Theorems ofGauss, Green, Stokes and related problems. | 7 |

**Reference / Text Books:**

1. R.G. Bartle & D.R. Sherbert, Introduction to Real Analysis, John Wiley & Sons
2. T.M. Apostal, Calculus Vol. I, John Wiley & Sons Inc.
3. S. Balachandra Rao & C. K. Shantha, Differential Calculus, New Age Publication.
4. H. Anton, I. Birens and S. Davis, Calculus, John Wiley and Sons, Inc.,2002.
5. G.B. Thomas and R.L. Finney, Calculus, Pearson Education,2007.
6. Suggestive digital platforms web links: NPTEL/SWAYAM/MOOCS.
7. Course Books (text/reference) published in Hindi may be prescribed by the Universities.

**Suggested Readings (Part-B Integral Calculus):**

1. T.M. Apostal, Calculus Vol. II, John Wiley Publication
2. Shanti Narayan & Dr. P.K. Mittal, Integral Calculus, S. Chand
3. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons.
4. Suggestive digital platforms web links: NPTEL/SWAYAM/MOOCS/MOOCS Based Approach. Narosa Publishing Comp. New Delhi.

If the course is available as Generic Elective, then the students of following departments may opt it.

1. Engg. and Tech. (UG)
2. Chemistry/Biochemistry/Life Sciences (UG)
3. Economics (UG/PG),
4. Commerce (UG),
5. BBA
6. BCA
7. B.Sc. (C.S.)

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 10 |
| 2) Presentations /Seminar | 5 |
| 3) Assignments | 5 |
| 4) Research Project Report<br>Seminar On Research Project Report | 5 |
| 5) ESE | **75** |
| **Total:** | **100** |

Prerequisites for the course: $12^{th}$ Mathematics

**Course Learning Outcomes:**

**CO1:** The programme outcome is to give foundation knowledge for the students to understand basics of mathematics including applied aspect for developing enhanced quantitative skills and pursuing higher mathematics and research as well.

**CO2:** By the time students complete the course they will have wide ranging application of the subject and have the knowledge of real valued functions such as sequence and series. They will also be able to know about convergence of sequence and series. Also, they have knowledge about curvature, envelope and evolutes and trace curve in polar, Cartesian as well as parametric curves.

**CO3:** The main objective of the course is to equip the student with necessary analytic and technical skills. By applying the principles of integral he learns to solve a variety of practical problems in science and engineering.

**CO4:** The student is equipped with standard concepts and tools at an intermediate to advance level that will serve him well towards taking more advanced level course in mathematics.

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year : I / Semester : I**

| | |
|---|---|
| **Programme:** **Certificate/Diploma/Degree/ UG(R)/PG/Ph.D.** **Class:B.Sc. (PCM)** | **Year: I** **Semester : I** |
| **Credits: 04** **Theory: 04** **Practical:** | **Subject: Chemistry** |
| **Course Code:BSCH-111** | **Title: Fundamentals of Chemistry** |

**Course Objectives:**

1. Molecular geometries, physical and chemical properties of the molecules.
2. The chapter Recapitulation of basics of organic chemistry gives the most primary and utmost important knowledge and concepts of organic Chemistry.
3. It describes the types of reactions and the Kinetic and thermodynamic aspects one should know for carrying out any reaction and the ways how the reaction mechanism can be determined.
4. This course gives a broader theoretical picture in multiple stages in an overall chemical reaction. It describes reactive intermediates, transition states and states of all the bonds broken and formed .It enables to understand the reactants, catalyst, steriochemistry and major and minor products of any organic reaction.
5. The chapters Steriochemistry gives the clear picture of two-dimensional and three-dimensional structure of the molecules, and their role in reaction mechanism.

Nature of Paper: **Core**

**Minimum Passing Marks/Credits: 40% Marks**

L: 4
T:
P: (In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits)

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | **Molecular polarity and Weak Chemical Forces:** Fajan's rules and consequences of polarization. Hydrogen bonding, van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interaction. Effects of weak chemical forces, melting and boiling points, solubility, energetics of dissolution process. Lattice energy and Borrn-Haber cycle, solvation energy, and solubility of ionic solids. | 10 |
| II | **Simple Bonding theories of Molecules:** Atomic orbitals, Aufbau principle, multiple bonding ($\sigma$ and $\pi$ bond approach) and bond lengths, the valence bond theory (VBT), Concept of hybridization, hybrid orbitals and molecular geometry, Bent's rule, Valence shell electron pair repulsion theory (VSEPR),. Molecular orbital theory (MOT). Molecular orbital diagrams, bond orders of homonuclear and heteronuclear diatomic molecules and ions ($N_2$,$O_2$,C2,$B_2$,$F_2$,CO, NO, | 10 |

| | | |
|---|---|---|
| | and their ions) | |
| III | **Periodic properties of Atoms (with reference to s & p-block):** Brief discussion, factors affecting and variation trends of following properties in groups and periods. Effective nuclear charge, shielding or screening effect, Slater rules, Atomic and ionic radii, Electronegativity, Pauling's/ Allred Rochow's scales, Ionization enthalpy, Electron gain enthalpy. | 05 |
| IV | **Recapitulation of basics of Organic Chemistry:** Hybridization, bond engths and bond angles, bond energy, hyperconjugation, Dipole moment; Electronic Displacements: Inductive, electromeric, resonance mesomeric effects and their applications. | 05 |
| V | **Mechanism of Organic Reactions:** Homolytic and heterolytic bond fission, Types of reagents – electrophiles and nucleophiles, Types of organic reactions, Energy considerations. Reactive intermediates Carbocations, carbanions, free radicals, carbenes, arynes and nitrenes (with examples). | 10 |
| VI | **Steriochemistry:** Concept of isomerism, Types of isomerism; Optical isomerism – elements of symmetry, molecular chirality, enantiomers, stereogenic center, optical activity, properties of enantiomers, chiral and achiral molecules with two stereogenic centers, disasteromers, threo and erythrodiastereomers, meso compounds, resolution of enantionmer, inversion, retention and recemization. Relative and absolute configuration, sequence rules, D & L and R & S systems of nomenclature. Geometric isomerism – determination of configuration of geometric isomers, E & Z system of nomenclature, geometric isomerism in oximes and alicyclic compounds. Conformational isomerism – conformational analysis of ethane and n-butane; conformations of cyclohexane, projection and Sawhorse formulae, Fischer and flying wedge formulae. | 10 |
| VII | **Basic Computer system (in brief):** Hard ware and Software; Input devices, Storage devices, Output devices, Central Processing Unit (Control Unitand Arithmetic Logic Unit); Numbersystem(Binary, Octal and Hexadecimal Operating System); Computer Codes (BCD and ASCII)**;** Numeric/String constants and variables. Operating Systems (DOS, WINDOWS, and Linux); Software languages: Low level and High Level languages (Machine language, Assembly language; QBASIC, FORTRAN and C++); Software Products (Office, chem. sketch, scilab, matlab, hyperchem, etc.), internet application. | 05 |
| VIII | **Mathematical Concepts for Chemistry:** Logarithmic relations, curve sketching, linear graphs and calculation of slopes, differentiation of functions like Kx, $e^x$, $X^n$ , sin x, log x; maxima and minima, partial differentiation and reciprocity relations, Integration of some useful/relevant functions; permutations and combinations, Factorials, Probability. | 05 |

**Reference / Text Books:**

1. Lee, J.D. Concise Inorganic Chemistry, Pearson Education2010
2. Huheey, J.E., Keiter, E.A., Keiter, R. L., Medhi, O.K. Inorganic Chemistry, Principles

of Structure and Reactivity, Pearson Education 2006.
3. Douglas, B.E. and Mc Daniel, D.H., Concepts & Models of Inorganic Chemistry, Oxford,1970
4. Shriver, D.D. & P. Atkins, *Inorganic Chemistry 2nd Ed.,* Oxford University Press,1994.
5. Day, M.C. and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications1962.
6. Singh J., Yadav L.D.S., Advanced Organic Chemistry, Pragati Edition
7. Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
8. Carey, F. A., Guiliano, R. M. *Organic Chemistry*, Eighth edition, McGraw Hill Education, 2012.
9. Loudon, G. M. *Organic Chemistry*, Fourth edition, Oxford University Press, 2008.
10. Clayden, J., Greeves, N. & Warren, S. *Organic Chemistry,* 2$^{nd}$ edition, Oxford University Press, 2012.
11. Graham Solomons, T.W., Fryhle, C. B. *Organic Chemistry,* John Wiley & Sons, Inc.
12. Sykes, P. *A guidebook to Mechanism in Organic Chemistry,* Pearson Education,2003
13. Francis, P. G.Mathematics for Chemists, Springer,1984

If the course is available as Generic Elective then the students of following departments may opt it.
1. B. Tech.
2. Diploma
3. B. Pharm.
4. D. Pharm.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 10+10 |
| 2) Assignments | 5 |
| 3) ESE | 75 |
| **Total:** | **100** |

Prerequisites for the course: PCM in 12$^{th}$

**Course Learning Outcomes:**

- Students will understand the concept of various molecular geometries and their affects in physical and chemical properties of the molecules.
- Students will be able to understand the various types of organic intermediates & transition states and its mechanistic importance in organic chemistry.
- Students will be able to understand Stereochemistry of the two and three-dimensional organic molecules and their role in reaction mechanisms.
- Students will be able to understand the basics of information technology and Mathematical tools needed in chemistry.

Format-3

**IIMTU-NEP IMPLEMENTATION**
Year : **I** / Semester : **I**

| | |
|---|---|
| **Programme:**<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>Class : **B.Sc (PCM)** | Year : **I**<br><br>Semester : **I** |
| **Credits: 02**<br>Theory:<br>Practical: 02 | Subject : **Chemistry** |
| **Course Code: BSCH-111P** | Title: **Quantitative Analysis** |
| **Course Objectives:**<br>Upon completion of this course the student will have the knowledge and skills to: understand the laboratory methods and tests related to estimation of metals ions and estimation of acids and alkali contents in commercial products. | |
| Nature of Paper: **Core** | |
| **Minimum Passing Marks/Credits: 50% Marks** | |
| L:<br>T:<br>P: 4 (In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits) | |

| Unit | Contents | Lecture |
|---|---|---|
| I | **Water Quality analysis**<br>1. Estimation of hardness of water by EDTA.<br>2. Determination of chemical oxygen demand (COD).<br>3. Determination of Biological oxygen demand (BOD). | 16 |
| II | **Estimation of Metals ions**<br>1. Estimation of ferrous and ferric by dichromate method.<br>2. Estimation of copper using thiosulphate. | 14 |
| III | **Estimation of acids and alkali contents**<br>1. Determination of acetic acid in commercial vinegar using NaOH.<br>2. Determination of alkali content – antacid tablet using HCl.<br>3. Estimation of oxalic acid by titrating it with $KMnO_4$. | 14 |
| IV | **Estimation of inorganic salts and hydrated water**<br>1. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.<br>2. Estimation of calcium content in chalk as calcium oxalate by permanganometry.<br>3. Estimation of water of crystallization in Mohr's salt by titrating with KMnO4. | 16 |

**Reference / Text Books:**

1. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
2. Harris, D. C. Quantitative Chemical Analysis. 6th Ed., Freeman (2007) Chapters3-5.
3. Harris, D.C. *Exploring Chemical Analysis*, 9th Ed. New York, W.H. Freeman, 2016.
4. Khopkar, S.M. *Basic Concepts of Analytical Chemistry*. New Age International Publisher, 2009.
5. Skoog, D.A. Holler F.J. and Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Edition

If the course is available as Generic Elective then the students of following departments may opt it.

1. B. Tech.
2. Diploma
3. B. Pharm.
4. D. Pharm.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 10 |
| 2) Assignments | 10 |
| 3) ESE | 30 |
| **Total:** | **50** |

Prerequisites for the course: PCM in $12^{th}$

**Course Learning Outcomes:**

1. Potability tests of water samples.
2. Estimation of metal ions in samples
3. Estimation of alkali and acid contents in samples
4. Estimation of inorganic salts and hydrated water in samples

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: I / Semester: I**

<table>
<tr><td colspan="2">Programme:<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>Class : B.Sc. (PCM/PSM)</td><td colspan="2">Year : I<br><br>Semester :I</td></tr>
<tr><td colspan="2">Credits: 03<br>Theory:03<br>Practical:</td><td colspan="2">Subject : Environment and ecology</td></tr>
<tr><td colspan="2">Course Code:NHU-112</td><td colspan="2">Title: Environment and ecology</td></tr>
<tr><td colspan="4">Course Objectives:<br>1. To understand the factors affecting ecosystem.<br>2. To provide knowledge of bio-geochemical and sedimentary cycles and its importance.<br>3. To understand about population and community ecology.</td></tr>
<tr><td colspan="4">Nature of Paper: Core</td></tr>
<tr><td colspan="4">Minimum Passing Marks/Credits: 40% Marks</td></tr>
<tr><td colspan="4">L: 3<br>T:<br>P:(In Hours/Week)<br>Theory - 3 Hr. = 3 Credit<br>Practical- 0</td></tr>
<tr><th>Unit</th><th colspan="2">Contents</th><th>No. of Lectures Allotted</th></tr>
<tr><td>I</td><td colspan="2">Introduction to environmental studies<br>Multidisciplinary nature of environmental studies;<br>Scope and importance; Concept of sustainability and sustainable development.</td><td>12</td></tr>
<tr><td>II</td><td colspan="2">Ecosystems<br>What is an ecosystem? Structure and function of ecosystem; Energy flow in an ecosystem: food chains, food webs and ecological succession. Case studies of the following ecosystems:<br>Forest ecosystem<br>Grassland ecosystem<br>Desert ecosystem<br>Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)</td><td>11</td></tr>
<tr><td>III</td><td colspan="2">Natural Resources: Renewable and Non---renewable Resources<br>Land resources and landuse change; Land degradation, soil erosion and desertification.<br>Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations.<br>Water: Use and over---exploitation of surface and ground water, floods, droughts, conflicts over water (international & interstate).<br>Energy resources: Renewable and non-renewable energy sources, use of alternate energy sources, growing energy needs, case</td><td>11</td></tr>
</table>

| | | |
|---|---|---|
| | studies. | |
| IV | **Biodiversity and Conservation**<br>Levels of biological diversity: genetic, species and ecosystem diversity; Biogeographic zones of India; Biodiversity patterns and global biodiversity hot spots<br>India as a mega---biodiversity nation; Endangered and endemic species of India<br>Threats to biodiversity: Habitat loss, poaching of wildlife, man---wildlife conflicts, biological invasions; Conservation of biodiversity: In---situ and Ex---situ conservation of biodiversity.<br>Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value. | 11 |
| V | **Environmental Pollution**<br>Environmental pollution: types, causes, effects and controls; Air, water, soil and noise pollution<br>Nuclear hazards and human health risks<br>Solid waste management: Control measures of urban and industrial waste.<br>Pollution case studies. | 12 |
| VI | **Environmental Policies & Practices**<br>Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture<br>Environment Laws: Environment Protection Act; Air (Prevention & Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act. International agreements: Montreal and Kyoto protocols and Convention on Biological Diversity (CBD).<br>Nature reserves, tribal populations and rights, and human wildlife conflicts in Indian context. | 11 |
| VII | **Human Communities and the Environment**<br>Human population growth: Impacts on environment, human health and welfare.<br>Resettlement and rehabilitation of project affected persons; case studies.<br>Disaster management: floods, earthquake, cyclones and landslides.<br>Environmental movements: Chipko, Silent valley, Bishnois of Rajasthan.<br>Environmental ethics: Role of Indian and other religions and cultures in environmental conservation.<br>Environmental communication and public awareness, case studies (e.g., CNG vehicles in Delhi). | 11 |
| If the course is available as Generic Elective then the students of following departments may opt it.<br>1. Engg. and Tech. (UG),<br>2. B.Sc.(C.S.) | | |

| Evaluation/Assessment Methodology | |
|---|---|
| | **Max. Marks** |
| 1) Class tasks/ Sessional Examination | 10 |
| 2) Presentations /Seminar | 0 |
| 3) Assignments | 5 |
| 4) Research Project Report<br>Seminar On Research Project Report | 0 |
| 5) ESE | **35** |
| **Total:** | 50 |
| Prerequisites for the course: $12^{th}$ | |
| **Course Learning Outcomes:** | |
| The course will enable the students to gather in-depth knowledge on the basic concepts of ecology. | |

**IIMTU-NEP IMPLEMENTATION**
**Year: I / Semester: II**

| | |
|---|---|
| Programme: Certificate/Diploma/Degree/ UG(R)/PG/Ph.D.<br>Class : **B.Sc (PCM/PSM)** | Year: **I**<br><br>Semester: **II** |
| Credits: **04**<br>Theory:**04**<br>Practical: | Subject: **Physics** |
| Course Code: **BSPH-121** | Title: **Thermal Physics & Semiconductor Devices** |

**Course Objectives:**
The purpose of the undergraduate Physics program at the university level is to provide the key knowledge of the fact of science understanding of the law of physics and laboratory resources to prepare students for careers as professionals in various industries and research institutions.

Nature of Paper: **Core**

Minimum Passing Marks/Credits: **40% Marks**

L: 04
T: 00
P: 0 (In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| | **Part A: Thermodynamics & Kinetic Theory of Gases** | |
| I | **0th & 1st Law of Thermodynamics:**<br>State functions and terminology of thermodynamics. Zeroth law and temperature. First law, internal energy, heat and work done. Work done in various thermodynamically processes. Enthalpy, relation between CP and CV. Carnot's engine, efficiency and Carnot's theorem. | **09** |
| II | **2nd & 3rd Law of Thermodynamics:**<br>Different statements of second law, Clausius inequality, entropy and its physical significance. Entropy changes in various thermo-dynamical processes. Third law of thermodynamics and unattainability of absolute zero. Thermo-dynamical potentials, Maxwell's Relations | **08** |
| III | **Kinetic Theory of Gases:**<br>Kinetic model and deduction of gas laws. Derivation of Maxwell's law of distribution of velocities and its experimental verification. Degrees of freedom, law of equipartition of energy (no derivation) and its application to specific heat of gases (mono and di atomic). | **07** |
| IV | **Theory of Radiation:**<br>Blackbody radiation, spectral distribution, concept of energy | **06** |

| | | |
|---|---|---|
| | density. Derivation of Planck's law, deduction of Wien's distribution law, Rayleigh-Jeans law, Stefan- Boltzmann law and Wien's displacement law from Planck's law. | |
| | **PART B: Circuit Fundamentals & Semiconductor Devices** | |
| V | **DC & AC Circuits:**<br>Growth and decay of currents in RL circuit. Charging and discharging of capacitor in RC, LC and RCL circuits. AC Bridges - measurement of inductance (Maxwell's, Owen's and Anderson's bridges) and measurement of capacitance (Schering's, Wein's and de Sauty's bridges). | **08** |
| VI | **Semiconductors & Diodes:**<br>P and N type semiconductors, qualitative idea of Fermi level. Formation of depletion layer in PN junction diode, field & potential at the depletion layer. Qualitative idea of current flow mechanism in forward & reverse biased diode. Diode fabrication. PN junction diode and its characteristics, static and dynamic resistance. Principle, structure, characteristics and applications of Zener, Tunnel, Light Emitting, Photo diodes. Half and Full wave rectifiers, calculation of ripple factor, rectification efficiency and voltage regulation. | **08** |
| VII | **Transistors:**<br>Bipolar Junction PNP and NPN transistors. Study of CB, CE & CC configurations w.r.t. characteristics; active, cutoff & saturation regions; current gains & relations between them | **06** |
| VIII | **Electronic Instrumentation:**<br>Multimeter: Principles of measurement of dc voltage, dc current, ac voltage, ac current and resistance. Cathode Ray Oscilloscope: Block diagram of basic CRO. Applications of CRO to study the waveform and measurement of voltage, current, frequency & phase difference. | **08** |

**Suggested Readings:**

**PART A**

1. M.W. Zemansky, R. Dittman, "Heat and Thermodynamics", McGraw Hill, 1997, 7e.
2. F.W. Sears, G.L. Salinger, "Thermodynamics, Kinetic theory & Statistical thermodynamics", Narosa Publishing House, 1998.
3. Enrico Fermi, "Thermodynamics", Dover Publications, 1956.
4. S. Garg, R. Bansal, C. Ghosh, "Thermal Physics", McGraw Hill, 2012, 2e.
5. Meghnad Saha, B.N. Srivastava, "A Treatise on Heat", Indian Press, 1973, 5e.

**PART B**

1. R.L. Boylestad, L. Nashelsky, "Electronic Devices and Circuit Theory", Prentice-Hall of India Pvt. Ltd., 2015, 11e.
2. J. Millman, C.C. Halkias, Satyabrata Jit, "Electronic Devices and Circuits", McGraw Hill, 2015, 4e
3. B.G. Streetman, S.K. Banerjee, "Solid State Electronic Devices", Pearson Education India, 2015, 7e
4. J.D. Ryder, "Electronic Fundamentals and Applications", Prentice-Hall of India Private Limited, 1975, 5e.
5. A. Sudhakar, S.S. Palli, "Circuits and Networks: Analysis and Synthesis", McGraw

| | |
|---|---|
| Hill, 2015, 5e.<br>6. S.L. Gupta, V. Kumar, "Hand Book of Electronics", Pragati Prakashan, Meerut, 2016, 43e | |
| If the course is available as Generic Elective then the students of following departments may opt it.<br>1. Yes open to all | |
| **Evaluation/Assessment Methodology** | |
| | **Max. Marks** |
| 1. Class tasks/ Sessional Examination<br>2. Assignments<br>3. ESE | 10 + 10<br>5<br>75 |
| **Total:** | **100** |
| Prerequisites for the course: Physics and Mathematics in 12th | |

**Course Learning Outcomes:**

- Recognize the difference between reversible and irreversible processes.
- Understand the physical significance of thermo-dynamical potentials.
- Comprehend the kinetic model of gases w.r.t. various gas laws.
- Study the implementations and limitations of fundamental radiation laws.
- Utility of AC bridges.
- Recognize the basic components of electronic devices.
- Design simple electronic circuits.
- Understand the applications of various electronic instruments.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: I / Semester: II**

| | |
|---|---|
| Programme: Certificate/Diploma/ Degree/ UG(R)/PG/Ph.D.<br>Class:**B.Sc (PCM/PSM)** | Year: **I**<br><br>Semester: **II** |
| Credits: **02**<br>Theory:<br>Practical:**02** | Subject: **Physics** |
| Course Code: **BSPH-121P** | Title: **Thermal Properties of Matter & Electronic Circuits** |

**Course Objectives:**
The purpose of the undergraduate Physics program at the university level is to provide the key knowledge of the fact of science understanding of the law of physics and laboratory resources to prepare students for careers as professionals in various industries and research institutions.

Nature of Paper: **Core**

**Minimum Passing Marks/Credits: 50% Marks**

L: 0
T: 00
P: 04 (In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| | **Lab Experiment List** | |
| | 1. Mechanical Equivalent of Heat by Callender and Barne's method.<br>2. Coefficient of thermal conductivity of copper by Searle's apparatus.<br>3. Coefficient of thermal conductivity of rubber.<br>4. Coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method.<br>5. Value of Stefan's constant.<br>6. Verification of Stefan's law.<br>7. Variation of thermo-emf across two junctions of a thermocouple with temperature.<br>8. Temperature coefficient of resistance by Platinum resistance thermometer<br>9. Charging and discharging in RC and RCL circuits.<br>10. A.C. Bridges: Various experiments based on measurement of L and C.<br>11. Resonance in series and parallel RCL circuit.<br>12. Characteristics of PN Junction, Zener, Tunnel, Light Emitting and Photo diode.<br>13. Characteristics of a transistor (PNP and NPN) in CE, CB and | **20** |

| | | |
|---|---|---|
| | CC configurations.<br>14. Half wave & full wave rectifiers and Filter circuits.<br>15. Unregulated and Regulated power supply.<br>16. Various measurements with Cathode Ray Oscilloscope (CRO) | |

**Suggested Readings:**


1. B.L. Worsnop, H.T. Flint, "Advanced Practical Physics for Students", Methuen & Co., Ltd., London, 1962, 9e
2. S. Panigrahi, B. Mallick, "Engineering Practical Physics", Cengage Learning India Pvt. Ltd., 2015, 1e
3. R.L. Boylestad, L. Nashelsky, "Electronic Devices and Circuit Theory", Prentice-Hall of India Pvt. Ltd., 2015, 11eA.
4. Sudhakar, S.S. Palli, "Circuits and Networks: Analysis and Synthesis", McGraw Hill, 2015, 5e


**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1. Record File | 15 |
| 2. Viva Voce | 5 |
| 3. Class Interaction | 10 |
| **Total:** | **30** |

Prerequisites for the course:

- The course can be opted by Botany / Chemistry / Computer Science / Mathematics / Statistics / Zoology
- **PREREQUISITE:** Opted / Passed Semester I, Theory Paper-1 (**BSPH-121**)

**Course Learning Outcomes:**

**Course outcomes:**

- Experimental physics has the most striking impact on the industry wherever the instruments are used to study and determine the thermal and electronic properties.
- Measurement precision and perfection is achieved through Lab Experiments.
- Online Virtual Lab Experiments give an insight in simulation techniques and provide a basis for modeling.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: I / Semester: II**

| | |
|---|---|
| **Programme: Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. Class:B.Sc. (PCM/PSM)** | **Year: I**<br><br>**Semester: II** |
| **Credits: 06**<br>**Theory: 06**<br>**Practical:** | **Subject: Mathematics** |
| **Course Code:BSMT-121** | **Title:** Matrices and Differential Equations& Geometry |

**Course Objectives:**

1. The primary objective of this course is to gain proficiency in matrix and differential equations and Geometry and introduce the basic tools of matrices and differential equations which are used to solve application problems in a variety of settings ranging from chemistry and physics to business and economics.
2. Matrix, Differential Equations and Geometry develops the concepts of numerical ability and problem-solving attitude and is fundamental for many fields of mathematics.

**Nature of Paper:** Core

**Minimum Passing Marks/Credits:40% Marks**

L: 6
T:
P:(In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical-

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | Rank of a Matrix, Echelon and Normal form of a Matrix, Inverse of a Matrix by elementary operations, System of linear homogeneous and non-homogeneous equations, Theorems on consistency of a system of linear equations. | 12 |
| II | Eigen values, Eigen vectors and characteristic equation of a matrix, Caley-Hamilton theorem and its use in finding inverse of a matrix. Complex functions and separation into real and imaginary parts, Exponential and Logarithmic functions Inverse trigonometric and hyperbolic functions. | 11 |
| III | Formation of differential equations, Geometrical meaning of a differential equation, Equation of first order and first degree, Equation in which the variables are separable, Homogeneous equations, Exact differential equations and equations reducible to the exact form, Linear equations. | 11 |
| IV | First order higher degree equations solvable for $x, y, p$, Clairaut's equation and singular solutions, orthogonal trajectories, Lineardifferential equation of order greater than one with constant coefficients, Cauchy- Euler form. | 11 |

| | | |
|---|---|---|
| V | General equation of second degree, System of conics, Tracing of conics, Polar equation of conics and its properties. | 12 |
| VI | Three-Dimensional Coordinates, Projection and Direction Cosine, Plane (Cartesian and vector form), Straight line in three dimension(Cartesian and vector form). | 11 |
| VII | Sphere, Cone and Cylinder. | 11 |
| VIII | Central conicoids, Paraboloids, Plane section of conicoids, Generating lines, Reduction of second degree equations. | 11 |

**Suggested Readings: (PART-A Matrices and Differential Equations):**

1. Stephen H. Friedberg, A.J Insel & L.E. Spence, Linear Algebra, Person
2. B. Rai, D.P. Choudhary & H. J. Freedman, A Course in Differential Equations, Narosa
3. D.A. Murray, Introductory Course in Differential Equations, Orient Longman
4. Suggested digital plateform: NPTEL / SWAYAM / MOOCs
5. Course Books published in Hindi may be prescribed by the Universities.

**Suggested Readings (Part-B Geometry):**

1. Robert J.T Bell, Elementary Treatise on Coordinate Geometry of three dimensions, Macmillan India Ltd.
2. P.R. Vittal, Analytical Geometry 2d&3D, Pearson.
3. S.L. Loney, The Elements of Coordinate Geometry, Mc.Millan and Company, London.
4. R.J.T. Bill, Elementary Treatise on Coordinate Geometry of Three Dimensions, McMillan India Ltd., 1994.
5. Suggested digital plateform: NPTEL / SWAYAM / MOOCs

If the course is available as Generic Elective then the students of following departments may opt it.

1. Engg. and Tech. (UG),
2. B.Sc. (C.S.)

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 10 |
| 2) Presentations /Seminar | 5 |
| 3) Assignments | 5 |
| 4) Research Project Report/Seminar On Research Project Report | 5 |
| 5) ESE | **75** |
| **Total:** | 100 |

Prerequisites for the course: $12^{th}$ Mathematics

**Course Learning Outcomes:**

CO1: The subjects of the course are designed in such a way that they focus on developing mathematical skills in algebra, calculus and analysis and give ij depth knowledge of geometry, calculus, algebra and other theories.

CO2: The student will be able to find the rank, eigen values of matrices and study the linear homogeneous and non-homogeneous equations. The course i1 differential equation intends to develop problem solving skills for solving various types of differential equation and geometrical meaning of differentia equation.

CO3: The subjects learn and visualize the fundamental ideas about coordinate geometry and learn to describe some of the surface by using analytical geometry.

CO4: On successful completions of the course students have gained knowledge about regular geometrical figures and their properties. They have the foundation for higher course in Geometry.

**IIMTU-NEP IMPLEMENTATION**
**Year: I / Semester: II**

<table>
<tr><td colspan="2">Programme:<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>Class:B.Sc (PCM)</td><td colspan="2">Year : I<br><br>Semester : II</td></tr>
<tr><td colspan="2">Credits: 04<br>Theory: 04<br>Practical:</td><td colspan="2">Subject: Chemistry</td></tr>
<tr><td colspan="2">Course Code: BSCH-121</td><td colspan="2">Title : Bioorganic and Medicinal Chemistry</td></tr>
<tr><td colspan="4">Course Objectives:<br>1. Importance of Chemistry of Carbohydrates, proteins, nucleic acids.<br>2. Importance of medicinal chemistry.<br>3. Introduction of solid state and its properties.<br>4. Introduction of polymer chemistry, kinetics and polymerization mechanisms.<br>5. About synthetic dyes and its various properties.</td></tr>
<tr><td colspan="4">Nature of Paper: Core</td></tr>
<tr><td colspan="4">Minimum Passing Marks/Credits: 40% Marks</td></tr>
<tr><td colspan="4">L: 4<br>T:<br>P: (In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)</td></tr>
<tr><th>Unit</th><th colspan="2">Contents</th><th>No. of Lectures Allotted</th></tr>
<tr><td>I</td><td colspan="2">Chemistry of Carbohydrates: Classification of carbohydrates, reducing and non-reducing sugars, General Properties of Glucose and Fructose, their open chain structure. Epimers, mutarotation and anomers. Mechanism of mutarotation Determination of configuration of Glucose (Fischer’s proof). Cyclic structure of glucose. Haworth projections. Cyclic structure of fructose. Inter conversions of sugars (ascending and descending of sugar series, conversion of aldoses to ketoses). Lobry de Bruyn-van Ekenstein rearrangement; stepping–up (Kiliani- Fischer method) and stepping–down (Ruff’s &Wohl’s methods) of aldoses; end-group- interchange of aldoses Linkage between monosachharides, structure of disacharrides (sucrose, maltose, lactose) and polysacharrides (starch and cellulose) excluding their structure elucidation</td><td>10</td></tr>
<tr><td>II</td><td colspan="2">Chemistry of Proteins:<br>Classification of amino acids, zwitter ion structure and Isoelectric point. Overview of primary, secondary, tertiary and quaternary structure of proteins. Determination of primary structure of peptides, determination of N-terminal amino acid (by DNFB and Edman method) and C–terminal amino acid (by thiohydantoin and with carboxy peptidase enzyme). Synthesis of simple peptides (upto dipeptides) by N-protection & C-activating groups and Merrifield solid phase synthesis. Protein</td><td>10</td></tr>
</table>

| | | |
|---|---|---|
| | denaturation/renaturation Mechanism of enzyme action, factors affecting enzyme action, Coenzymes and cofactors and their role in biological reactions, Specificity of enzyme action (Including stereo specifity), Enzyme inhibitors and their importance, phenomenon of inhibition (Competitive and Non-Competitive inhibition including allosteric inhibition). | |
| III | **Chemistry of Nucleic Acids:** Constituents of Nucleic acids: Adenine, guanine, thymine and Cytosine (Structure only), Nucleosides and nucleotides (**no menclature**), Synthesis of nucleic acids, Structure of polynucleotide's; Structure of DNA (Watson-Crickmodel) and RNA (**types of RNA**), Genetic Code, Biologicalroles of DNA and RNA: Replication, Transcription and Translation | 05 |
| IV | **Introductory Medicinal Chemistry :** Drug discovery, design and development; Basic Retro synthetic approach. Drugaction-receptor theory. Structure–activity relationships of drug molecules, binding role of –OH group,-$NH_2$ group, double bond and aromatic ring. Synthesis of the representative drugs of the following classes: analgesicsagents, antipyreticagents, anti-inflammatory agents (Aspirin, paracetamol); antibiotics (Chloramphenicol); antibacterial and antifungal agents (Sulphonamides; Sulphanethoxazol, Sulphacetamide); antiviral agents (Acyclovir), Central Nervous System agents (Phenobarbital, Diazepam), Cardiovascular (Glyceryltrinitrate), HIV-AIDS related drugs (AZT-Zidovudine | 10 |
| V | **Solid State:**<br>Definition of space lattice, unit cell. Laws of crystallography – (i) Law of constancy of interfacial angles, (ii) Law of rationality of indices and iii) Symmetry elements in crystals and law of symmetry .X-ray diffraction by crystals. Derivation of Bragg equation. Determination of crystal structure of NaCl, KCl and CsCl (Laue's method and powder method). | 05 |
| VI | **Introduction to Polymer:**<br>Monomers, Oligomers, Polymers and their characteristics, Classification of polymers: Natural synthetic, linear, cross linked and network; plastics, elastomers, fibres, Homopolymers and Co-polymers, Bonding in polymers: Primary and secondary bond forces in polymers; cohesive energy, and decomposition of polymers. Determination of Molecular mass of polymers: Number Average molecular mass (Mn) and Weight average molecular mass (Mw) of polymers and determination by (i) Viscosity (ii) Light scattering method (iii) Gel permeation chromatography (iv) Osmometry and Ultra centrifuging.<br>**Silicones and Phosphazenes**:<br>Silicones and phosphazenes as examples of inorganic polymers, nature of bonding in triphosphazenes. | 10 |
| VII | **Kinetics and Mechanism of Polymerizatio:**<br>Polymerization techniques, Mechanism and kinetics of copolymerization, Addition or chain- growth polymerization, Free radical vinyl polymerization, ionic vinylpolymerization, Ziegler-Natta polymerization and vinyl polymers, Condensation or step growth-polymerization, Polyesters, polyamides, phenol formaldehyde resins, | 05 |

| | | |
|---|---|---|
| | urea formaldehyde resins, epoxy resins and polyurethanes, Natural and synthetic rubbers, Elementary idea of organic conducting polymers. | |
| VIII | **Synthetic Dyes:** Colour and constitution (electronic Concept), Classification of dyes, Chemistry and synthesis of Methyl orange, Congo red, Malachite green, crystal violet, phenolphthalein, fluorescein, Alizarin and Indigo. | 05 |

**Reference / Text Books:**


1. Davis, B. G., Fairbanks, A. J., *Carbohydrate Chemistry*, Oxford Chemistry Primer, Oxford University Press.
2. Finar, I. L. *Organic Chemistry* (*Volume 2)*, Dorling Kindersley (India) Pvt. Ltd.(Pearson Education).
3. Nelson, D. L. & Cox, M. M. *Lehninger's Principles of Bioch*emistry *7th Ed.,* W. H. Freeman.
4. Berg, J. M., Tymoczko, J. L. & Stryer, L. *Biochemistry 7th Ed.,* W. H. Freeman.
5. Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
6. Patrick, G. L. Introduction to Medicinal Chemistry, Oxford University Press, UK, 2013.
7. Singh, H. & Kapoor, V.K. Medicinal and Pharmaceutical Chemistry, Vallabh Prakashan, Pitampura, New Delhi, 2012.
8. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry Ed., Oxford University Press 13(2006).
9. Ball, D. W. Physical Chemistry Thomson Press, India (2007).
10. Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).
11. R.B. Seymour & C.E. Carraher: *Polymer Chemistry: An Introduction,* Marcel Dekker, Inc. New York, 1981.
12. G. Odian: *Principles of Polymerization*, 4$^{th}$Ed.Wiley, 2004.
13. F.W. Billmeyer: *Textbook of Polymer Science*, 2ndEd. Wiley Inter science, 1971.
14. P. Ghosh: Polymer Science & Technology, Tata McGraw-Hill Education,1991.


If the course is available as Generic Elective then the students of following departments may opt it.

1. B. Tech.
2. Diploma
3. B. Pharm.
4. D. Pharm.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination<br>2) Assignments<br>3) ESE | 10 + 10<br>5<br>75 |
| **Total:** | **100** |

Prerequisites for the course: Basic knowledge of Chemistry taught in the preceding semester.

**Course Learning Outcomes:**

1. Students will understand the concept of carbohydrates, proteins, nucleic acids.
2. Students will be able to understand the various types of drugs and medicines and its importance.
3. Students will be able to understand solid state chemistry.
4. Students will be able to understand the basics of polymer chemistry & its mechanisms.
5. Students will be able to understand about synthetic dyes and its importance in daily life.

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: I / Semester: II**

| | | |
|---|---|---|
| Programme: Certificate/Diploma/Degree/ UG(R)/PG/Ph.D.<br>Class : **B.Sc (PCM)** | Year : **I**<br><br>Semester : **II** | |
| **Credits: 02**<br>Theory:<br>Practical: **02** | Subject: **Chemistry** | |
| **Course Code: BSCH-121P** | **Title : Biochemical Analysis** | |
| **Course Objectives:**<br>This course will provide basic qualitative and quantitative experimental knowledge of biomolecules such as carbohydrates, proteins, amino acids, nucleic acids drug molecules. Upon successful completion of this course students may get job opportunities in food, beverage and pharmaceutical industries. | | |
| Nature of Paper: **Core** | | |
| **Minimum Passing Marks/Credits: 50% Marks** | | |
| L:<br>T:<br>P: 4 (In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits) | | |

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | **Qualitative and quantitative analysis of Carbohydrates: .**<br>1. Separation of a mixture of two sugars by ascending paper chromatography<br>2. Differentiate between a reducing/ non reducing sugar Synthesis of Osazones. | 15 |
| II | **Qualitative and quantitative analysis of Proteins, amino acids and Fats**<br>1. Isolation of protein.<br>2. Determination of protein by the Biuret reaction.<br>3. TLC separation of a mixture containing 2/3 amino acids<br>4. Paper chromatographic separation of a mixture containing 2/3 amino acids<br>5. Action of salivary amylase on starch<br>6. To determine the concentration of glycine solution by formulation method.<br>7. To determine the saponification value of anoil/fat.<br>To determine the iodine value of anoil/fat Estimation of copper using thiosulphate. | 20 |
| III | **Determination and identification of Nucleic Acids**<br>1. Determination of nucleic acids<br>2. Extraction of DNA from onion/cauliflower | 12 |

| | | |
|---|---|---|
| IV | **Synthesis of Simple drug molecules**<br>1. To synthesize aspirin by acetylation of salicylic acid and compare it with the ingredient of an aspirin tablet by TLC.<br>2. Synthesis of barbituric acid<br>3. Synthesis of propranolol | 13 |

**Reference / Text Books:**

1. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. *Practical Organic Chemistry, 5th Ed.,* Pearson (2012).
2. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry,* Pearson Education.
3. *Vogel's Qualitative Inorganic Analysis*, Revised by G. Svehla.
4. Vogel, A.I. *A Textbook of Quantitative Analysi*s, ELBS.1986
5. Furniss, B.S.; Hannaford, A.J.; Rogers, V.; Smith, P.W.G.; Tatchell, A.R. *Vogel's Textbook of Practical Organic Chemistry*, ELBS.
6. Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry,* Universities Pres
7. Cooper, T.G. Tool of Biochemistry. Wiley-Blackwell (1977).
8. Wilson, K. & Walker, J. Practical Biochemistry. Cambridge University Press (2009).
9. Varley, H., Gowenlock, A.H & Bell, M.: Practical Clinical Biochemistry, Heinemann,

If the course is available as Generic Elective then the students of following departments may opt it.
1. B. Tech.
2. Diploma
3. B. Pharm.
4. D. Pharm.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 10 |
| 2) Assignments | 10 |
| 3) ESE | 30 |
| **Total:** | **50** |

Prerequisites for the course: Basic knowledge of chemistry taught in the preceding semester.

**Course Learning Outcomes:**

This course will provide basic qualitative and quantitative experimental knowledge of bio molecules such as carbohydrates, proteins, amino acids, nucleic acids drug molecules. Upon successful completion of this course students may get job opportunities in food, beverage and pharmaceutical industries.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: II / Semester: III**

| | |
|---|---|
| Programme: Certificate/Diploma/Degree/ UG(R)/PG/Ph.D.<br>Class:**B.Sc. (PCM/PSM)** | Year: **II**<br><br>Semester: **III** |
| Credits: **04**<br>Theory: **04**<br>Practical: | Subject: **Physics** |
| Course Code : **BSPH-231** | Title: **Electromagnetic Theory & Modern Optics** |

**Course Objectives:**
The purpose of the undergraduate Physics program at the university level is to provide the key knowledge of the fact of science understanding of the law of physics and laboratory resources to prepare students for careers as professionals in various industries and research institutions.

Nature of Paper: **Core**

Minimum Passing Marks/Credits: **40% Marks**

L: 04
T: 00
P: 0(In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit(4Hrs./Week=4Credits)

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| | **Part A: Electromagnetic Theory** | |
| I | **Electrostatics:**<br>Electric charge & charge densities, electric force between two charges. General expression for Electric field in terms of volume charge density (divergence & curl of Electric field), general expression for Electric potential in terms of volume charge density and Gauss law (applications included). Study of electric dipole. Electric fields in matter, polarization, auxiliary field **D** (Electric displacement), electric susceptibility and permittivity. | **08** |
| II | **Magnetostatics:**<br>Electric current & current densities, magnetic force between two current elements. General expression for Magnetic field in terms of volume current density (divergence and curl of Magnetic field), General expression for Magnetic potential in terms of volume current density and Ampere's circuital law (applications included). Study of magnetic dipole (Gilbert & Ampere model). Magnetic fields in matter, magnetization, auxiliary field **H**, magnetic susceptibility and permeability. | **08** |
| III | **Time Varying Electromagnetic Fields:**<br>Faraday's laws of electromagnetic induction and Lenz's law. Displacement current, equation of continuity and Maxwell-Ampere's circuital law. Self and mutual induction (applications | **07** |

| | | |
|---|---|---|
| | included). Derivation and physical significance of Maxwell's equations. Theory and working of moving coil ballistic galvanometer (applications included). | |
| IV | **Electromagnetic Waves:**<br>Electromagnetic energy density and Poynting vector. Plane electromagnetic waves in linear infinite dielectrics, homogeneous & inhomogeneous plane waves and dispersive & non-dispersive media. Reflection and refraction of homogeneous plane electromagnetic waves, law of reflection, Snell's law, Fresnel's formulae (only for normal incidence & optical frequencies) and Stoke's law. | **07** |
| | **PART B: Physical Optics & Lasers** | |
| V | **Interference:**<br>Conditions for interference and spatial & temporal coherence. Division of Wave front - Fresnel's Biprism and Lloyd's Mirror. Division of Amplitude - Parallel thin film, wedge shaped film and Newton's Ring experiment. Interferometer - Michelson and Fabry-Perot. | **08** |
| VI | **Diffraction:**<br>Distinction between interference and diffraction. Fresnel's and Fraunhofer's class of diffraction. Fresnel's Half Period Zones and Zone plate. Fraunhofer diffraction at a single slit, n slits and Diffracting Grating. Resolving Power of Optical Instruments - Rayleigh's criterion and resolving power of telescope, microscope & grating. | **08** |
| VII | **Polarization:**<br>Polarization by dichroic crystals, birefringence, Nicol prism, retardation plates and Babinet's compensator. Analysis of polarized light. Optical Rotation - Fresnel's explanation of optical rotation and Half Shade & Biquartz polarimeters. | **07** |
| VIII | **Lasers:**<br>Characteristics and uses of Lasers. Quantitative analysis of Spatial and Temporal coherence. Conditions for Laser action and Einstein's coefficients. Three and four level laser systems qualitative discussion). Types of lasers and laser. | **07** |

**Suggested Readings:**

**PART A**


1. H. K. Malik and A.K. Singh "Engineering Physics", McGraw Hill Education (India) Private Limited, 2018, 2e.
2. Richard P. Feynman, Robert B. Leighton, Matthew Sands, "The Feynman Lectures on Physics - Vol. 2", Pearson Education Limited, 2012
3. D. J. Griffiths, "Introduction to Electrodynamics", Prentice-Hall of India Private Limited, 2002, 3e
4. E. M. Purcell, "Electricity and Magnetism (In SI Units): Berkeley Physics Course Vol 2", McGraw Hill, 2017, 2e
5. D.C. Tayal, "Electricity and Magnetism", Himalaya Publishing House Pvt. Ltd., 2019, 4e


**PART B**

1. H. K. Malik, “Engineering Physics”, McGraw Hill Education (India) Private Limited, 2018, 2e.
2. Francis A. Jenkins, Harvey E. White, “Fundamentals of Optics”, McGraw Hill, 2017, 4e
3. Samuel Tolansky, “An Introduction to Interferometry”, John Wiley & Sons Inc., 1973, 2e
4. A. Ghatak, “Optics”, McGraw Hill, 2017, 6e

If the course is available as Generic Elective then the students of following departments may opt it.
Yes Open to all

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1. Class tasks/ Sessional Examination<br>2. Assignments<br>3. ESE | 10 + 10<br>5<br>75 |
| **Total:** | **100** |

Prerequisites for the course: Physics and Mathematics in $12^{th}$

**Course Learning Outcomes:**

- Better understanding of electrical and magnetic phenomenon in daily life.
- To troubleshoot simple problems related to electrical devices.
- Comprehend the powerful applications of ballistic galvanometer.
- Study the fundamental physics behind reflection and refraction of light (electromagnetic waves).
- Study the working and applications of Michelson and Fabry-Perot interferometers.
- Recognize the difference between Fresnel’s and Fraunhofer’s class of diffraction.
- Comprehend the use of polarimeters.
- Study the characteristics and uses of lasers.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: II / Semester: III**

<table>
<tr><td colspan="2">Programme:<br>Certificate/Diploma/ Degree/ UG(R)/PG/Ph.D.<br>Class:B.Sc (PCM/PSM)</td><td colspan="2">Year: II<br><br>Semester: III</td></tr>
<tr><td colspan="2">Credits: 02<br>Theory:<br>Practical: 02</td><td colspan="2">Subject: Physics</td></tr>
<tr><td colspan="2">Course Code:<br>BSPH-231P</td><td colspan="2">Title: Demonstrative Aspects of Electricity & Magnetism</td></tr>
<tr><td colspan="4">Course Objectives:<br>The purpose of the undergraduate Physics program at the university level is to provide the key knowledge of the fact of science understanding of the law of physics and laboratory resources to prepare students for careers as professionals in various industries and research institutions.</td></tr>
<tr><td colspan="4">Nature of Paper: Core</td></tr>
<tr><td colspan="4">Minimum Passing Marks/Credits: 50% Marks</td></tr>
<tr><td colspan="4">L: 0<br>T: 00<br>P: 04 (In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)</td></tr>
<tr><th>Unit</th><th colspan="2">Contents</th><th>No. of Lectures Allotted</th></tr>
<tr><td colspan="4" align="center">Lab Experiment List</td></tr>
<tr><td></td><td colspan="2">1. Variation of magnetic field along the axis of single coil.<br>2. Variation of magnetic field along the axis of Helmholtz coil.<br>3. Ballistic Galvanometer: Ballistic constant, current sensitivity and voltage sensitivity.<br>4. Ballistic Galvanometer: High resistance by Leakage method.<br>5. Ballistic Galvanometer: Low resistance by Kelvin’s double bridge method.<br>6. Ballistic Galvanometer: Self-inductance of a coil by Rayleigh’s method.<br>7. Ballistic Galvanometer: Comparison of capacitances.<br>8. Carey Foster Bridge: Resistance per unit length and low resistance.<br>9. Deflection and Vibration Magnetometer: Magnetic moment of a magnet and horizontal component of earth’s magnetic field.<br>10. Earth Inductor: Horizontal component of earth’s magnetic field.<br>11. Newton’s Rings: Wavelength of sodium light.<br>12. Plane Diffraction Grating: Spectrum of mercury light.<br>13. Spectrometer: Refractive index of the material of a prism using sodium light.<br>14. Spectrometer: Dispersive power of the material of a prism</td><td>20</td></tr>
</table>

| | | |
|---|---|---|
| | using mercury light.<br>15. Polarimeter: Specific rotation of sugar solution | |

**Suggested Readings:**


1. B.L. Worsnop, H.T. Flint, "Advanced Practical Physics for Students", Methuen & Co., Ltd., London, 1962, 9e
2. S. Panigrahi, B. Mallick, "Engineering Practical Physics", Cengage Learning India Pvt. Ltd., 2015, 1e
3. R.K. Agrawal, G. Jain, R. Sharma, "Practical Physics", Krishna Prakashan Media (Pvt.) Ltd., Meerut, 2019
4. S.L. Gupta, V. Kumar, "Practical Physics", Pragati Prakashan, Meerut, 2014, 2e


If the course is available as Generic Elective then the students of following departments may opt it.

1. Yes Botany/Chem./Comp. Sc./Maths/Stat./Zool.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1. Record File | 15 |
| 2. Viva Voce | 5 |
| 3. Class Interaction | 10 |
| **Total:** | **30** |

Prerequisites for the course:

- The course can be opted by Botany / Chemistry / Computer Science / Mathematics / Statistics / Zoology
- **PREREQUISITE:** Opted / Passed Semester I, Theory Paper-1 (**BSPH-231**)

**Course Learning Outcomes:**

- Experimental physics has the most striking impact on the industry wherever the instruments are used to study and determine the electric and magnetic properties.
- Measurement precision and perfection is achieved through Lab Experiments.
- Online Virtual Lab Experiments give an insight in simulation techniques and provide a basis for modeling.

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: II / Semester: III**

| | |
|---|---|
| **Programme :** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D.<br>**Class : B.Sc. (PCM/PSM)** | Year: **II**<br><br>Semester: **III** |
| **Credits: 06**<br>Theory: 06<br>Practical: | **Subject: Mathematics** |
| **Course Code:BSMT-231** | **Title: Algebra & Mathematical Methods** |
| **Course Objectives:**<br>1. Objective of this course is to introduce students to basic concepts of Group, Ring theory. and their properties.<br>2. On successful completion of the course students should have knowledge about higher different mathematical methods and will help him in going to higher studies and research. | |
| **Nature of Paper:** Core | |
| **Minimum Passing Marks/Credits: 40% Marks** | |
| L: 6<br>T:<br>P:<br>Theory - 1 Hr. = 1 Credit<br>Practical- | |

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | Equivalence relations and partitions, Congruence modulon, Definition of a group with examples and simple properties, Subgroups, Generators of a group, Cyclic groups. | 12 |
| II | Permutation groups, Even and odd permutations, The alternating group, Cayley's theorem, Direct products, Coset decomposition, Lagrange's theorem and its consequences, Fermat and Euler theorems. | 11 |
| III | Normal subgroups, Quotient groups, Homomorphism and isomorphism, Fundamental theorem of homomorphism, Theorems on isomorphism. | 11 |
| IV | Rings, Sub rings, Integral domains and fields, Characteristic of a ring, Ideal and quotient rings, Ring homomorphism, Field of quotient of an integral domain. | 11 |
| V | Limit and Continuity of functions of two variables, Differentiation of function of two variables, Necessary and sufficient condition for differentiability of functions two variables, Taylor's theorem for functions of two variables with examples, Maxima and minima for functions of two variables, Lagrange multiplier method, Jacobians. | 12 |
| VI | Existence theorems for Laplace transforms, Linearity of Laplace transform and their properties, Laplace transform of the derivatives and integrals of a function, Convolution theorem, inverse Laplace | 11 |

| | | |
|---|---|---|
| | transforms, Solution of the differential equations using Laplace transforms. | |
| VII | Fourier series, Fourier expansion of piecewise monotonic functions, Half and full range expansions, Fourier transforms, Fourier integral. | 11 |
| VIII | Calculus of variations-Variational problems with fixed boundaries. The topic “Indian Ancient Mathematics and Mathematicians should be covered under Continuous Internal Evaluation (CIE). | 11 |

**Reference / Text Books: (Part-A Algebra):**

1. J.B. Fraleigh, A first course in Abstract Algebra, Addison-weley
2. I. N. Herstein, Topics in Algebra, John Wiley & Sons
3. Suggested digital plateform: NPTEL/SWAYAM/MOOCS
4. Course Books (text/reference) published in Hindi may be prescribed by the Universities at local levels.

**Suggested Readings (Part- B Mathematical Methods):**

1. T.M. Apostal, Mathematical Analysis, Person
2. G.F. Simmons, Differential Equations with Application and Historical Notes, Tata -McGraw Hill
3. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons.
4. Suggested digital plateform : NPTEL/SWAYAM/MOOCs

If the course is available as Generic Elective, then the students of following departments may opt it.

1. Engg. and Tech. (UG)
2. B.Sc. (C.S.)

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 10 |
| 2) Presentations /Seminar | 5 |
| 3) Assignments | 5 |
| 4) Research Project Report<br>Seminar On Research Project Report | 5 |
| 5) ESE | **75** |
| **Total:** | 100 |

Prerequisites for the course: Certificate Course in Mathematics

**Course Learning Outcomes:**

CO1: Group theory is one of the building blocks of modern algebra. Objective of this course is to introduce students to basic concepts of Group, Ring theory. and their properties.

CO2: A student learning this course gets a concept of Group, Ring, Integral Domain and their properties. This course will lead the student to basic course in advanced mathematics and Algebra.

CO3: The course gives emphasis to enhance students’ knowledge of functions of two variables, Laplace Transforms, Fourier Series.

CO4: On successful completion of the course students should have knowledge about higher different mathematical methods and will help him in going to higher studies and research.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: II / Semester: III**

| | |
|---|---|
| **Programme:**<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>Class : **B.Sc (PCM)** | **Year: II**<br><br>**Semester: III** |
| **Credits: 04**<br>Theory: **04**<br>Practical: | Subject: **Chemistry** |
| **Course Code:BSCH-231** | **Title: Chemical Dynamics & Coordination Chemistry** |

**Course Objectives:**
1. Importance of Chemical kinetics in chemistry.
2. Importance of various equilibria in chemistry such as chemical and phase equilibria.
3. Introduction of various states in chemistry such as gaseous and liquid states of matter.
4. Introduction of various aspects of co-ordination chemistry.
5. Inorganic spectroscopy and its various factors and usefulness of it in chemistry.

Nature of Paper: **Core**

**Minimum Passing Marks/Credits: 40% Marks**

L: 4
T:
P: (In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | **Chemical Kinetics:** Rate of a reaction, molecularity and order of reaction, concentration dependence of rates, mathematical characteristic of simple chemical reactions – zero order, first order, second order, pseudo order, half-life and mean life. Determination of the order of reaction – differential method, method of integration, half-life method and isolation method.<br>**Theories of chemical kinetics:** Effect of temperature on rate of reaction, Arrhenius equation, concept of activation energy | 10 |
| II | **Chemical Equilibrium:**<br>Equilibrium constant and free energy, thermodynamic derivation of law of mass action. Le-Chatelier's principle. | 05 |
| III | **Phase Equilibrium**:<br>Statement and meaning of the terms-phase, component and degree of freedom, derivation of Gibbs phase rule, phase equilibria of one component system– water systems. Phase equilibria of two component systems – Solid - liquid equilibria. | 05 |
| IV | **Kinetic theories of gases:**<br>**Gaseous State:** Postulates of kinetic theory of gases, deviation from ideal behavior, vander Waals equation of state.<br>**Critical phenomena**: PV isotherms of real gases, continuity of states, | 10 |

| | | |
|---|---|---|
| | the isotherms of Vander Waals equation, relationship between critical constants and Vander Waals constants, the law of corresponding states, reduced equation of state. | |
| V | **Liquid State:**<br>Intermolecular forces, structure of liquids (a qualitative description). Structural differences between solids, liquids and gases. Liquid crystals: Difference between liquid crystal, solid and liquid. Classification, structure of nematic and cholesterol phases. Thermography and seven segment cell.<br>**Liquids in solids (gels)**: Classification, preparation and properties, inhibition, general application | 05 |
| VI | **Coordination Chemistry:**<br>**Coordinate bonding:** Double and complex salts. Werner's theory of coordination complexes, classification of ligands, ambidentateligands, chelates, coordination numbers, IUPAC nomenclature of coordination complexes (up to two metal centers), Isomerism in coordination compounds, constitutional and stereo isomerism, geometrical and optical isomerism in square planar and octahedral complexes. | 05 |
| VII | **Theories of Coordination Chemistry**<br>**I** Metal-ligand bonding in transition metal complexes, limitations of valance bond theory, an elementary idea of crystal field theory, crystal field splitting in octahedral, tetrahedral and square planner complexes, factors affecting the crystal-field parameters.<br>II. Thermodynamic and kinetic aspects of metal complexes: A brief outline of thermodynamic stability of metal complexes and factors affecting the stability, stability constants of complexes and their determination, substitution reactions of square planar complexes | 10 |
| VIII | **Inorganic Spectroscopy and Magnetism**<br>I) Electronic spectra of Transition Metal Complexes Types of electronic transitions, selection rules for d-d transitions, spectroscopic ground states, spectrochemical series, Orgel-energy level diagram for d1 and d9 states, discussion of the electronic spectrum of $[Ti(H2O)6]^{3+}$ complex ion.<br>II) Magnetic properties of transition metal complexes, types of magnetic behaviour, methods of determining magnetic susceptibility, spin-only formula, L-S coupling, correlation of μ s and μ eff values, orbital contribution to magnetic moments, application of magnetic moment data for 3 d-metal complexes.<br>**Physical properties and molecular structure:**<br>Optical activity, polarization – (Clausius - Mossotti equation), orientation of dipoles in an electric field, dipole moment, induced dipole moment, measurement of dipole moment-temperature method and refractivity method, dipole moment and structure of molecules, magnetic properties paramagnetism, diamagnetism and ferromagnetism, magnetic susceptibility, its measurements and its importance. | 10 |

**Reference / Text Books:**


1. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry Ed., Oxford University Press 13(2006).
2. Ball, D. W. Physical Chemistry Thomson Press, India (2007).
3. Castellan, G. W. Physical Chemistry 4$^{th}$Ed. Narosa (2004).
4. Cotton, F.A, Wilkinson, G and Gaus, P. L , Basic Inorganic Chemistry,3$^{rd}$ Edition ,Wiley1995
5. Lee, J.D, Concise Inorganic Chemistry 4$^{th}$ EditionELBS,1977
6. Douglas, B, Mc Daniel, D and Alexander, J, Concepts of Models of Inorganic Chemistry, John Wiley &Sons; 3rd edition ,1994
7. Shriver, D. EAtkins, P.W and Langford, C.H, Inorganic Chemistry, Oxford University Press,1994.
8. Porterfield ,W.W, Inorganic Chemistry, Addison Wesley1984.
9. Sharpe, A .G, Inorganic Chemistry, ELBS,3$^{RD}$ edition,1993
10. Miessler, G.L, Tarr, D.A, Inorganic Chemistry, 2$^{nd}$ edition, PrenticeHall,2001


If the course is available as Generic Elective then the students of following departments may opt it.

1. B. Tech.
2. Diploma
3. B. Pharm.
4. D. Pharm.

**Evaluation/Assessment Methodology**

| | Max. Marks |
|---|---|
| 1. Class tasks/ Sessional Examination | 10 + 10 |
| 2. Assignments | 5 |
| 3. ESE | 75 |
| **Total:** | **100** |

Prerequisites for the course : Basic knowledge of chemistry taught in the preceding semester.

**Course Learning Outcomes:**

1. Students will understand the concept of chemical klinetics and various parameters related.
2. Students will be able to understand the various type's equilibria in chemistry such as chemical and phase equilibria.
3. Students will be able to understand liquid state chemistry and kinetic theory of gases.
4. Students will be able to understand the basics co-ordination chemistry & its various aspects of it.
5. Students will be able to understand about inorganic spectroscopy and magnetism effects.

Format-3

**IIMTU-NEP IMPLEMENTATION**
Year : **II /** Semester : **III**

<table>
<tr><td>Programme:<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>Class : B.Sc (PCM)</td><td colspan="2">Year : II<br><br>Semester : III</td></tr>
<tr><td>Credits: 02<br>Theory:<br>Practical: 02</td><td colspan="2">Subject: Chemistry</td></tr>
<tr><td>Course Code: BSCH-231P</td><td colspan="2">Title : Physical Analysis</td></tr>
<tr><td colspan="3">Course Objectives:<br>Upon successful completion of this course students should be able to calibrate apparatus and prepare solutions of various concentrations, estimation of components through volumetric analysis; to perform dilatometric experiments: one and two component phase equilibrium experiments.</td></tr>
<tr><td colspan="3">Nature of Paper: Core</td></tr>
<tr><td colspan="3">Minimum Passing Marks/Credits: 50% Marks</td></tr>
<tr><td colspan="3">L:<br>T:<br>P: 4 (In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)</td></tr>
</table>

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | **Strengths of Solution**<br>Calibration of fractional weights, pipettes and burettes. Preparation of standards solutions. Dilution–0.1 M to 0.001 M solutions. Mole Concept and Concentration Units: Mole Concept, molecular weight, formula weight, and equivalent weight. Concentration units: Molarity, Formality, Normality, Molality, Mole fraction, Percent by weight, Percent by volume, Parts per thousand, Parts per million, Parts per billion, pH, pOH, milli equivalents, Milli moles | **20** |
| II | **Surface Tension and Viscosity**<br>1. Determination of surface tension of pure liquid or solution.<br>2. Determination of viscosity of liquid pure liquid or solution. | **06** |
| III | **Boiling point and Transition Temperature**<br>1. Boiling point of common organic liquid compounds *n* butyl alcohol, cyclohexanol, ethyl methyl ketone, cyclohexanone, acetylacetone, isobutyl methyl ketone, isobutyl alcohol, acetonitrile, benzaldehyde and acetophenone. [Boiling points of the chosen organic compounds should preferably be within180$^0$C].<br>2. Transition Temperature, Determination of the transition temperature of the given substance by thermometric/dialometric method (e.g. $MnCl_2.4H_2O/SrBr_2.2H_2O$ ) | **14** |

| | | |
|---|---|---|
| IV | **Phase Equilibrium**<br>1. To study the effect of a solute (e.g. NaCl, succinic acid) on the critical solution temperature of two partially miscible liquids (e.g. phenol water system) and to determine the concentration of that solute in the given phenol-water system.<br>2. To construct the phase diagram of two component (e.g .diphenylamine benzophenone) system by cooling curve method. | **20** |

**Reference / Text Books:**

1. Skoog D.A., West. D.M and Holler .F.J., "Analytical Chemistry: An Introduction", 7th edition, Saunders college publishing, Philadelphia,(2010).
2. Larry Hargis. G" Analytical Chemistry: Principles and Techniques" Pearson© (1988)

**Note**:-For the promotion of Hindi language, course books published in Hindi may be prescribed by the University

If the course is available as Generic Elective then the students of following departments may opt it.
1. B. Tech.
2. Diploma
3. B. Pharm.
4. D. Pharm.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1. Class tasks/ Sessional Examination | 10 |
| 2. Assignments | 10 |
| 3. ESE | 30 |
| **Total:** | **50** |

Prerequisites for the course:Basic knowledge of practical chemistry taught in the preceding semester

**Course Learning Outcomes:**

Upon successful completion of this course students should be able to calibrate apparatus and prepare solutions of various concentrations, estimation of components through volumetric analysis; to perform dilatometric experiments: one and two component phase equilibrium experiments.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: II / Semester: IV**

| | |
|---|---|
| Programme: Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. Class:**B.Sc (PCM/PSM)** | Year: II<br><br>Semester: IV |
| Credits: **04**<br>Theory: 0**4**<br>Practical: | Subject: **Physics** |
| Course Code : **BSPH-241** | Title: **Perspectives of Modern Physics & Basic Electronics** |
| **Course Objectives:**<br>The purpose of the undergraduate Physics program at the university level is to provide the key knowledge of the fact of science understanding of the law of physics and laboratory resources to prepare students for careers as professionals in various industries and research institutions. | |
| Nature of Paper: **Core** | |
| Minimum Passing Marks/Credits: **40% Marks** | |
| L: 04<br>T: 00<br>P: 0(In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits) | |

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| | **Part A: Perspectives of Modern Physics** | |
| I | **Relativity-Experimental Background:**<br>Structure of space & time in Newtonian mechanics and inertial & non-inertial frames. Galilean transformations. Galilean transformation. Attempts to locate the Absolute Frame: Michelson-Morley experiment and significance of the null result. Einstein's postulates of special theory of relativity. | **07** |
| II | **Relativity-Relativistic Kinematics:**<br>Structure of space & time in Relativistic mechanics and derivation of Lorentz transformation equations Transformation of Simultaneity (Relativity of simultaneity); Transformation of Length (Length contraction); Transformation of Time (Time dilation); Transformation of Velocity (Relativistic velocity addition); Transformation of Acceleration; Transformation of Mass (Variation of mass with velocity). Relation between Energy & Mass (Einstein's mass & energy relation) and Energy & Momentum. | **08** |

| | | |
|---|---|---|
| III | **Inadequacies of Classical Mechanics:**<br>Particle Properties of Waves: Photoelectric effect, Compton Effect and their explanations based on Max Planck's Quantum hypothesis. Wave Properties of Particles: Louis de Broglie's hypothesis of matter waves and their experimental verification by Davisson-Germer's experiment. | 08 |
| IV | **Introduction to Quantum Mechanics:**<br>Matter Waves: Mathematical representation, Wavelength, Concept of Wave group, Group (particle) velocity, Phase (wave) velocity and relation between Group & Phase velocities. Wave Function: Functional form, Normalisation of wave function and Probabilistic interpretation of wave function. | 07 |
| **PART B: Basic Electronics & Introduction to Fiber Optics** | | |
| V | **Transistor Biasing:**<br>Faithful amplification & need for biasing. Stability Factors and its calculation for transistor biasing circuits for CE configuration: Fixed Bias (Base Resistor Method), Emitter Bias (Fixed Bias with Emitter Resistor), Collector to Base Bias (Base Bias with Collector Feedback) &, Voltage Divider Bias. Discussion of Emitter-Follower configuration. | 07 |
| VI | **Amplifiers:**<br>Classification of amplifiers based on Mode of operation (Class A, B, AB, C & D), Stages (single & multi stage, cascade & cascode connections), Coupling methods (RC, Transformer, Direct & LC couplings), Nature of amplification (Voltage & Power amplification) and Frequency capabilities (AF, IF, RF & VF). Theory & working of RC coupled voltage amplifier (Uses of various resistors & capacitors, and Frequency response) and Transformer coupled power amplifier (calculation of Power, Effect of temperature, Use of heat sink & Power dissipation). Calculation of Amplifier Efficiency (power efficiency) for Class A Series-Fed, Class A Transformer Coupled, Class B Series-Fed and Class B Transformer Coupled amplifiers. | 08 |
| VII | **Feedback & Oscillator Circuits:**<br>Feedback Circuits: Effects of positive and negative feedback. Voltage Series, Voltage Shunt, Current Series and Current Shunt feedback connection types and their uses for specific amplifiers. Estimation of Input Impedance, Output Impedance, Gain, Stability, Distortion, Noise and Band Width for Voltage Series negative feedback. Oscillator Circuits: Use of positive feedback for oscillator operation. Barkhausen criterion for self-sustained oscillations. Feedback factor and frequency of oscillation for RC Phase Shift oscillator and Wein Bridge oscillator. Qualitative discussion of Reactive Network feedback oscillators (Tuned oscillator circuits): Hartley & Colpitts oscillators. | 09 |
| VIII | **Introduction to Fiber Optics:**<br>Basics of Fiber Optics, step index fiber, graded index fiber, light propagation through an optical fiber, acceptance angle & numerical | 06 |

| | | |
|---|---|---|
| | aperture, qualitative discussion of fiber losses and applications of optical fibers. | |

**Suggested Readings:**

**PART A**

1. Beiser, Shobhit Mahajan, "Concepts of Modern Physics: Special Indian Edition", McGraw Hill, 2009, 6e
2. H. K. Malik and A.K. Singh "Engineering Physics", McGraw Hill Education (India) Private Limited, 2018, 2e.
3. John R. Taylor, Chris D. Zafiratos, Michael A. Dubson, "Modern Physics for Scientists and Engineers", Prentice-Hall of India Private Limited, 2003, 2e
4. R.A. Serway, C.J. Moses, and C.A. Moyer, "Modern Physics", Cengage Learning India Pvt. Ltd, 2004, 3e
5. R. Resnick, "Introduction to Special Relativity", Wiley India Private Limited, 2007
6. R. Murugeshan, Kiruthiga Sivaprasath, "Modern Physics", S. Chand Publishing, 2019, 18e

**PART B**

1. H. K. Malik and A.K. Singh "Engineering Physics", McGraw Hill Education (India) Private Limited, 2018, 2e.
2. R.L. Boylestad, L. Nashelsky, "Electronic Devices and Circuit Theory", Prentice-Hall of India Pvt. Ltd., 2015, 11e
3. J. Millman, C.C. Halkias, Satyabrata Jit, "Electronic Devices and Circuits", McGraw Hill, 2015, 4e
4. B.G. Streetman, S.K. Banerjee, "Solid State Electronic Devices", Pearson Education India, 2015, 7e
5. J.D. Ryder, "Electronic Fundamentals and Applications", Prentice-Hall of India Private Limited, 1975, 5e
6. John M. Senior, "Optical Fiber Communications: Principles and Practice", Pearson Education Limited, 2010, 3e
7. John Wilson, John Hawkes, "Optoelectronics: Principles and Practice", Pearson Education Limited, 2018, 3e
8. S.L. Gupta, V. Kumar, "Hand Book of Electronics", Pragati Prakashan, Meerut, 2016, 43e

If the course is available as Generic Elective then the students of following departments may opt it.

1. Yes open to all

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1. Class tasks/ Sessional Examination | 10 + 10 |
| 2. Assignments | 5 |
| 3. ESE | 75 |
| **Total:** | **100** |

Prerequisites for the course: Passed Semester I, Theory Paper-1 (BSPH-111)

**Course Learning Outcomes:**

- Recognize the difference between the structure of space & time in Newtonian & Relativistic mechanics.
- Understand the physical significance of consequences of Lorentz transformation equations.
- Comprehend the wave-particle duality.

- Develop an understanding of the foundational aspects of Quantum Mechanics.
- Study the working and applications of Michelson and Fabry-Perot interferometers.
- Recognize the difference between Fresnel's and Fraunhofer's class of diffraction.
- Comprehend the use of polarimeters. Study the characteristics and uses of lasers.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: II / Semester: IV**

| | |
|---|---|
| Programme: **B.Sc (PCM/PSM)**<br>Certificate/Diploma/ Degree/ UG(R)/PG/Ph.D.<br>Class:**B.Sc (PCM/PSM)** | Year: **II**<br><br>Semester: **IV** |
| Credits:**02**<br>Theory:<br>Practical:**02** | Subject: **Physics** |
| Course Code:**BSPH-241P** | Title: **Basic Electronics Instrumentation** |

**Course Objectives:**
The purpose of the undergraduate Physics program at the university level is to provide the key knowledge of the fact of science understanding of the law of physics and laboratory resources to prepare students for careers as professionals in various industries and research institutions.

Nature of Paper: **Core**

**Minimum Passing Marks/Credits: 50% Marks**

L: 00
T: 00
P: 04 (In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| | **Lab Experiment List** | |
| | 1. Transistor Bias Stability.<br>2. Comparative Study of CE, CB and CC amplifier.<br>3. Clippers and Clampers.<br>4. Study of Emitter Follower.<br>5. Frequency response of single stage RC coupled amplifier.<br>6. Frequency response of single stage Transformer coupled amplifier.<br>7. Effect of negative feedback on frequency response of RC coupled amplifier.<br>8. Study of Schmitt Trigger.<br>9. Study of Hartley oscillator.<br>10. Study of Wein Bridge oscillator. | **20** |

**Suggested Readings:**

1. R.L. Boylestad, L. Nashelsky, "Electronic Devices and Circuit Theory", Prentice-Hall of India Pvt. Ltd., 2015, 11e
2. J. Millman, C.C. Halkias, Satyabrata Jit, "Electronic Devices and Circuits", McGraw Hill, 2015, 4e
3. B.G. Streetman, S.K. Banerjee, "Solid State Electronic Devices", Pearson Education India, 2015, 7e
4. J.D. Ryder, "Electronic Fundamentals and Applications", Prentice-Hall of India Private Limited, 1975, 5e

5. John M. Senior, "Optical Fiber Communications: Principles and Practice", Pearson Education Limited, 2010, 3e
6. John Wilson, John Hawkes, "Optoelectronics: Principles and Practice", Pearson Education Limited, 2018, 3e
7. S.L. Gupta, V. Kumar, "Hand Book of Electronics", Pragati Prakashan, Meerut, 2016, 43e

If the course is available as Generic Elective then the students of following departments may opt it.

1. Yes Botany/Chem./Comp. Sc./Maths/Stat./Zool.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1. Record File | 15 |
| 2. Viva Voce | 5 |
| 3. Class Interaction | 10 |
| **Total:** | **30** |

Prerequisites for the course:

- The course can be opted by Botany / Chemistry / Computer Science / Mathematics / Statistics / Zoology
- **PREREQUISITE:** Opted / Passed Semester I, Theory Paper-1 (**BSPH-241**)

**Course Learning Outcomes:**

- Basic Electronics instrumentation has the most striking impact on the industry wherever the components / instruments are used to study determine the electronic properties.
- Measurement precision and perfection is achieved through Lab Experiments.
- Online Virtual Lab Experiments give an insight in simulation techniques and provide a basis for modeling.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: II / Semester: IV**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. Class:**B.Sc. (PCM/PSM)** | Year: **II** Semester: **IV** |
| Credits: **06** Theory:**06** Practical: | Subject: **Mathematics** |
| Course Code:**BSMT-241** | Title: **Differential Equations & Mechanics** |

**Course Objectives:**

1. The objective of this course is to familiarize the students with various methods of solving differential equations, partial differential equations of firs order and second order and to have qualitative applications
2. The student, after completing the course can go for higher problems in mechanic such as Hydrodynamics, this will be helpful in getting employment in industry.

Nature of Paper: Core

Minimum Passing Marks/Credits : **40% Marks**

L : 6
T :
P : (In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical-

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | Second order linear differential equations with variable coefficients: Use of a known solution to find another, normal form, method of undetermined coefficient, variation of parameters, Series solutions of differential equations, Power series method. | 12 |
| II | Bessel, Legendre and Hypergeometric functions and their properties, recurrence and generating relations. | 11 |
| III | Origin of first order partial differential equations. Partial differential equations of the first order and degree one, Lagrange's solution, Partial differential equation of first order and degree greater than one. Charpit's method of solution, Surfaces Orthogonal to the given system of surfaces. | 11 |
| IV | Origin of second order PDE, Solution of partial differential equations of the second and higher order with constant coefficients, Classification of linear partial differential equations of second order, Solution of second order partial differential equations with variable coefficients. | 11 |
| V | Frame of reference, work energy principle, Forces in three dimensions, Poinsot's central axis, Wrenches, Null lines and planes. | 12 |
| VI | Virtual work, Stable and Unstable equilibrium, Catenary, Catenary of uniform strength. | 11 |
| VII | Velocities and accelerations along radial and transverse directions, and along tangential and normal directions, Simple Harmonic motion, | 11 |

| | | |
|---|---|---|
| | Motion under other law of forces. Motion in resisting medium, Constrained motion, Motion on smooth and rough plane curves. | |
| VIII | Central orbit, Kepler's laws of motion, Motion of particle in three dimensions, Rotating frame of reference, Rotating Earth, Acceleration in terms of different coordinates systems. | 11 |

**Reference / Text Books:**

**(Part-A Differential Equations):**

1. G.F. Simmons, Differential Equations with Application and Historical Notes, Tata - Mc. Graw Hill.
2. B. Rai, D.P. Choudhary & H. J. Freedman, A Course of Ordinary Differential Equations, Narosa
3. Ian N. Snedden, Elements of Partial Differential Equations, Dover Publication
4. L.E. Elsgolts, Differential Equation and Calculus of variations, University Press of the Pacific.
5. Suggested digital plateform: NPTEL / SWAYAM / MOOCs
6. Course Books (text/reference) published in Hindi may be prescribed by the Universities at local levels.

**Suggested Readings**

**(Part-B Mechanics):**

1. R.C. Hibbeler, Engineering Mechanics-Statics, Prentics Hall Publishers.
2. R.C. Hibbeler, Engineering Mechanics-Dynamics, Prentics Hall Publishers.
3. A. Nelson, Engineering Mechanics Statics and Dynamics, Tata Mc. Graw Hill.
4. J.L. Synge & B.A. Griffith, Principles of Mechanics, Tata Mc. Graw Hill.
5. Suggested digital plateform : NPTEL/SWAYAM/MOOCs.

If the course is available as Generic Elective then the students of following departments may opt it.

1. Engg. and Tech. (UG)
2. Economics (UG/PG)
3. B.Sc. Physics
4. B.Sc. (C.S.)

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 10 |
| 2) Presentations /Seminar | 5 |
| 3) Assignments | 5 |
| 4) Research Project Report<br>Seminar On Research Project Report | 5 |
| 5) ESE | 75 |
| **Total:** | **100** |

| |
|---|
| Prerequisites for the course: Certificate Course in Mathematics |
| Course Learning Outcomes: |
| CO1: The objective of this course is to familiarize the students with various methods of solving differential equations, partial differential equations of firs order and second order and to have qualitative applications.<br>CO2: A student doing this course is able to solve differential equations and is able to model problems in nature using ordinary differential equations. After completing this course, a student will be able to take more courses on wave equation, heat equation, diffusion equation, gas dynamics, non-linear evolution equation etc. These entire courses are important in engineering and industrial applications for solving boundary value problem.<br>CO3: The object of the paper is to give students knowledge of basic mechanics such as simple harmonic motion, motion under other laws and forces.<br>The student, after completing the course can go for higher problems in mechanic such as Hydrodynamics, this will be helpful in getting employment in industry. |

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
Year : **II /** Semester : **IV**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. Class:**B.Sc (PCM)** | **Year: II** **Semester: IV** |
| **Credits: 04** Theory: **04** Practical: | Subject : **Chemistry** |
| **Course Code:BSCH-241** | Title : **Quantum Mechanics and Analytical Techniques** |

**Course Objectives**

1. Students will be able to explore new area so free search in both chemistry and allied fields of science and technology.
2. Students will be able to function as a member of an interdisciplinary problem solving team.
3. Students will be skilled in problem solving, critical thinking and analytical reasoning as applied to scientific problems.
4. Students will gain an understanding of how to determine the structure of organic molecules using IR and NMR spectroscopic techniques.
5. To develop basic skills required for purification, solvent extraction, TLC and column chromatography.

Nature of Paper: **Core**

**Minimum Passing Marks/Credits: 40% Marks**

L: 4
T:
P: (In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| **Unit** | **Contents** | **No.of Lectures Allotted** |
|---|---|---|
| I | **Atomic Structure:** Idea of de-Broglie matter waves, Heisenberg uncertainty principle, atomic orbitals, Schrödinger wave equation, significance of $\Psi$ and $\Psi^2$, quantum numbers, radial and angular wave functions and probability distribution curves, shapes of s, p, d, orbitals. Aufbau and Pauli exclusion principles, Hund's multiplicity rule. | **5** |
| II | **Elementary Quantum Mechanics**: Black-body radiation, Planck's radiation law, photoelectric effect, heat capacity of solids, Bohr's model of hydrogen atom (noderivation) and its defects, Comptoneffect. de-Broglie hypothesis. Heisenberg uncertainty principle. Hamiltonian Operator. Schrödinger wave equation (time dependent and time independent) and its importance, physical interpretation of the wave function, postulates of quantum mechanics, particle in a one dimensional | **10** |

| | | |
|---|---|---|
| | box. Schrödinger wave equation for H-atom, separation into three equations (without derivation), quantum numbers and their importance, hydrogen like wave functions, radial wave functions, angular wave functions. Molecular orbital theory, basic ideas – Criteria for forming MO from AO, construction of MO by LCAO – H2 + ion, calculation of energy levels from wave functions, physical picture of bonding and anti-bonding wave functions, concept of σ, σ*, π, π* orbitals and their characteristics. | |
| III | **MolecularSpectroscopy**:Introduction:Electromagneticradiation,regionsofthe spectrum,basic features of different spectrometers, statement of the Born-Oppenheimer approximation, degrees of freedom<br>**Rotational Spectrum**:<br>Diatomic molecules. Energy levels of a rigid rotor (semi-classical principles), selection rules, spectral intensity, distribution using population distribution (Maxwell- Boltzmann distribution) determination of bond length, qualitative description of non-rigid rotor, isotope effect.<br>**Vibrational Spectrum:**<br>Infrared spectrum : Energy levels of simple harmonic oscillator, selection rules, pure vibrational spectrum, intensity, determination of force constant and qualitative relation of force constant and bond energies, effect of anharmonic motion and isotope on the spectrum, idea of vibrational frequencies of different functional groups.<br>**Raman spectrum:**<br>Concept of polarizability, pure rotational and pure vibrational, Raman spectra of diatomic molecules, selection rules. Electronic Spectrum: Concept of potential energy curves for bonding and anti-bonding molecular orbitals, qualitative description of selection rules and Franck-Condon principle. | **10** |
| IV | **UV-Visible Spectroscopy:**<br>Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules. Types of electronic transitions, λmax, chromophores and auxochromes, Bathochromic and Hypsochromic shifts, Intensity of absorption; application of Woodward Rules for calculation of λmax for the conjugated dienes: alicyclic, homoannular and heteroannular; extended conjugated systems distinction between cis and trans isomers. | **05** |
| V | **Infrared Spectroscopy:**<br>**IR Spectroscopy**: Fundamental and non-fundamental molecular vibrations; Hooke's law selection rule, IR absorption positions of various functional groups; Effect of H-bonding, conjugation, resonance and ring size on IR absorptions; Finger print region and its significance; application in functional group analysis and inter pretation of I.R. spectra of simple organic compounds. | **05** |
| VI | **$^{1}$H-NMR Spectroscopy (PMR)**<br>NMR Spectroscopy : introduction ; nuclearspin; NMR active molecules; basic principles of Proton Magnetic Resonance; choice of solvent and internal standard; equivalent and non-equivalent protons; chemical shift and factors influencing it; ring current effect; significance of the terms: up-/downfield, shielded and deshielded protons; spin coupling and coupling constant (1st order spectra); relative intensities of first-order multiplets: Pascal’s triangle; chemical and magnetic equivalence in NMR ; anisotropic | **10** |

| | | |
|---|---|---|
| | effects in alkene, alkyne, aldehydes and aromatics; NMR peak area, integration; relative peak positions with coupling patterns of common organic compounds; interpretation of NMR spectra of simple compounds. Applications of IR, UV and NMR spectroscopy for identification of simple organic molecules. | |
| VII | **Introduction to Mass Spectrometry:** Principle of mass spectrometry, the mass spectrum, mass spectrometry diagram, molecularion, metastable ion, fragmentation process, Mc-Lafferty rearrangement. | **05** |
| VIII | **Separation Techniques: Solvent:** Extraction: Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation. Technique of extraction: batch, continuous and counter current extractions. Qualitative and quantitative aspects of solvent extraction: extraction of metalions from aqueous solution, extraction of organic species from the aqueous and non-aqueous media. Chromatography: Classification, principle and efficiency of the technique. Mechanism of separation: adsorption, partition & Ionex change. Development of chromatograms: frontal, elution and displacement methods. | **10** |

**Reference / Text Books:**


1. Alberty, R A, Physical Chemistry,4th edition Wiley Eastern Ltd, 2001.
2. Atkins, PW, the elements of physical chemistry,Oxford,1991
3. Barrow, G .M, International student Edition. McGraw Hill, McGraw-Hill, 1973.
4. Cotton, F.A, Wilkinson, G and Gaus, P. L, Basic Inorganic Chemistry, 3rd Edition,Wiley1995
5. Lee, J.D, Concise Inorganic Chemistry 4th Edition ELBS,1977.
6. Clayden, J., Greeves, N., Warren, S., Organic Chemistry, Second edition, Oxford University Press 2012.
7. Silverstein, R. M., Bassler, G. C., Morrill, T. C. Spectrometric Identification of Organic Compounds, John Wiley and Sons, INC, Fifth edition.
8. Pavia, D. L. et al. Introduction to Spectroscopy, 5th Ed. Cengage Learning India Ed.
9. Willard, H.H. et al.: Instrumental Methods of Analysis, 7th Ed. Wards worth Publishing Company, Belmont, California, USA,1988.
10. Christian, G.D. Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.
11. Harris, D.C.: Exploring Chemical Analysis, 9th Ed. New York, W.H. Freeman, 2016.
12. Khopkar, S.M. *Basic Concepts of Analytical Chemistry*. New Age International Publisher, 2009.


If the course is available as Generic Elective then the students of following departments may opt it.

1. B. Pharm.
2. D.Pharm.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1. Class tasks/ Sessional Examination | 10 + 10 |
| 2. Assignments | 5 |
| 3. ESE | 75 |
| **Total:** | **100** |

| |
|---|
| Prerequisites for the course: Basic knowledge of chemistry taught in the preceding semester. |
| **Course Learning Outcomes:**<br>• Students will understand the concept of atomic structure and basic concept of quantum mechanics.<br>• Students will be able to understand the various types of molecular spectroscopies and its importance in chemistry.<br>• Students will be able to understand various aspects mass spectroscopy.<br>• Students will be able to understand the basics of separation techniques and chromatography. |

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: II / Semester: IV**

<table>
<tr><td colspan="2">Programme:<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>Class:B.Sc (PCM)</td><td>Year: II<br><br>Semester: IV</td></tr>
<tr><td colspan="2">Credits:02<br>Theory:<br>Practical:02</td><td>Subject : Chemistry</td></tr>
<tr><td colspan="2">Course Code: BSCH-241P</td><td>Title : Instrumental Analysis</td></tr>
<tr><td colspan="3">Course Objectives:<br>Upon completion of this course, chemistry majors are able to employ critical thinking and scientific inquiry in the performance, design, inter pretation an documentation of laboratory experiments, data level suitable to succeed at an entry-level position in chemical industry or a chemistry graduate program.</td></tr>
<tr><td colspan="3">Nature of Paper: Core</td></tr>
<tr><td colspan="3">Minimum Passing Marks/Credits: 50% Marks</td></tr>
<tr><td colspan="3">L:<br>T:<br>P: 4 (In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)</td></tr>
<tr><th>Unit</th><th>Contents</th><th>No. of Lectures Allotted</th></tr>
<tr><td>I</td><td>Molecular Weight Determination<br>1. Determination of molecular weight of a non-volatile solute by Rast method/ Beckmann freezing point method.<br>2. Determination of the apparent degree of dissociation of an electrolyte (e.g., NaCl) in aqueous solution at different concentrations by ebullioscopy</td><td>10</td></tr>
<tr><td>II</td><td>Spectrophotometry<br>1. To verify Beer – Lambert Law for $KMnO_4/K_2Cr_2O_7$ and determining the concentration of the given solution of the substance from absorption measurement<br>2. Determination of pKa values of indicator using spectrophotometry.<br>3. Determination of chemical oxygen demand (COD).<br>4. Determination of Biological oxygen demand (BOD).</td><td>20</td></tr>
<tr><td>III</td><td>Spectroscopy<br>1. Assignment of labeled peaks in the IR spectrum of the same compound explaining the relative frequencies of the absorptions (C-H, O-H, N-H, C-O, C-N, C-X, C=C, C=O, N=O, C≡C, C≡N stretching frequencies; characteristic bending vibrations are included. Spectra to be provided).<br>2. Assignment of labeled peaks in the $^1H$ NMR spectra of the known organic compounds explaining the relative $\delta$-values and splitting</td><td>10</td></tr>
</table>

| | | |
|---|---|---|
| | pattern.<br>3. Identification of simple organic compounds by IR spectroscopy and NMR spectroscopy (Spectra to be provided). | |
| IV | **Chromatographic Separations**<br>1. Paper chromatographic separation of following metal ions: i. Ni (II) and Co (II) ii. Cu(II) and Cd(II)<br>2. Separation of a mixture of o-and p-nitrophenol or o-and p-aminophenol by thin layer Chromatography(TLC)<br>3. Separation and identification of the amino acids present in the given mixture by paper chromatography. Reporting the Rf values<br>4. TLC separation of a mixture of dyes (fluoresce in and methylene blue) | 20 |

**Reference / Text Books:**


1. Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis 6$^{th}$ Ed.,* Pearson, 2009.
2. Willard, H.H. *et al.*: *Instrumental Methods of Analysis*, 7$^{th}$Ed. Wards worth Publishing Company, Belmont, California, USA,1988.
3. Christian, G.D. *Analytical Chemistry*, 6$^{th}$Ed. John Wiley & Sons, New York, 2004.
4. Harris, D.C. *Exploring Chemical Analysis*, 9$^{th}$Ed. New York, W.H. Freeman,2016.
5. Khopkar, S.M. *Basic Concepts of Analytical Chemistry*. New Age International Publisher, 2009.
6. Skoog, D.A. Holler F.J. and Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Edition.
7. Mikes, O. &Chalmes, R.A. *Laboratory Handbook of Chromatographic & Allied Methods*, Elles Harwood Ltd. London.
8. Ditts, R.V. *Analytical Chemistry: Methods of separation.* Van Nostrand, New York, 1974.


If the course is available as Generic Elective then the students of following departments may opt it.
1. B. Pharm.
2. D. Pharm.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1. Class tasks/ Sessional Examination | 10 |
| 2. Assignments | 10 |
| 3. ESE | 30 |
| **Total:** | **50** |

Prerequisites for the course: Basic knowledge of practical chemistry taught in the preceding semester.

**Course Learning Outcomes:**
- Students will be able to explore new areas of research in both chemistry and allied fields of science and technology.
- Students will be able to function as a member of an interdisciplinary problem solving team.
- Students will be skilled in problem solving, critical thinking and analytical reasoning as applied to scientific problems
- Students will gain an understanding of how to determine the structure of organic molecules using IR and NMR spectroscopic techniques
- To develop basic skills required for purification, solvent extraction, TLC and column chromatography

**IIMTU-NEP IMPLEMENTATION**
**Year: III / Semester: V**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. Class : **B.Sc (PCM/PSM)** | Year: **III** Semester: **V** |
| Credits: **04** Theory: **04** Practical:**0** | Subject: **Physics** |
| **Course code:BSPH-352** | Title: **Quantum Mechanics & Spectroscopy** |

**Course Objectives:**
The purpose of the undergraduate Physics program at the university level is to provide the key knowledge of the fact of science understanding of the law of physics and laboratory resources to prepare students for careers as professionals in various industries and research institutions.

Nature of Paper: **DSC**

Minimum Passing Marks/Credits: **40% Marks**

L: 04
T: 00
P: 00(In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| | **Part A: Introduction to Quantum Mechanics** | |
| I | **Formulation of quantum mechanics & Operators:** Basic idea about particle aspect of radiation, wave aspect of particles and wave particle duality; Double slit experiment, Probabilistic interpretation, wave packet, observables and operators, Hermitian operator (Definition, Proof, properties), commutative and simultaneous operators, Wave function, Orthonormalization condition of wave function, Swartz inequality. Review of matrix algebra, definition of an operator, special operators, operator algebra and operators. | 07 |
| II | **Eigen & Expectation Values and Uncertainty Principle:** Eigen & Expectation Values: Eigen equation for an operator, eigen state (value) and eigen functions. Linear superposition of eigen functions and Non-degenerate & Degenerate eigen states. Expectation value pertaining to an operator and its physical interpretation. Heisenberg uncertainty principle: Commutativity & simultaneity (theorems with proofs). Noncommutativity of operators as the basis for uncertainty principle and derivation of general form of uncertainty principle through Schwarz inequality. Uncertainty principle for various conjugate pairs of physical-dynamical parameters and its applications. | 07 |

| | | |
|---|---|---|
| III | **Quantum Postulates and Schrodinger Equation:**<br>Postulates of quantum mechanics: statements and their physical interpretation. Hamiltonian operator. Schrodinger Equation: formulation (time independent & time dependent forms), Schrodinger equation as an eigen equation, Deviation & interpretation of equation of continuity in Schrodinger representation, and Equation of motion of an operator in Schrodinger representation. Free particle solution of Schrödinger equation. | 07 |
| IV | **Applications of Schrodinger Equation:**<br>Application to 1D Problems: Infinite Square well potential (Particle in 1D box), Finite Square well potential, Potential step, Rectangular potential barrier and 1D Harmonic oscillator. Application to 3D Problems: Infinite Square well potential (Particle in a 3D box) and the Hydrogen atom (radial distribution function and radial probability included). (Direct solutions of Hermite, Associated Legendre and Associated Laguerre differential equations to be substituted). | 09 |
| **PART B: Introduction to Spectroscopy** | | |
| V | **Vector Atomic Model:**<br>Inadequacies of Bohr and Bohr-Sommerfeld atomic models w.r.t. spectrum of Hydrogen atom (fine structure of H-alpha line). Modification due to finite mass of nucleus and Deuteron spectrum. Vector atomic model (Stern-Gerlach experiment included) and physical & geometrical interpretations of various quantum numbers for single & many valence electron systems. LS & JJ couplings, spectroscopic notation for energy states, selection rules for transition of electrons and intensity rules for spectral lines. Fine structure of H-alpha line on the basis of vector atomic model. | 10 |
| VI | **Spectra of Alkali & Alkaline Elements:**<br>Spectra of alkali elements: Screening constants for s, p, d & f orbitals; sharp, principle, diffuse & fundamental series; doublet structure of spectra and fine structure of Sodium D line. Spectra of alkaline elements: Singlet and triplet structure of spectra. | 06 |
| VII | **X-Rays & X-Ray Spectra:**<br>Nature & production, Continuous X-ray spectrum & Duane-Hunt's law, Characteristic X-ray spectrum & Mosley's law, Fine structure of Characteristic X-ray spectrum, and X-ray absorption spectrum. | 07 |
| VIII | **Molecular Spectra:**<br>Discrete set of energies of a molecule, electronic, vibrational and rotational energies. Quantisation of vibrational energies, transition rules and pure vibrational spectra. Quantisation of rotational energies, transition rules, pure rotational spectra and determination of inter nuclear distance. Basics of UV Visible & photoluminescence spectroscopy | 07 |

**Suggested Readings:**
**PART A**


1. D.J. Griffiths, "Introduction to Quantum Mechanics", Pearson Education, India, 2004, 2e
2. H. K. Malik and A.K. Singh "Engineering Physics", McGraw Hill Education (India)

Private Limited, 2018, 2e.
3. N. Zettili, “Quantum Mechanics, Concepts and Applications”, ohn Wiley and Sons, Ltd., Publication 2009.
4. E. Wichmann, “Quantum Physics (In SI Units): Berkeley Physics Course Vol 4”, McGraw Hill, 2017
5. Richard P. Feynman, Robert B. Leighton, Matthew Sands, “The Feynman Lectures on Physics - Vol. 3”, Pearson Education Limited, 2012
6. R Murugeshan, Kiruthiga Sivaprasath, “Modern Physics”, S. Chand Publishing, 2019, 18e

**PART B**

1. H.E. White, “Introduction to Atomic Spectra”, McGraw Hill, 1934
2. C.N. Banwell, E.M. McCash, “Fundamentals of Molecular Spectroscopy”, McGraw Hill, 2017, 4e
3. R Murugeshan, Kiruthiga Sivaprasath, “Modern Physics”, S. Chand Publishing, 2019, 18e
4. S.L. Gupta, V. Kumar, R.C. Sharma, “Elements of Spectroscopy”, Pragati Prakashan, Meerut, 2015, 27e

If the course is available as Generic Elective then the students of following departments may opt it.

1. Yes Chem./ Comp. Sc./ Maths/ Stats

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1. Class tasks/ Sessional Examination | 10 + 10 |
| 2. Assignments | 5 |
| 3. ESE | 75 |
| **Total:** | **100** |

Prerequisites for the course: Passed Semester I, Theory Paper-1 (BSPH-111)

**Course Learning Outcomes:**

- Understand the significance of operator formalism in Quantum mechanics.
- Study the eigen and expectation value methods.
- Understand the basis and interpretation of Uncertainty principle.
- Develop the technique of solving Schrodinger equation for 1D and 3D problems.
- Comprehend the success of Vector atomic model in the theory of Atomic spectra.
- Study the different aspects of spectra of Group I & II elements.
- Study the production and applications of X-rays.
- Develop an understanding of the fundamental aspects of Molecular spectra.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: III / Semester: V**

| | |
|---|---|
| **Programme:** Certificate/Diploma/ Degree/ UG(R)/PG/Ph.D. **Class : B.Sc. (PCM/PSM)** | Year: **III** Semester: **V** |
| Credits:**02** Theory: Practical:**02** | Subject: **Physics** |
| **Course Code:BSPH-351P** | Title: **Demonstrative Aspects of Optics & Lasers** |

**Course Objectives:**
The purpose of the undergraduate Physics program at the university level is to provide the key knowledge of the fact of science understanding of the law of physics and laboratory resources to prepare students for careers as professionals in various industries and research institutions.

Nature of Paper:**Core**

**Minimum Passing Marks/Credits: 50% Marks**

L: 00
T: 00
P: 04 (In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| | **Lab Experiment List** | |
| | 1. Fresnel Biprism: Wavelength of sodium light<br>2. Fresnel Biprism: Thickness of mica sheet)<br>3. Wavelength of Laser light using diffraction by single slit.<br>4. Study of Spectra of Hydrogen & Deuterium (Rydberg Constant).<br>5. Laser – Wavelength of Laser light using diffraction by single slit.<br>6. Study of polarization of light by simple reflection & variation of degree of polarization.<br>7. Study of Absorption spectrum of Iodine Vapour.<br>8. Laser beam divergence & spot size.<br>9. Newton's Rings: Refractive index of liquid<br>10. Plane Diffraction Grating: Resolving power | **20** |

**Suggested Readings:**


1. B.L. Worsnop, H.T. Flint, "Advanced Practical Physics for Students", Methuen & Co., Ltd., London, 1962, 9e
2. S. Panigrahi, B. Mallick, "Engineering Practical Physics", Cengage Learning India Pvt. Ltd., 2015, 1e
3. R.K. Agrawal, G. Jain, R. Sharma, "Practical Physics", Krishna Prakashan Media (Pvt.) Ltd., Meerut, 2019
4. S.L. Gupta, V. Kumar, "Practical Physics", Pragati Prakashan, Meerut, 2014, 2e

If the course is available as Generic Elective then the students of following departments may opt it.

1. Yes Botany/Chem./Comp. Sc./Maths/Stat./Zool.

| Evaluation/Assessment Methodology | |
|---|---|
| | **Max. Marks** |
| 1. Record File<br>2. Viva Voce<br>3. Class Interaction | 15<br>5<br>10 |
| **Total:** | **30** |

Prerequisites for the course:

- The course can be opted by Botany / Chemistry / Computer Science / Mathematics / Statistics / Zoology
- **PREREQUISITE:** Opted / Passed Semester I, Theory Paper-1 (**BSPH-351 and BSPH-352**)

**Course Learning Outcomes:**

- Experimental physics has the most striking impact on the industry wherever the instruments are used to study and determine the optical properties.
- Measurement precision and perfection is achieved through Lab Experiments.
- Online Virtual Lab Experiments give an insight in simulation techniques and provide a basis for modeling.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: III / Semester: V**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D.<br>**Class:**B.Sc. (PCM/PSM) | Year: **III**<br><br>Semester: **V** |
| **Credits: 04**<br>Theory: **04**<br>Practical: | Subject: **Mathematics** |
| **Course Code:BSMT-351** | Title: **Group and Ring Theory & Linear Algebra** |

**Course Objectives:**
1. Linear algebra is a basic course in almost all branches of science. The objective of this course is to introduce a student to the basics of linear algebra and some of its applications.
2. The student will use this knowledge in computer science, finance mathematics, industrial mathematics and bio mathematics. After completion of this course students appreciate its interdisciplinary nature.

**Nature of Paper:** Core

**Minimum Passing Marks/Credits: 40% Marks**

L: 4
T:
P: (In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical-

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | Automorphism, inner automorphism, Automorphism groups, Automorphism groups of finite and infinite cyclic groups, Characteristic subgroups, Commutator subgroup and its properties; Applications of factor groups to automorphism groups. | 10 |
| II | Conjugacy classes, The class equation, □-groups, The Sylow theorems and consequences, Finite simple groups, Generalized Cayley's theorem, Index theorem, Embedding theorem and applications. | 10 |
| III | Polynomial rings over commutative rings, Division algorithm and consequences, Principal ideal domains, Factorization of polynomials, Reducibility tests, Irreducibility tests. | 9 |
| IV | Divisibility in integral domains, Irreducibles, Primes, Unique factorization domains, Euclidean domains. | 9 |
| V | Vector spaces, Subspaces, Linear independence and dependence of vectors, Basis and Dimension, Quotient space. | 10 |
| VI | Linear transformations, The Algebra of linear transformations, rank nullity theorem, their representation as matrices. | 9 |
| VII | Linear functionals, Dual space, Characteristic values, Cayley Hamilton Theorem.<br>Inner product spaces and norms, Cauchy-Schwarz inequality, | 9 |

| | | |
|---|---|---|
| | Orthogonal vectors, | |
| VIII | Orthonormal sets and bases, Bessel's inequality for finite dimensional spaces, Gram-Schmidt orthogonalization process, Bilinear and Quadratic forms.<br>The topic "Indian Ancient Mathematics and Mathematicians" should be covered under Continuous Internal Evaluation (CIE). | 9 |

**Reference / Text Books:**

1. Topics in Algebra by I. N. Herstein.
2. Linear Algebra by K. Hoffman and R. Kunze.
3. Suggested digital plateform:NPTEL/SWAYAM/MOOCS

If the course is available as Generic Elective, then the students of following departments may opt it.

1. Engg. and Tech. (UG)
2. Economics (UG/PG)
3. B.Sc. (C.S.)

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 10 |
| 2) Presentations /Seminar | 5 |
| 3) Assignments | 5 |
| 4) Research Project Report<br>Seminar On Research Project Report | 5 |
| 5) ESE | **75** |
| **Total:** | 100 |

Prerequisites for the course: Diploma in Mathematics

**Course outcomes:**

CO1: Linear algebra is a basic course in almost all branches of science. The objective of this course is to introduce a student to the basics of linear algebra and some of its applications.

CO2: The student will use this knowledge in computer science, finance mathematics, industrial mathematics and bio mathematics. After completion of this course students appreciate its interdisciplinary nature.

**IIMTU-NEP IMPLEMENTATION**
**Year: III / Semester: V**

| | |
|---|---|
| **Programme:**<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>Class:**B.Sc. (PCM)** | **Year: III**<br><br>**Semester: V** |
| **Credits: 04**<br>Theory: **04**<br>Practical: 0 | Subject: **Chemistry** |
| **Course Code:BSCH-351** | Title: **Organic Synthesis A** |

**Course Objectives:**
1. Synthesis and chemical properties of aliphatic and aromatic hydrocarbons
2. Synthesis and chemical properties of alcohols, halides carbonyl compounds, carboxylic acids and esters.
3. How to design and synthesize aliphatic and aromatic hydrocarbons.
4. How to convert aliphatic and aromatic hydrocarbons to other industrially important compounds.
5. T Functional group inter conversion.

Nature of Paper: **DSE**

**Minimum Passing Marks/Credits: 40% Marks**

L: 4
T:
P: 4 (In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | **Chemistry of Alkanes and Cycloalkanes**<br>A) **Alkanes** : Classification of carbonatom in alkanes, General methods of preparation, physical and chemical properties of alkanes: Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halo genation-relative reactivity and selectivity<br>B) **Cycloalkanes:** Nomenclature, methods of formation, chemical reactions, Baeyer's strain theory and its limitations. Chair, Boatand Twist boat forms of cyclohexane with energy diagrams ring strain in small rings, theory of strain less rings. The case of cyclopropane ring, banana bonds. | **10** |
| II | **Chemistry of Alkenes**<br>Methods of formation of alkenes, Addition to **C=C :** mechanism (with evidence wherever applicable), reactivity, regioselectivity (Markownikoff and anti-Markownikoff additions) and stereoselectivity; reactions: hydrogenation, halogenation, hydrohalogenation, hydration, oxymercurationdemercuration, hydroboration-oxidation, epoxidation, *syn*and*anti*-hydroxylation, ozonolysis, addition of singlet and triplet carbenes; Simmons-Smith cyclopropanation reaction; electrophilic | **10** |

| | | |
|---|---|---|
| | Addition to diene (conjugated di enes and allene); radical addition: HBr addition; mechanism of allylic and benzylicbromination in competition with bromination across C=C; use of NBS; interconversion of *E*- and *Z*- alkenes; contra-thermodynamic isomerization of internal alkenes | |
| III | **Chemistry of Alkynes**<br>Methods of formation of alkynes, Addition to C≡C, mechanism, reactivity, regioselectivity and stereoselectivity; reactions: hydrogenation, halogenations, hydrohalogenation, hydration, oxymercurationdemercuration, hydroboration-oxidation, dissolving metal reduction of alkynes (Birch); reactions of terminal alkynes by exploring its acidity; inter conversion of terminal and non- terminal alkynes. | **05** |
| IV | **Aromaticity and Chemistry of Arenes**<br>Nomenclature of benzene derivatives, MO picture of benzene, Aromaticity: Hückel's rule, aromatic character of arenes, cyclic carbocations/carbanions. Electrophilic aromatic substitution: halogenations,nitration, sulphonationandFriedel-Craft'salkylation/acylationwiththeirMechanism. Directingeffectsofthegroups.Birchreduction,Methodsofformationandchemicalreactionsof<br>Alkyl benzenes, alkyl benzenes and biphenyl, naphthalene and anthracene. | **05** |
| V | **Chemistry of Alcohols**<br>Classification and nomenclature, Monohydric alcohols – nomenclature, methods of formation by reduction of Aldehydes, Ketones, Carboxylic acids and Esters, Hydrogen bonding, Acidic nature, Reactions of alcohols. Dihydric alcohols nomenclature, methods of formation, chemical reactions of vicinal glycols, oxidative cleavage [Pb(OAc)4 and HIO4] and pinacolpinacolone rearrangement. Trihydric alcohols - nomenclature, methods of formation, chemical reactions of glycerol. | **10** |
| VI | **Chemistry of Phenols** : Nomenclature, structure and bonding, preparation of phenols, physical properties and acidic character, Comparative acidic strengths of alcohols and phenols, resonance stabilization of phenoxideion. Reactions of phenols – electrophilic aromatic substitution, acylation and carboxylation. Mechanisms of Friesrearrangement, Claisen rearrangement, Gatterman syntheis, Hauben Hoesch reaction, Lederer-Manasse reaction and Reimer-Tiemann reaction | **10** |
| VII | **Chemistry of Ethers and Epoxides**: Nomenclature of ethers and methods of their formation, physical properties, Chemical reactions – cleavage and autoxidation, Ziesel's method. Synthesis of epoxides, Acid and base-catalyzed ring opening of epoxides, orientation of epoxide ring opening, reactions of Grignard and organo lithium reagents with epoxides. | **05** |
| VIII | **Chemistry of Organic Halides**<br>Nomenclature and classes of alkyl halides, methods of formation, chemical reactions, Mechanisms of nucleophilic substitution reactions of alkyl halides, SN2 and SN1 reactions with energy profile | **05** |

| | | |
|---|---|---|
| | diagrams;Polyhalogencompounds:Chloroform,carbontetrachloride;Methodsofformationofaryl halides, nuclear and side chain reactions; The addition-elimination and the elimination-addition mechanisms of nucleophilic aromatic substitution reactions; Relative reactivities of alkyl halides vs allyl, vinyl and aryl halides, Synthesis and uses of DDT and BHC. | |

**Reference / Text Books:**


1. Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Sykes, P. *A guidebook to Mechanism in Organic Chemistry,* Pearson Education, 2003.
3. Carey, F. A., Guiliano, R. M. *Organic Chemistry*, Eighth edition, McGraw Hill Education, 2012.
4. Loudon, G. M. *Organic Chemistry*, Fourth edition, Oxford University Press, 2008.
5. Clayden, J., Greeves, N. &Warren, S. *Organic Chemistry,* 2nd edition, Oxford University Press, 2012.
6. Graham Solomons, T.W., Fryhle, C. B. *Organic Chemistry,* John Wiley & Sons, Inc.
7. Smith, J. G. *Organic Chemistry*, Tata McGraw-Hill Publishing Company Limited.
8. March, J. *Advanced Organic Chemistry*, Fourth edition, Wiley.


If the course is available as Generic Elective then the students of following departments may opt it.

1. B. Pharm.
2. D. Pharm.

**Evaluation/Assessment Methodology**

| **Max. Marks** | |
|---|---|
| 1. Class tasks/ Sessional Examination | 10 + 10 |
| 2. Assignments | 5 |
| 3. ESE | 75 |
| **Total:** | **100** |

Prerequisites for the course: Knowledge of chemistry taught in the preceding semester.

**Course Learning Outcomes:**

1. Students will able to understand the concept of introductory and advance knowledge of hydrocarbons.
2. Students will be able to understand aromaticity and arenes.
3. Students will be able to understand alcohols, phenols and epoxides.
4. Students will be able to understand the basics chemistry of organic halides.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: III / Semester: V**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. Class:**B.Sc. (PCM)** | Year: **III** Semester: **V** |
| Credits:**02** Theory: Practical:**02** | Subject: **Chemistry** |
| **Course Code: BSCH-351P** | Title: **Qualitative Analysis** |

**Course Objectives:**
Upon completion of this course the students will have the knowledge and skills to: understand the laboratory methods and tests related to inorganic mixtures and organic compounds.

Nature of Paper: **DSE**

**Minimum Passing Marks/Credits: 50% Marks**

L:
T:
P: 4 (In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | **Inorganic Qualitative Analysis**<br>Semi micro Analysis–cation analysis, separation and identification of ions from Groups I, II, III, IV, V and VI, Anion analysis. Mixture containing 6 radicals-2 +4 or 4+ or 3+3 | 16 |
| II | **Elemental analysis and identification of functional groups**<br>Detection of extra elements (N, S and halogens) and functional groups (phenolic, carboxylic, carbonyl, esters, carbohydrates, amines, amides, nitro and anilide) in simple organic compounds. | 14 |
| III | **Separation of Organic Mixture**<br>Analysis of an organic mixture containing two solid components using water, $NaHCO_3$, NaOH for separation and preparation of suitable derivatives | 18 |
| IV | **Identification of organic compounds**<br>Identification of anorganic compound through the functional group analysis, determination of melting point and preparation of suitable derivatives. | 12 |

**Reference / Text Books:**

1. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
2. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
3. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.

4. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960.
5. Harris,D.C. *Exploring Chemical Analysis*, 9thEd. New York, W.H. Freeman, 2016.
6. Khopkar, S.M. *Basic Concepts of Analytical Chemistry*. New Age International Publisher, 2009.

If the course is available as Generic Elective then the students of following departments may opt it.

1. B. Pharm.
2. D. Pharm.

| **Evaluation/Assessment Methodology** | |
|---|---|
| | **Max. Marks** |
| 1. Class tasks/ Sessional Examination<br>2. Assignments<br>3. ESE | 10<br>10<br>30 |
| **Total:** | **50** |

Prerequisites for the course: Knowledge of practical chemistry taught in the preceding semester.

**Course Learning Outcomes:**

- Identification of acidic and basic radicals in inorganic mixtures
- Separation of organic compounds from mixture
- Elemental analysis in organic compounds
- Identification of functional group in organic compounds
- Identification of organic compound

**IIMTU-NEP IMPLEMENTATION**
**Year: III / Semester: V**

<table>
<tr><td colspan="2">Programme:<br>Certificate/Diploma/Degree/<br>UG/PG/Ph.D.<br>Class:B.Sc. (PCM)</td><td>Year: III<br><br>Semester: V</td></tr>
<tr><td>Credits: 04<br>Theory: 04<br>Practical:</td><td colspan="2">Subject: Chemistry</td></tr>
<tr><td>Course Code:BSCH-352</td><td colspan="2">Title: Rearrangements and Chemistry of Group Elements</td></tr>
<tr><td colspan="3">Course Objectives:<br>This paper provides detailed knowledge of synthesis of various classes of organic compounds and functional groups inter conversion. Organic synthesis is the most important branch of organic chemistry which provides jobs in production & QC departments related to chemicals, drugs, medicines, FMCG etc. industries.</td></tr>
<tr><td colspan="3">Nature of Paper: DSE</td></tr>
<tr><td colspan="3">Minimum Passing Marks/Credits: 40% Marks</td></tr>
<tr><td colspan="3">L: 4<br>T:<br>P: (In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)</td></tr>
</table>

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | **Rearrangements**<br>A detailed study of the following rearrangements: Pinacol-pinacolone, Demjanov, Benzil Bensilic acid, Favorskii, Hofman, Curtius, Schmidt, Baeyer-Villiger and Fries rearrangement | **6** |
| II | **Catalysis**<br>General principles and properties of catalysts, homogenous catalysis (catalytic steps and examples) and heterogenous catalysis (catalytic steps and examples) and their industrial applications, Deactivation or regeneration of catalysts. Phase transfer catalysts, application of zeolites as catalysts. Enzyme catalysis; Michaelis-Menten equation, Lineweaver-Burk plot, turn-overnumber. | **8** |
| III | **Chemistry of Main Group Elements**<br>**s-Block Elements :** Comparative study, diagonal relationship, salient features of hydrides, solvation and complexation tendencies including their function in bio systems, an introduction to alkyls and aryls.<br>**p-Block Elements** : Comparative study (including diagonal relationship) of groups13-17elements, compound slikehydrides, oxides, oxyacids and halides of group13-16, hydrides of boron-diborane and higher boranes, borazine, borohydrides, fullerenes, carbides, fluorocarbons, silicates (structural principle), tetra sulphur | **10** |

| | | |
|---|---|---|
| | tetra nitride, basic properties of halogens, inter halogens and polyhalides.<br>**Chemistry of Noble Gasses** : Chemical properties of the noblegases, chemistry of xenon, structure and bonding in xenon compounds. | |
| IV | **Chemistry of Transition Elements**<br>**Chemistry of Elements of First Transition Series**-Characteristic properties of d-block elements. Binary compounds (hydrides, carbides and oxides) of the elements of the first transition series and complexes with respect to relative stability of their oxidation states, coordination number and geometry.<br>**Chemistry of Elements of Second and Third Transition Series-** General characteristics, comparative treatment of Zr/Hf, Nb/Ta, Mo/W in respect of ionic radii, oxidation states, magnetic behavior, spectral properties and stereochemistry. | **06** |
| V | **Chemistry of Alcohols Chemistry of Lanthanides**<br>Electronic structure, oxidation states and ionic radii and lanthanide contraction, complex formation, occurrence and isolation, ceric ammonium sulphate and its analytical uses. | **4** |
| VI | **Chemistry of Actinides**<br>Electronic configuration, oxidation states and magnetic properties, chemistry of separation of Np, Pu and Am from U. | **4** |
| VII | **Metal Carbonyls**<br>Metal carbonyls: 18-electronrule, preparation, structure and nature of bonding in the mononuclear and dinuclea carbonyls. | **06** |
| VIII | **Bioinorganic Chemistry**<br>Essential and trace elements in biological processes, metallo porphyrins with special reference to heamoglobin and myoglobin. Biological role of alkali and alkaline earth metal ions with special reference to $Ca^{2+}$ . Nitrogen fixation. | **06** |

**Reference / Text Books:**

1. Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Sykes, P. *A guidebook to Mechanism in Organic Chemistry,* Pearson Education, 2003.
3. Carey, F. A., Guiliano, R. M. *Organic Chemistry*, Eighth edition, McGraw Hill Education,2012.
4. Loudon, G. M. *Organic Chemistry*, Fourth edition, Oxford University Press, 2008.
5. Clayden, J., Greeves, N. &Warren, S. *Organic Chemistry,* 2nd edition, Oxford University Press, 2012.
6. Graham Solomons, T.W., Fryhle, C. B. *Organic Chemistry,* John Wiley & Sons, Inc.

If the course is available as Generic Elective then the students of following departments may opt it.

1. B. Pharm.
2. D. Pharm.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1. Class tasks/ Sessional Examination | 10 + 10 |
| 2. Assignments | 5 |
| 3. ESE | 75 |

| | |
|---|---|
| **Total:** | **100** |

| |
|---|
| Prerequisites for the course: Knowledge of chemistry taught in the preceding semester. |
| **Course Learning Outcomes:**<br>• It relates and gives an analytical aptitude for synthesizing various industrially important compounds.<br>• This paper also provides a detailed knowledge on the elements present in our surroundings, their occurrence in nature. Their position in periodic table, their physical and chemical properties as well as their extraction. This paper also gives detailed understanding of thes, p,d and f block elements and their characteristics. |

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: III / Semester: VI**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. Class:**B.Sc. (PCM/PSM)** | Year: **III**<br><br>Semester: **VI** |
| Credits: **04**<br>Theory:**04**<br>Practical: | Subject: **Physics** |
| **Course Code:BSPH-361** | Title: **Solid State & Nuclear Physics** |

**Course Objectives:**
The purpose of the undergraduate Physics program at the university level is to provide the key knowledge of the fact of science understanding of the law of physics and laboratory resources to prepare students for careers as professionals in various industries and research institutions.

Nature of Paper: **DSC**

**Minimum Passing Marks/Credits:40% Marks**

L: 04
T: 00
P: 0 (In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| | **Part A: Introduction to Solid State Physics I** | |
| I | **Crystal Structure:**<br>Lattice, Basis & Crystal structure. Lattice translation vectors, Primitive & non-primitive cells. Symmetry operations. 2D & 3D Bravais lattice. Parameters of cubic lattices. Lattice planes and Miller indices. Simple crystal structures - Sodium Chloride. | 07 |
| II | **Diffraction:**<br>X-ray diffraction and Bragg's law. Experimental diffraction methods - Laue, Rotating crystal and Powder methods. Derivation of scattered wave amplitude. Reciprocal lattice, Reciprocal lattice vectors and relation between Direct & Reciprocal lattice. Reciprocal lattice to SC, BCC & FCC lattices. | 07 |
| III | **Crystal Bindings:**<br>Classification of Crystals on the Basis of Bonding - Ionic, Covalent, Metallic, van der Waals Molecular) and Hydrogen bonded. Crystals of inert gases, Attractive interaction (vander Waals-London) & Repulsive interaction, Equilibrium lattice constant, Cohesive energy and Compressibility & Bulk modulus. Ionic crystals, Cohesive energy, Madelung energy and evaluation of Madelung constant. | 07 |
| IV | **Lattice Vibrations:**<br>Lattice Vibrations: Lattice vibrations for linear mono & di atomic | 09 |

| | | |
|---|---|---|
| | chains. Qualitative description of Phonons in solids. Free Electron Theory: Fermi energy, Density of states, Heat capacity of conduction electrons, and Paramagnetic susceptibility of conduction electrons and Hall Effect in metals. Band Theory: Origin of band theory, Qualitative idea of Bloch theorem, Kronig-Penney model, Effectice mass of an electron & Concept of Holes and Classification of solids on the basis of band theory. | |
| | **Part B: Introduction to Nuclear Physics** | |
| V | **Nuclear Forces & Radioactive Decays:**<br>General Properties of Nucleus: Mass, binding energy, angular momentum, magnetic dipole moment vector. Nuclear Forces: General characteristic of nuclear force and Deuteron ground state properties. | 08 |
| VI | **Nuclear Models & Nuclear Reactions:**<br>Nuclear Models: Liquid drop model Nuclear Reactions: types of nuclear reaction, Conservation laws, Cross-section of nuclear reaction, Theory of nuclear fission (qualitative), Nuclear reactors and Nuclear fusion. | 08 |
| VII | **Accelerators & Detectors:**<br>Accelerators: Theory, working and applications of Van de Graaff accelerator, Cyclotron and Synchrotron. | 06 |
| VIII | **Elementary Particles:**<br>Fundamental interactions & their mediating quanta. Concept of antiparticles. Classification of elementary particles based on intrinsicspin, mass, interaction & lifetime. Families of Leptons, Mesons, Baryons & Baryon Resonances. Conservation laws for mass-energy, linear momentum, angular momentum, electric charge, baryonic charge, leptonic charge, isospin & strangeness. Concept of Quark model. | 08 |

**Suggested Readings**

**PART A**


1. Charles Kittel, "Introduction to Solid State Physics", Wiley India Private Limited, 2004, 8e
2. J.P. Srivastava, "Elementa of Solid State Physics", Prentice-Hall of India Private Limited, 2014, 4e
3. R.K. Puri, V.K. Babbar, "Solid State Physics", S. Chand Publishing, 2015


**PART B**


1. Kenneth S. Krane, "Introductory Nuclear Physics", Wiley India Private Limited, 2008
2. Bernard L. Cohen, "Concepts of Nuclear Physics", McGraw Hill, 2017
3. D.C. Tayal, "Nuclear Physics", Himalaya Publishing House Pvt. Ltd., 2011, 5e


If the course is available as Generic Elective then the students of following departments may opt it.

1. Chem./Comp. Sc/ Maths/ Stat.

| Evaluation/Assessment Methodology | |
|---|---|
| | **Max. Marks** |
| 1. Class tasks/ Sessional Examination<br>2. Assignments<br>3. ESE | 10 + 10<br>5<br>75 |
| **Total:** | **100** |
| Prerequisites for the course: Passed Semester I, Theory Paper-1 (BSPH-111) | |

**Course Learning Outcomes:**

- Understand the crystal geometry w.r.t. symmetry operations.
- Comprehend the power of X-ray diffraction and the concept of reciprocal lattice.
- Study various properties based on crystal bindings.
- Recognize the importance of Free Electron & Band theories in understanding the crystal properties.
- Study the salient features of nuclear forces & radioactive decays.
- Understand the importance of nuclear models & nuclear reactions.
- Comprehend the working and applications of nuclear accelerators and detectors.
- Understand the classification and properties of basic building blocks of nature.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: III / Semester: VI**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. Class:**B.Sc (PCM/PSM)** | Year: **III** Semester: **VI** |
| Credits: **04** Theory: **04** Practical: | Subject: **Physics** |
| **Course Code:BSPH-362** | Title: **Analog & Digital Principles & Applications** |
| **Course Objectives:** The purpose of the undergraduate Physics program at the university level is to provide the key knowledge of the fact of science understanding of the law of physics and laboratory resources to prepare students for careers as professionals in various industries and research institutions. | |
| Nature of Paper: **DSC** | |
| Minimum Passing Marks/Credits: **40% Marks** | |
| L: 04<br>T: 00<br>P: 00 (In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits) | |

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| | **Part A: Analog Electronic Circuits** | |
| I | **Semiconductor Junction:** Expressions for Fermi energy, Electron density in conduction band, Hole density in valence band, Drift of charge carriers (mobility & conductivity), Diffusion of charge carries and Life time of charge carries in a semiconductor. Work function in metals and semiconductors. Expressions for Barrier potential, Barrier width and Junction capacitance (diffusion & transition) for depletion layer in a PN junction. Expressions for Current (diode equation) and Dynamic resistance for PN junction. | 09 |
| II | **Transistor Modeling:** Transistor as Two-Port Network. Notation for dc & ac components of voltage & current. Quantitative discussion of Z, Y & h parameters and their equivalent two-generator model circuits. h-parameters for CB, CE & CC configurations. Analysis of transistor amplifier using the hybrid equivalent model and estimation of Input Impedance, Output Impedance and Gain (current, voltage & power). | 08 |
| III | **Field Effect Transistors:** JFET: Construction (N channel & P channel); Configuration (CS, CD & CG); Operation in different regions (Ohmic or Linear, Saturated or Active or Pinch off & Break down); Important Terms (Shorted Gate Drain Current, Pinch Off Voltage & Gate Source Cut- | 08 |

| | | |
|---|---|---|
| | Off Voltage); Expression for Drain Current (Shockley equation); Characteristics (Drain & Transfer); Parameters (Drain Resistance, Mutual Conductance or Tran conductance & Amplification Factor); Biasing w.r.t. CS configuration (Self Bias & Voltage Divider Bias); Amplifiers (CS & CD or Source Follower); Comparison (N & P channels and BJTs & JFETs). MOSFET: Construction and Working of D-MOSFET (N channel & P channel) and E-MOSFET (N channel & P channel); Characteristics (Drain & Transfer) of D-MOSFET and E-MOSFET; Comparison of JFET and MOSFET. | |
| IV | **Other Devices:**<br>SCR: Construction; Equivalent Circuits (Two Diodes, Two Transistors & One Diode-One Transistor); Working (Off state & On state); Characteristics; Applications (Static switch, Phase control system & Battery charger). UJT: Construction; Equivalent Circuit; Working (Cutoff, Negative Resistance & Saturation regions); Characteristics (Peak & Valley points); Applications (Trigger circuits, Relaxation oscillators & Sawtooth generators). | 05 |
| **PART B: Digital Electronics** | | |
| V | **Number System:**<br>Number Systems: Binary, Octal, Decimal & Hexadecimal number systems and their inter conversion. Binary Codes: BCD, Excess-3 (XS3), Parity, Gray, ASCII & EBCDIC Codes and their advantages & disadvantages. Data representation. | 06 |
| VI | **Binary Arithmetic:**<br>Binary Addition, Decimal Subtraction using 9's & 10's complement, Binary Subtraction using 1's & 2's compliment, Multiplication and Division. | 05 |
| VII | **Logic Gates:**<br>Truth Table, Symbolic Representation and Properties of OR, AND, NOT, NOR, NAND, EX-OR & EX-NOR Gates. Implementation of OR, AND & NOT gates (realization using diodes & transistor). De Morgan's theorems. NOR & NAND gates as Universal Gates. Application of EX-OR & EX-NOR gates as pairty checker. Boolean Algebra. Karnaugh Map. | 09 |
| VIII | **Combinational & Sequential Circuits:**<br>Combinational Circuits: Half Adder, Full Adder, Parallel Adder, Half Substractor, Full Substractor. Data Processing Circuits: Multiplexer, Demultiplexer, Decoders & Encoders. Sequential Circuits: SR, JK & D Flip-Flops, Shift Register (transfer operation of Flip-Flops), and Asynchronous & Synchronous counters. | 10 |

**Suggested Readings**

**PART A**


1. R.L. Boylestad, L. Nashelsky, "Electronic Devices and Circuit Theory", Prentice-Hall of India Pvt. Ltd., 2015, 11e
2. J. Millman, C.C. Halkias, Satyabrata Jit, "Electronic Devices and Circuits", McGraw Hill, 2015, 4e
3. B.G. Streetman, S.K. Banerjee, "Solid State Electronic Devices", Pearson Education India, 2015, 7e

4. J.D. Ryder, "Electronic Fundamentals and Applications", Prentice-Hall of India Private Limited, 1975, 5e
5. S.L. Gupta, V. Kumar, "Hand Book of Electronics", Pragati Prakashan, Meerut, 2016, 43e

**PART B**

1. D. Leach, A. Malvino, Goutam Saha, "Digital Principles and Applications", McGraw Hill, 2010, 7e
2. William H. Gothmann, "Digital Electronics: An Introduction to Theory and Practice", Prentice-Hall of India Private Limited, 1982, 2e
3. R.P. Jain, "Modern Digital Electronics", McGraw Hill, 2009, 4e

If the course is available as Generic Elective then the students of following departments may opt it.

1. Chem./Comp. Sc/ Maths/ Stat.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1. Class tasks/ Sessional Examination | 10 + 10 |
| 2. Assignments | 5 |
| 3. ESE | 75 |
| **Total:** | **100** |

Prerequisites for the course: Passed Semester I, Theory Paper-1 (BSPH-111)

**Course outcomes:**

- Study the drift and diffusion of charge carriers in a semiconductor.
- Understand the Two-Port model of a transistor.
- Study the working, properties and uses of FETs.
- Comprehend the design and operations of SCRs and UJTs.
- Understand various number systems and binary codes.
- Familiarize with binary arithmetic.
- Study the working and properties of various logic gates.
- Comprehend the design of combinational and sequential circuits.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: III / Semester: VI**

| | |
|---|---|
| **Programme:** Certificate/Diploma/ Degree/ UG(R)/PG/Ph.D. Class:**B.Sc. (PCM/PSM)** | Year: **III** Semester: **VI** |
| Credits: **02** Theory: Practical:**02** | Subject: **Physics** |
| **Course Code:BSPH-361P** | **Title: Analog & Digital Circuits** |

**Course Objectives:**
The purpose of the undergraduate Physics program at the university level is to provide the key knowledge of the fact of science understanding of the law of physics and laboratory resources to prepare students for careers as professionals in various industries and research institutions.

Nature of Paper: **DSE**

**Minimum Passing Marks/Credits: 50% Marks**

L: 00
T: 00
P: 04 (In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| | **Lab Experiment List** | |
| | 1. Energy band gap of semiconductor by reverse saturation current method.<br>2. Energy band gap of semiconductor by four probe method.<br>3. Hybrid parameters of transistor.<br>4. Characteristics of FET, MOSFET, SCR, UJT.<br>5. FET Conventional Amplifier<br>6. FET as VVR and VCA.<br>7. Study and Verification of AND gate using TTL IC 7408.<br>8. Study and Verification of OR gate using TTL IC 7432.<br>9. Study and Verification of NAND gate and use as Universal gate using TTL IC 7400.<br>10. Study and Verification of NOR gate and use as Universal gate using TTL IC 7402.<br>11. Study and Verification of NOT gate using TTL IC 7404.<br>12. Study and Verification of Ex-OR gate using TTL IC 7486 | **20** |

**Suggested Readings:**

1. R.L. Boylestad, L. Nashelsky, “Electronic Devices and Circuit Theory”, Prentice-Hall of India Pvt. Ltd., 2015, 11e
2. J. Millman, C.C. Halkias, Satyabrata Jit, “Electronic Devices and Circuits”, McGraw Hill, 2015, 4e.
3. B.G. Streetman, S.K. Banerjee, “Solid State Electronic Devices”, Pearson Education

| |
|---|
| India, 2015, 7e.<br>4. J.D. Ryder, "Electronic Fundamentals and Applications", Prentice-Hall of India Private Limited, 1975, 5e.<br>5. S.L. Gupta, V. Kumar, "Hand Book of Electronics", Pragati Prakashan, Meerut, 2016, 43e<br>6. D. Leach, A. Malvino, Goutam Saha, "Digital Principles and Applications", McGraw Hill, 2010, 7e.<br>7. William H. Gothmann, "Digital Electronics: An Introduction to Theory and Practice", Prentice-Hall of India Private Limited, 1982, 2e.<br>8. R.P. Jain, "Modern Digital Electronics", McGraw Hill, 2009, 4e |
| If the course is available as Generic Elective then the students of following departments may opt it.<br>1. Yes Chem./Comp. Sc./Maths/Stat. |

**Evaluation/Assessment Methodology**

| | Max. Marks |
|---|---|
| 1. Record File | 15 |
| 2. Viva Voce | 5 |
| 3. Class Interaction | 10 |
| **Total:** | **30** |

Prerequisites for the course:

- The course can be opted by Botany / Chemistry / Computer Science / Mathematics / Statistics / Zoology
- **PREREQUISITE:** Opted / Passed Semester I, Theory Paper-1 (**BSPH-361 and BSPH-362**)

**Course Learning Outcomes:**

- Analog & digital circuits have the most striking impact on the industry wherever the electronics instruments are used to study and determine the electronic properties.
- Measurement precision and perfection is achieved through Lab Experiments.
- Online Virtual Lab Experiments give an insight in simulation techniques and provide a basis for modeling.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: III / Semester: VI**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. **Class:B.Sc. (PCM/PSM)** | Year: **III** Semester: **VI** |
| **Credits: 04** Theory: **04** Practical: | **Subject: Mathematics** |
| **Course Code: BSMT-361** | **Title: Metric Spaces & Complex Analysis** |

**Course Objectives:**

1. The course is aimed at exposing the students to foundations of analysis which will be useful in understanding various physical phenomena and gives th1 student the foundation in mathematics.
2. The student will be able to solve various problems based on linear programming. After successful completion of this paper will enable the students to apply th1

**Nature of Paper:** Core

**Minimum Passing Marks/Credits: 40% Marks**

L: 4
T:
P: (In Hours/Week)
Theory - 1 Hr. = 1 Credit

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | Metric spaces: Definition and examples, Sequences in metric spaces, Cauchy sequences, Complete metric space. | 10 |
| II | Open and closed ball, Neighborhood, Open set, Interior of a set, limit point of a set, derived set, closed set, closure of a set, diameter of a set. | 9 |
| III | Continuous mappings, Sequential criterion and other characterizations of continuity, Uniform continuity, Homeomorphism, Contraction mapping, Banach fixed point theorem. | 9 |
| IV | Connectedness, Connected subsets of R, Connectedness and continuous mappings, Compactness, Compactness and boundedness, Continuous functions on compact spaces. | 9 |
| V | Functions of complex variable, Mappings; Mappings by the exponential function, Limits, Limits involving the point at infinity, Continuity, Derivatives, Differentiation formulae, Cauchy-Riemann equations, Sufficient conditions for differentiability; Analytic functions and their examples. | 10 |
| VI | Exponential function, Logarithmic function, Branches of logarithms, Trigonometric function, Derivatives of functions, Definite integrals of functions, Contours, Contour integrals and its examples, Upper bounds. | 9 |

| | | |
|---|---|---|
| VII | Antiderivatives, Proof of antiderivative theorem, Cauchy-Goursat theorem, Cauchy integral formula; An extension of Cauchy integral formula, Consequences of Cauchy integral formula, Liouville's theorem and the fundamental theorem of algebra. | 9 |
| VIII | Convergence of sequences and series, Taylor series and its examples; Laurent series and its examples. Isolated singular points, Residues, Cauchy's residue theorem, residue at infinity; Types of isolated singular points, Residues at poles and its examples. | 9 |

**Reference / Text Books:**
**(Part-A Metric Space):**

1. Mathematical Analysis by Shanti Narain.
2. Shirali, Satish & Vasudeva, H. L. (2009). Metric Spaces, Springer, First Indian Print.
3. Kumaresan, S. (2014). Topology of Metric Spaces (2nd ed.). Narosa Publishing House. New Delhi.
4. Simmons, G. F. (2004). Introduction to Topology and Modern Analysis.Tata McGraw Hill. New Delhi.
5. Suggested digital plateform:NPTEL/SWAYAM/MOOCS.
6. Course Books (text/reference) published in Hindi may be prescribed by the Universities at local levels.

**Suggested Readings (Part-B Complex Analysis):**

1. Function of Complex Variable by Shanti Narain.
2. Complex variable and applications by Brown & Churchill.
3. Suggested digital plateform:NPTEL/SWAYAM/MOOCS.

If the course is available as Generic Elective, then the students of following departments may opt it.

1. Engg. and Tech. (UG)
2. B.Sc. (C.S.)

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 10 |
| 2) Presentations /Seminar | 5 |
| 3) Assignments | 5 |
| 4) Research Project Report<br>Seminar On Research Project Report | 5 |
| 5) ESE | **75** |
| **Total:** | 100 |

Prerequisites for the course: Diploma in Mathematics

**Course outcomes:**

CO1: The course is aimed at exposing the students to foundations of analysis which will be useful in understanding various physical phenomena and gives th1 student the foundation in mathematics.

CO2: After completion of this course the student will have rigorous and deeper understanding of fundamental concepts in Mathematics. This will be helpful the student in understanding pure mathematics and in research.

CO3: The student will be able to solve various problems based on linear programming.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: III / Semester: VI**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. **Class:B.Sc. (PCM/PSM)** | Year: **III**<br><br>Semester: **VI** |
| **Credits: 04**<br>Theory: **04**<br>Practical: | **Subject: Mathematics** |
| **Course Code:BSMT-362** | **Title: Operation Research & Numerical Analysis** |

**Course Objectives:**

1. The aim of this course is to teach the student the application of various numerical technique for variety of problems occurring in daily life. At the end 01he course the student will be able to understand the basic concept of Numerical Analysis and to solve algebraic and differential equation.
2. The student will be able to solve various problems based on linear programming. After successful completion of this paper will enable the students tt apply the basic concepts of operations research.

**Nature of Paper:** Core

**Minimum Passing Marks/Credits: 40% Marks**

L: 4
T:
P: (In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical-

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | Solution of equations: bisection, Secant, Regular Falsi, Newton Raphson's method, Interpolation, Lagrange, Difference schemes, Divided differences, Interpolation formula using differences. | 8 |
| II | Numerical differentiation, Numerical Quadrature: Newton Cotes Formulas.<br>System of Linear equations: Direct method for solving systems of linear equations, Iterative methods. The Algebraic Eigen value problem: Jacobi's method, Givens method, Power method. | 8 |
| III | Numerical solution of Ordinary differential equations: Euler method, single step methods, Runge-Kutta method, Multi-step methods: Milne-Simpson method, Difference Equations and their solutions. | 7 |
| IV | Types of approximation: Last Square polynomial approximation, Uniform approximation, Legendre's approximation, Chebyshev polynomial approximation. | 7 |
| V | Introduction, Linear programming problems, statement and formation of general linear programming problems, graphical method, standard and matrix forms of linear programming problem, basic feasible solution. | 8 |

| | | |
|---|---|---|
| VI | Convex sets, fundamental theorem of linear programming, basic solution, Simplex method, introduction to artificial variables, two phase method, Big-M method. | 8 |
| VII | Resolution of degeneracy, duality in linear programming problems, primal dual relationships, revised simplex method, sensitivity analysis. | 7 |
| VIII | Transportation problems, assignment problems. | 7 |

**Suggested Readings (Part-A Numerical Analysis):**

1. Numerical Methods for Engineering and scientific computation by M. K. Jain, S.R.K. Iyengar & R.K. Jain.
2. Suggested digital plateform : NPTEL/SWAYAM/MOOCs
3. Course Books(text/reference) published in Hindi may be prescribed by the Universities at local levels.

**Suggested Readings (Part-B Operation Research):**

1. Introductory methods of Numerical Analysis by S. S. Sastry
2. Taha, Hamdy Opearations Research- An Introduction†', Pearson Education.
3. Gupta, Prem Kumar, Initials, Operations Research, Chand (S) & Co Ltd, India
4. Hillier Frederick S and Lieberman Gerald J., "Operations Research", McGraw Hill Publication.
5. Winston Wayne L., "Operations Research: Applications and Algorithms", Cengage Learning, $4^{th}$ Edition.
6. Hira D.S. and Gupta Prem Kumar, "Problems in Operations Research: Principles and Solutions", S Chand & Co Ltd.
7. Kalavathy S., "Operations Research", S Chand.
8. Suggested digital platform: NPTEL/SWAYAM/MOOCs.

If the course is available as Generic Elective, then the students of following departments may opt it.

1. Engg. and Tech. (UG)
2. Economics (UG/PG)
3. BCA/BBA
4. B.Sc.(C.S.)

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 10 |
| 2) Presentations /Seminar | 5 |
| 3) Assignments | 5 |
| 4) Research Project Report<br>Seminar On Research Project Report | 5 |
| 5) ESE | **75** |
| **Total:** | 100 |

Prerequisites for the course: Diploma in Mathematics

**Course Learning Outcomes:**

CO1: The aim of this course is to teach the student the application of various numerical techniques for variety of problems occurring in daily life. At the end 01he course the student will be able to understand the basic concept of Numerical Analysis and to solve algebraic and differential equation.

CO2: The main outcome will be that students will be able to handle problems and finding approximated solution. Later he can opt for advance course numerical Analysis in higher Mathematics.

CO3: The student will be able to solve various problems based on linear programming. After successful completion of this paper will enable the students tt apply the basic concepts of operations research.

**IIMTU-NEP IMPLEMENTATION**
**Year: III / Semester: VI**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. **Class:B.Sc. (PCM/PSM)** | Year: **III** Semester: **VI** |
| **Credits: 02** Theory: Practical: **02** | **Subject:** Mathematics |
| **Course Code: BSMT-361P** | **Title: Practical (Practicals to be done using Mathematical /MATLAB /Maple /Scilab/Maxima etc.)** |

**Course Objectives:** The main objective of the course is to equip the student to solve the transcendental and algebraic equations, system of linear equations, ordinary differentia equations, Interpolation, Numerical Integration, Method of finding Eigen value by Power method (up to $4 \times 4$), Fitting a Polynomial Function (up to third degree).

**Nature of Paper:** Core

**Minimum Passing Marks/Credits: 50% Marks**

L:
T:
P: 4 (In Hours/Week)
Theory -
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | List of the practical's to be done using computer algebra software (CAS), for example R/Python/Mathematica/MATLAB/Maple/ Maxima/Scilab etc<br>1. Solution of transcendental and algebraic equations.<br>2. Solution of system of linear equations.<br>3. Interpolation.<br>4. Numerical Integration.<br>5. Method of finding Eigen value by Power method (up to $4 \times 4$ )<br>6. Fitting a Polynomial Function (up to third degree).<br>7. Solution of ordinary differential equations. | |

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 10 |
| 2) Presentations /Seminar | 5 |
| 3) Assignments | 5 |
| 4) Research Project Report<br>Seminar On Research Project Report | |
| 5) ESE | 5 |
| **Total:** | 25 |

Prerequisites for the course: $12^{th}$ Mathematics

**Course outcomes:**
The main objective of the course is to equip the student to solve the transcendental and algebraic equations, system of linear equations, ordinary differentia equations, Interpolation, Numerical Integration, Method of finding Eigen value by Power method (up to $4 \times 4$ ), Fitting a Polynomial Function (up to third degree).

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: III / Semester: III**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. Class:**B.Sc. (PCM)** | **Year: III** **Semester: VI** |
| **Credits: 04** Theory: **04** Practical: | Subject: **Chemistry** |
| **Course Code: BSCH-361** | Title: **Organic Synthesis B** |

**Course Objectives:**
1. It relates and gives an analytical aptitude for synthesizing various industrially important compounds.
2. Learn the different types of alkaloids, &terpenesetc and their chemistry and medicinal importance.
3. Explain the importance of natural compounds as lead molecules for new drug discovery.

Nature of Paper: **DSE**

**Minimum Passing Marks/Credits: 40% Marks**

L: 4
T:
P: (In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | **Reagents in Organic Synthesis:** A detailed study of the following reagents in organic transformations Oxidation with DDQ, CAN and SeO2, mCPBA, Jones Oxidation, PCC, PDC, PFC, Collin's reagent and ruthenium tetraoxide. Reduction with NaBH4, LiAlH4, Meerwein-Ponndorf-Verley (MPV) reduction, Wilkinson's catalyst, Birch reduction, DIBAL-H | 06 |
| II | **Organ metallic Compounds:** Organ magnesium compounds: the Grignard reagents, formation, structure and chemical reactions. Organozinc compounds: formation and chemical reactions. Organ lithium compounds: formation and chemical reactions. | 04 |
| III | **Chemistry of Aldehydes and ketones:** Nomenclature and structure of the carbonyl groups, synthesis of aldehydes and ketones with particular reference to the synthesis of aldehydes from acid chlorides, synthesis of aldehydes and ketonesuses1,3-dithianes, synthesis of ketones from nitrites and from carboxylic acids, Physical properties. Mechanism of nucleophillic additions to carbonyl group with particular emphasis on benzoin, aldol, Perkin and Knoevenagel condensations, Condensation with ammonia and its derivatives. Wittig reaction, Mannich reaction. Oxidation of aldehydes, Cannizzaro reaction, MPV, Clemmensen, Wolff-Kishner, LiAlH4 and NaBH4 reductions. | 10 |

| | | |
|---|---|---|
| | Halogenation of enolizable ketones An introduction to α, β unsaturated aldehydes and Ketones. | |
| IV | **Carboxylic acids and their Functional Derivatives**<br>Nomenclature and classification of aliphatic and aromatic carboxylic acids. Preparation and reactions. Acidity (effect of substituents on acidity) and salt formation, Reactions: Mechanism of reduction, substitutionin alkyl or aryl group. Preparation and properties of dicarboxylic acid ssuch as oxalic, malonic, succinic, glutaric, adipic and phthalic acids and unsaturated carboxylic acids suchasacrylic, crotonic and cinnamic acids, Reactions: Action of heat on hydroxyl and amino acids, and saturated dicarboxylic acids, stereospecific addition to maleic and fumaric acids. Preparation and reactions of acid chlorides, acid anhydrides, amides and esters, acid and alkaline hydrolysis of esters, trans-esterification. | **08** |
| V | **Organic Synthesis via Enolates**<br>Acidity of α-hydrogens, alkylation of diethyl malonate and ethyl acetoacetate, Synthesis of ethyl acetoacetate: the Claisen condensation, Keto-enoltautomerism of ethyl acetoacetate. Alkylation of 1, 3-dithianes, Alkylation and acylation of enamines. | **05** |
| VI | **Organic Compounds of Nitrogen-** Preparation of nitroalkanes and nitroarenes, Chemical reactions of nitroalkanes. Mechanisms of nucleophilic substitution in nitroarenes and their reductions in acidic, neutral and alkaline media, Picric acid. Halo nitroarenes: reactivity, Structure and nomenclature of amines, physical properties, Stereochemistry of amines, Separation of a mixture of primary, secondary and tertiary amines. Structural features effecting basicity of amines. Amine salts as phase-transfer catalysts, Preparation of alkyl and aryl amines (reduction of nitro compounds, nitrities), reductive amination of aldehydic and ketonic compounds, Gabriel- phthalimide reaction, Hofmann bromamide reaction. Reactions of amines, electrophilic aromatic substituton in aryl amines, reactions of amines with nitrous acid. Synthetic transformations of aryl diazonium salts, azo coupling | **10** |
| VII | **Heterocyclic Chemistry**<br>Molecular orbital picture and aromatic characteristics of pyrrole, furan, thiophene and pyridine, Methods of synthesis and chemical reactions with particular emphasis on the mechanism of electrophilic substitution, Mechanism of nucleophilic substitution reaction in pyridine derivatives, Comparison of basicity of pyridine, piperidine and pyrrole. Introduction to condensed five and six membered heterocycles, Preparation and reactions of indole, quinoline and isoquinoline with special reference to Fisher indolesynthesis, Skraup synthesis and Bischler-Nepieralskisynthesis, Mechanism of electrophilc substitution reactions of indole, quinoline and isoquinoline | **10** |
| VIII | **Natural Products Alkaloids &Terpenes:**<br>Natural occurrence, General structural features, their physiological action, Hoffmann's exhaustive methylation, Emde's modification;. Medicinal importance of Nicotine, Hygrine, Quinine, Morphine, Cocaine, and Reserpine. Natural Occurrence and classification of terpenes, isoprene rule. | **07** |

**Reference / Text Books:**

1. Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Sykes, P. *A guidebook to Mechanism in Organic Chemistry,* Pearson Education, 2003.
3. Carey, F. A., Guiliano, R. M.*Organic Chemistry*, Eighth edition, McGraw Hill Education, 2012.
4. Loudon, G. M. *Organic Chemistry*, Fourth edition, Oxford University Press, 2008.
5. Clayden, J., Greeves, N. &Warren, S. *Organic Chemistry,* 2$^{nd}$ edition, Oxford University Press, 2012.
6. Graham Solomons, T.W., Fryhle, C. B. *Organic Chemistry,* John Wiley & Sons, Inc.
7. Smith, J. G. *Organic Chemistry*, Tata McGraw-Hill Publishing Company Limited.
8. March, J. *Advanced Organic Chemistry*, Fourth edition, Wiley.
9. Acheson, R.M. Introduction to the Chemistry of Heterocyclic compounds, John Welly & Sons (1976).
10. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
11. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural
12. Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
13. Singh, J.; Ali, S.M. & Singh, J. Natural Product Chemistry, PragatiPrakashan (2010).

If the course is available as Generic Elective then the students of following departments may opt it.

1. B. Pharm.
2. D. Pharm.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1. Class tasks/ Sessional Examination | 10 + 10 |
| 2. Assignments | 5 |
| 3. ESE | 75 |
| **Total:** | **100** |

Prerequisites for the course: Knowledge of chemistry taught in the preceding semester.

**Course Learning Outcomes:**

1. Students will understand the concept of various reagents used in organic synthesis.
2. Students will be able to understand the organo metallic compounds and carbonyl compounds.
3. Students will be able to understand carboxylic acid and its various derivatives.
4. Students will be able to understand the enolates, nitrogeneous organic compounds and various heterocyclic compounds.
5. Students will be able to understand natural products such as alkeloids and terpenoids.

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: III / Semester: III**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. Class:**B.Sc. (PCM)** | **Year: III** **Semester: VI** |
| **Credits: 04** Theory: **04** Practical: | Subject: **Chemistry** |
| **Course Code: BSCH-362** | Title: **Chemical Energetics and Radio Chemistry** |
| **Course Objectives:** Upon successful completion of this course students should be able to describe laws of thermodynamics and its applications, phase equilibria of one and two component system, electro chemistry ,ionic equilibrium applications of conductivity and potentiometric measurements | |
| Nature of Paper: **DSE** | |
| **Minimum Passing Marks/Credits: 40% Marks** | |
| L: 4<br>T:<br>P: (In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits) | |

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | **Thermodynamics-1 :**<br>**First Law of Thermodynamics:** Statement, definition of internal energy and enthalpy. Heat capacity, heat capacities at constant volume and pressure and their relationship. Joule's law – Joule- Thomson coefficient and inversion temperature. Calculation of w, q, dU & dH for the expansion of ideal gases under isothermal and adiabatic conditions for reversible process.<br>**Thermochemistry:** Standard state, standard enthalpy of formation – Hess's law of heat summation and its applications. Heat of reaction at constant pressure and at constant volume. Enthalpy of neutralization. Bond dissociation energy and its calculation from thermo-chemical data, temperature dependence of enthalpy. Kirchhoff's equation | 08 |
| II | **Thermodynamics II**<br>Second Law of Thermodynamics, Need for the law, different statements of the law, Carnot cycle and its efficiency. Carnot theorem. Thermodynamic scale of temperature.<br>Concept of Entropy, Entropy as a state function, entropy as a function of V & T, entropy as a function of P&T, entropy change in physical change, Clausius inequality , entropy as a criteria of spontaneity and equilibrium. Entropy change in ideal gases and mixing of gases. Gibbs and Helmholtz Functions Gibbs function (G) and Helmhotz function (A) as | 10 |

| | | |
|---|---|---|
| | thermodynamic quantities. A &G as criteria for thermodynamic equilibrium and spontaneity, their advantage over entropy change, Variation of G and A with P, V and T.<br>Third Law of Thermodynamics; Nernst heat theorem, statement and concept of residual entropy.<br>Nernst distribution law – Thermodynamic derivation, applications. | |
| III | **Electrochemistry**: Electrical transport:- Conduction in metals and in electrolyte solutions, specific conductance molar and equivalent conductance, measurement of equivalent conductance, variation of molar, equivalent and specific conductances with dilution. Migration of ions and Kohlrausch law, Arrhenius theory of electrolyte dissociation and its limitations. Weak and strong electrolytes. Ostwald's dilution law, its uses and limitations. Debye-Huckel-Onsager equation for strong electrolytes (elementary treatment only). Transport number, definition and determination by Hittorf method and moving boundary method. | 8 |
| IV | **IonicEquilibrium**:Types of reversible electrodes–Gas-metalion, metal-metalion, metal insoluble salt-anion and redox electrodes. Electrode reactions, Nernst equation, derivation of cell EMF and single electrode potential, standard hydrogen electrode-reference electrodes and their applications, standard electrode potential, sign conventions, Electrolytic and Galvanic cells–Reversible and irreversible cells, conventional representation of electrochemical cells. EMF of a cell and its measurement. Calculation of thermodynamic quantities of cell reactions ($\Delta$G, $\Delta$Hand K).Definition of pH and pKa, determination of pH using hydrogen, quinhydrone and glass electrodes by potentiometric methods. Buffers – Mechanism of buffer action, Henderson-Hazel equation, application of buffer solution. Hydrolysis of salts | 10 |
| V | **Photo Chemistry:** Interaction of radiation with matter, difference between thermal and photochemical processes. Laws of photochemistry: Grothus-Drapper law, Stark-Einstein law, Jablonski diagram depicting various processes occurring in the excited state, qualitative description of fluorescence, phosphorescence, non-radiative processes (internal conversion, intersystem crossing), quantum yield, photosensitized reactions–energy transfer processes (simple examples),kinetics of photochemical reaction. | 04 |
| VI | **Colligative Properties-**Ideal and non-ideal solutions, methods of expressing concentrations of solutions, activity and activity coefficient. Dilute solution, colligative properties, Raoult's law, relative lowering of vapour pressure, molecular weight determination, Osmosis, law of osmotic pressure and its measurement, determination of molecular weight from osmotic pressure, Elevation of boiling point and depression of freezing, Thermodynamic derivation of relation between molecular weight and elevation in boiling point and depression in freezing point. Experimental methods for determining various colligative properties. Abnormal molar mass, Van't Hoff factor, Colligative properties of degree of dissociation and association of solutes. | 6 |

| | | |
|---|---|---|
| VII | **Surface Chemistry**<br>**Adsorption**: Physical and chemical adsorption; Freundlich and Langmuir adsorption isotherms; multilayer adsorption and BET isotherm (no derivation required); Gibbs adsorption isotherm and surface excess; Heterogenous catalysis (single reactant).<br>**Colloids**: Lyophobic and lyophilic sols, Origin of charge and stability of lyophobic colloids, Coagulation and Schultz-Hardyrule, Zetapotential and Stern double layer (qualitative idea), Tyndall effect; Electrokinetic phenomena (qualitative idea only); Stability of colloids and zeta potential; Micelle formation.<br>**Dipole moment and polarizability**: Polarizability of atoms and molecules, dielectric constant and polarisation, molar polarisation for polar and non-polar molecules; Clausius-Mosotti equation and Debye equation (both without derivation) and their application; Determination of dipole m. | 7 |
| VIII | **Radiochemistry**<br>Natural and induced radioactivity; radioactive decay-a-decay, b-decay, g-decay; neutron emission, positron emission, electron capture; unit of radio activity (Curie); half life period; Geiger-Nuttalrule, radioactive displacement law, radioactive series. Measurement of radioactivity: ionization chamber, Geiger counters, scintillation counters. Applications: energy tapping, dating of objects, neutron activation analysis, isotopic labelling studies, nuclear medicine-99mTc radiopharmaceuticals. | 07 |

**Reference / Text Books:**


1. Foye, W.O., Lemke, T.L. & William, D.A.: Principles of Medicinal Chemistry, 4th ed., B..I. Waverly Pvt. Ltd. New Delhi.
2. Peter Atkins & Julio De Paula, Physical Chemistry 9th Ed., Oxford University Press (2010).
3. Metz, C. R. Physical Chemistry 2nd Ed., Tata McGraw-Hill (2009).
4. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry Ed., Oxford University Press 13 (2006).
5. Ball, D. W. Physical Chemistry Thomson Press, India (2007).
6. Castellan, G. W. Physical Chemistry 4th Edn. Narosa (2004).
7. Allen Bard ,J Larry . Faulkner R,Fundamentals of Electrochemical methods – fundamentals and applications, new York John ,Wiley &sons ,2001
8. H. J. Arnikar, *Essentials of Nuclear Chemistry*, 4th ed., New Age International, New Delhi, 1995.


If the course is available as Generic Elective then the students of following departments may opt it.
1. B. Pharm.
2. D. Pharm.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1. Class tasks/ Sessional Examination | 10 + 10 |
| 2. Assignments | 5 |
| 3. ESE | 75 |
| **Total:** | **100** |

Prerequisites for the course: Knowledge of chemistry taught in the preceding semester.

**Course Learning Outcomes:**

Upon successful completion of this course students should be able to describe laws of thermodynamics and its applications, phase equilibria of one and two component system, electro chemistry ,ionic equilibrium applications of conductivity and potentiometric measurements terpenoids.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: III / Semester: VI**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. Class:**B.Sc. (PCM)** | **Year: III** <br> **Semester: VI** |
| **Credits: 02** Theory: Practical: **02** | Subject : **Chemistry** |
| **Course Code: BSCH-361P** | Title :**Analytical Methods** |
| **Course Objectives :** Upon successful completion of this course students should be able to quantify the product obtained through gravimetric method; determination of R*f* values and identification of organic compounds through paper and thin layer chromatography laboratory techniques: perform thermo chemical reactions. | |
| **Nature of Paper: DSE** | |
| **Minimum Passing Marks/Credits: 50% Marks** | |
| L: <br> T: <br> P: 4 (In Hours/Week) <br> Theory - 1 Hr. = 1 Credit <br> Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits) | |

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | **GravimetricAnalysis** <br> 1. Analysis of Cu as CuSCN, <br> 2. Analysis of Ni as Ni (dimethylgloxime) <br> 3. Analysis of Ba as BaSO4. | **30** |
| II | **Paper Chromatography** <br> Ascending and Circular. Determination of R*f* values and identification of organic compounds: Separation of a mixture of phenylalanine and glycine. Alanine and aspartic acid Leucine and glutamic acid. Spray reagent – ninhydrin. Separation of a mixture of D, L–alanine, glycine, and L-leucineusingnbutanol : aceticacid : water(4:1:5). Sprayreagent– ninhydrin. Separation of monosaccharaides– a mixture of D-galactose and D –fructoseusing n- butanol: acetone: water (4:5:1). Spray reagent – aniline hydrogen phthalate | **8** |
| III | **Thin Layer Chromatography** <br> Determination of R*f* values and identification of organic compounds: Separation of green leaf pigments (spinach leaves may be used) Preparation of separation of 2,4- di-nitrophenylhydrazones of acetone, 2-butanone, hexan-2, and 3-one using toluene and light petroleum (40:60)Separation of a mixture of dyes using cyclohexane and ethyl acetate (8.5:1.5) | 8 |
| IV | **Thermochemistry** <br> To determine the solubility of benzoic acid at different temperatures and | |

| | | |
|---|---|---|
| | to determine<br>ΔH of the dissolution process<br>1. To determine the enthalpy of neutralization of a weak acid/weak base versus strong base/strong acid and determine the enthalpy of ionization of the weak acid/weak base<br>2. To determine the enthalpy of solution of solid calcium chloride and calculate the lattice energy of calcium chloride from its enthalpy data using Born-Haber cycle | 14 |

**Reference / Text Books:**

1. Skoog .D.A., West D.M and Holler .F.J., "Analytical Chemistry: An Introduction", 7th edition, Saunders college publishing, Philadelphia, (2010).
2. Larry Hargis.G" Analytical Chemistry: Principles and Techniques" Pearson© (1988)

If the course is available as Generic Elective then the students of following departments may opt it.

1. B. Pharm.
2. D. Pharm.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1. Class tasks/ Sessional Examination | 10 |
| 2. Assignments | 10 |
| 3. ESE | 30 |
| **Total:** | **50** |

Prerequisites for the course : Practical Chemistry taught in the preceding semester.

**Course Learning Outcomes:**

Upon successful completion of this course students should be able to quantify the product obtained through gravimetric method; determination of R*f* values and identification of organic compounds through paper and thin layer chromatography laboratory techniques: perform thermo chemical reactions.

**IIMTU-NEP IMPLEMENTATION**
**Year: I / Semester: I**

| | | |
|---|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. Class:**B.Sc (PCM/PSM)** | | Year: **I** Semester: **I** |
| Credits: **04** Theory: **04** Practical: | **Subject: Physics** | |
| **Course Code: BSPH-111** | **Title: Mathematical Physics & Newtonian Mechanics** | |
| **Course Objectives:** The purpose of the undergraduate Physics program at the university level is to provide the key knowledge of the fact of science understanding of the law of physics and laboratory resources to prepare students for careers as professionals in various industries and research institutions. | | |
| Nature of Paper: **Core** | | |
| Minimum Passing Marks/Credits:**40% Marks** | | |
| L: 04<br>T: 00<br>P: 00(In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits) | | |

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| | **Part A: Basic Mathematical Physics** | |
| I | Introduction to Indian ancient Physics and contribution of Indian Physicists, in context with the holistic development of modern science and technology, should be included under Continuous Internal Evaluation (CIE).<br>**Vector Algebra:**<br>Basis for defining scalars, vectors, Component form in 2D. Geometrical and physical interpretation of addition, subtraction, dot product, cross product and triple product of vectors. Position. | **09** |
| II | Geometrical and physical interpretation of vector differentiation, Gradient, Divergence and Curl and their significance. Vector integration, Line, Surface (flux) and Volume integrals of vector fields. Gauss-divergence theorem, Stoke-curl theorem. | **08** |
| III | **Coordinate Systems:**<br>2D & 3D Cartesian, coordinate systems, basis vectors, transformation equations. Expressions for displacement vector. Components of velocity and acceleration in different coordinate systems. Examples of non-inertial coordinate system. | **07** |

| | | |
|---|---|---|
| IV | **Introduction to Tensors:**<br>Principle of invariance of physical laws w.r.t. different coordinate systems as the basis for defining tensors. Symmetric and skew symmetric tensors. Invariant tensors. | **06** |
| | **PART B : Newtonian Mechanics & Wave Motion** | |
| V | **Dynamics of a System of Particles:**<br>Review of historical development of mechanics up to Newton. Dynamics of a system of particles, centre of mass motion, and conservation laws & their deductions. Rotating frames of reference, general derivation of origin of pseudo forces (centrifugal) in rotating frame | **08** |
| VI | **Dynamics of a Rigid Body:**<br>Angular momentum, Torque, Rotational energy. Rotational inertia for simple bodies (ring, disk, rod, solid and hollow sphere). The combined translational and rotational motion of a rigid body on horizontal and inclined planes. Elasticity, relations between elastic constants. | **08** |
| VII | **Motion of Planets & Satellites:**<br>Two particle central force problem, reduced mass, relative and centre of mass motion. Newton's law of gravitation, gravitational field and gravitational potential. Kepler's laws of planetary motion | **06** |
| VIII | **Wave Motion:**<br>Differential equation of simple harmonic motion and its solution, damped and forced oscillations, Quality factor. Composition of simple harmonic motion, Lissajous figures. Differential equation of wave motion. Plane progressive waves in fluid media, reflection of waves and phase change, pressure and energy distribution. Principle of superposition of waves, stationary waves, phase and group velocity. | **08** |

**Reference / Text Books:**

**PART A**

1. Murray Spiegel, Seymour Lipschutz, Dennis Spellman, "Schaum's Outline Series: Vector Analysis", McGraw Hill, 2017
2. Shanti Narayan, P.K. Mittal, "A Text Book of Vector Analysis", S. Chand Publishing, 2010
3. Shanti Narayan, P.K. Mittal, "A Text Book of Vector Calculus", S. Chand Publishing, 1987

**PART B**

1. Charles Kittel, Walter D. Knight, Malvin A. Ruderman, Carl A. Helmholz, Burton J. Moyer, "Mechanics (In SI Units): Berkeley Physics Course Vol 1", McGraw Hill, 2017
2. Richard P. Feynman, Robert B. Leighton, Matthew Sands, "The Feynman Lectures on Physics - Vol. 1", Pearson Education Limited, 2012
3. Hugh D. Young and Roger A. Freedman, "Sears & Zemansky's University Physics with Modern Physics", Pearson Education Limited, 2017
4. D.S. Mathur, P.S. Hemne, "Mechanics", S. Chand Publishing, 1981

If the course is available as Generic Elective then the students of following departments may opt it.

1. Yes Open to all

| Evaluation/Assessment Methodology | |
|---|---|
| | **Max. Marks** |
| 1. Class tasks/ Sessional Examination<br>2. Assignments<br>3. ESE | 10 + 10<br>5<br>75 |
| **Total:** | **100** |
| Prerequisites for the course: Physics and Mathematics in $12^{th}$ | |

**Course Learning Outcomes:**

- Recognize the difference between scalars, vectors, pseudo-scalars and pseudo-vectors.
- Understand the physical interpretation of gradient, divergence and curl.
- Comprehend the difference and connection between Cartesian, spherical and cylindrical coordinate systems.
- Know the meaning of 4-vectors, Kronecker delta and Epsilon (Levi Civita) tensors.
- Study the origin of pseudo forces in rotating frame.
- Study the response of the classical systems to external forces and their elastic deformation.
- Understand the dynamics of planetary motion and the working of Global Positioning System (GPS).
- Comprehend the different features of Simple Harmonic Motion (SHM) and wave propagation.

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: I / Semester: I**

<table>
<tr><td colspan="2">Programme:<br>Certificate/Diploma/Degree/ UG(R)/PG/Ph.D.<br>Class:B.Sc (PCM/PSM)</td><td colspan="2">Year: I<br><br>Semester: I</td></tr>
<tr><td colspan="2">Credits: 02<br>Theory:<br>Practical:02</td><td colspan="2">Subject: Physics</td></tr>
<tr><td colspan="2">Course Code: BSPH-111P</td><td colspan="2">Title: Mechanical Properties of Matter</td></tr>
<tr><td colspan="4">Course Objectives:<br>The purpose of the undergraduate Physics program at the university level is to provide the key knowledge of the fact of science understanding of the law of physics and laboratory resources to prepare students for careers as professionals in various industries and research institutions.</td></tr>
<tr><td colspan="4">Nature of Paper: Core</td></tr>
<tr><td colspan="4">Minimum Passing Marks/Credits: 50% Marks</td></tr>
<tr><td colspan="4">L: 0<br>T: 00<br>P: 04 (In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)</td></tr>
<tr><td>Unit</td><td colspan="2">Contents</td><td>No. of Lectures Allotted</td></tr>
<tr><td colspan="4">Lab Experiment List</td></tr>
<tr><td></td><td colspan="2">1. Moment of inertia of a flywheel<br>2. Moment of inertia of an irregular body by inertia table.<br>3. Modulus of rigidity by statistical method (Barton’s apparatus).<br>4. Modulus of rigidity by dynamical method (sphere / disc / Maxwell’s needle)<br>5. Young’s modulus by bending of beam.<br>6. Young’s modulus and Poisson’s ratio by Searle’s method.<br>7. Poisson’s ratio of rubber by rubber tubing.<br>8. Surface tension of water by capillary rise method.<br>9. Surface tension of water by Jaeger’s method.<br>10. Coefficient of viscosity of water by Poiseuille’s method.<br>11. Acceleration due to gravity by bar pendulum.<br>12. Frequency of AC mains by Sonometer<br>13. Height of a building by Sextant.<br>14. Study the wave form of an electrically maintained tuning fork / alternating current source with the help of cathode ray oscilloscope.</td><td>20</td></tr>
</table>

**Reference / Text Books:**

**PART A**

1. Murray Spiegel, Seymour Lipschutz, Dennis Spellman, "Schaum's Outline Series: Vector Analysis", McGraw Hill, 2017
2. Shanti Narayan, P.K. Mittal, "A Text Book of Vector Analysis", S. Chand Publishing, 2010.
3. Shanti Narayan, P.K. Mittal, "A Text Book of Vector Calculus", S. Chand Publishing, 1987.

**PART B**

1. Charles Kittel, Walter D. Knight, Malvin A. Ruderman, Carl A. Helmholz, Burton J. Moyer, "Mechanics (In SI Units): Berkeley Physics Course Vol 1", McGraw Hill, 2017
2. Richard P. Feynman, Robert B. Leighton, Matthew Sands, "The Feynman Lectures on Physics - Vol. 1", Pearson Education Limited, 2012
3. Hugh D. Young and Roger A. Freedman, "Sears & Zemansky's University Physics with Modern Physics", Pearson Education Limited, 2017
4. D.S. Mathur, P.S. Hemne, "Mechanics", S. Chand Publishing, 1981

If the course is available as Generic Elective then the students of following departments may opt it.

1. Yes Botany/Chem./Comp. Sc./Maths/Stat./Zool.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1. Record File | 15 |
| 2. Viva Voce | 5 |
| 3. Class Interaction | 10 |
| **Total:** | **30** |

Prerequisites for the course:

- The course can be opted by Botany / Chemistry / Computer Science / Mathematics / Statistics / Zoology
- **PREREQUISITE:** Opted / Passed Semester I, Theory Paper-1 (**BSPH-111P**)

**Course Learning Outcomes:**

- Experimental physics has the most striking impact on the industry wherever the instruments are used to determine the mechanical properties.
- Measurement precision and perfection is achieved through Lab Experiments.
- Online Virtual Lab Experiments give an insight in simulation techniques and provide a basis for modeling.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: I / Semester: I**

| | |
|---|---|
| **Programme:** B.Sc.<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>**Class:B.Sc (PCM/PSM)** | **Year: I**<br><br>**Semester: I** |
| **Credits 04**<br>Theory: **04**<br>Practical: | **Subject: Mathematics** |
| **Course Code: BSMT-111** | **Title: Differential Calculus & Integral Calculus** |

**Course Objectives:**

1. The primary objective of this course is to gain proficiency in differentialcalculus, and introduce the basic tools of matrices and complex numbers which are used to solveapplication problems in a variety of settings ranging from chemistry and physics to business andeconomics.
2. Differential calculus develops the concepts of limit, continuity and derivative, and isfundamental for many fields of mathematics.

**Nature of Paper:** Core

**Minimum Passing Marks/Credits: 40% Marks**

L: 4
T:
P: (In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | **Indian Ancient Mathematics and Mathematicians**<br>Definition of a sequence, theorems on limits of sequences, bounded and monotonic sequences, Cauchy's convergence criterion, limit superior and limit inferior of a sequence, subsequence, Series of non-negative terms, convergence and divergence, Comparison tests, tests for convergence, alternating series, absolute and conditional convergence. | 9 |
| II | Limit, continuity and differentiability of function of single variable, Cauchy's definition, Uniform continuity, Borel's theorem, boundedness theorem, Bolzano's theorem, Intermediate value theorem, extreme value theorem, Chain rule, indeterminate forms. | 7 |
| III | Rolle's theorem, Mean value theorems, mean value theorems of higher order, Taylor's theorem with variousforms of remainders, Maclaurin's and Taylor's series, Partial differentiation, Euler'stheorem on homogeneous function. | 7 |
| IV | Tangent and normals, Asymptotes, Curvature, Tests for concavity and | 7 |

| | | |
|---|---|---|
| | convexity, Points of inflexion, Multiple points, Parametric representation of curves, Tracing of curves in Cartesian and Polar forms. | |
| V | Definite integrals as limit of the sum, Riemann integral, Integrability of continuous and monotonic functions, Fundamental theorem of integral calculus, Mean value theorems of integral calculus, Differentiation under the sign of Integration. | 9 |
| VI | Improper integrals, convergence tests, Beta and Gamma functions. | 7 |
| VII | Volumes and Surfaces of Solid of revolution, Multiple integrals, change of order of double integration, Dirichlet's theorem, Liouville's theorem for multiple integrals. | 7 |
| VIII | Vector Differentiation, Gradient, Divergence and Curl, Directional Derivative, Vector Integration, Theorems ofGauss, Green, Stokes and related problems. | 7 |

**Reference / Text Books:**

1. R.G. Bartle & D.R. Sherbert, Introduction to Real Analysis, John Wiley & Sons
2. T.M. Apostal, Calculus Vol. I, John Wiley & Sons Inc.
3. S. BalachandraRao& C. K. Shantha, Differential Calculus, New Age Publication.
4. H. Anton, I. Birens and S. Davis, Calculus, John Wiley and Sons, Inc.,2002.
5. G.B. Thomas and R.L. Finney, Calculus, Pearson Education,2007.
6. Suggestive digital platforms web links: NPTEL/SWAYAM/MOOCS
7. Course Books (text/reference) published in Hindi may be prescribed by the Universities.

**Suggested Readings (Part-B Integral Calculus):**

1. T.M. Apostal, Calculus Vol. II, John Wiley Publication
2. Shanti Narayan & Dr. P.K. Mittal, Integral Calculus, S.Chand
3. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons.
4. Suggestive digital platforms web links: NPTEL/SWAYAM/MOOCS Based Approach. Narosa Publishing Comp. New Delhi.

If the course is available as Generic Elective, then the students of following departments may opt it.

1. Engg. and Tech. (UG)
2. Chemistry/Biochemistry/Life Sciences (UG)
3. Economics (UG/PG),
4. Commerce (UG),
5. BBA
6. BCA
7. B.Sc. (C.S.)

| Evaluation/Assessment Methodology | |
|---|---|
| | **Max. Marks** |
| 1) Class tasks/ Sessional Examination | 10 |
| 2) Presentations /Seminar | 5 |
| 3) Assignments | 5 |
| 4) Research Project Report<br>Seminar On Research Project Report | 5 |
| 5) ESE | **75** |
| **Total:** | **100** |
| Prerequisites for the course: $12^{th}$ Mathematics | |

**Course Learning Outcomes:**

**CO1:** The programme outcome is to give foundation knowledge for the students to understand basics of mathematics including applied aspect for developing enhanced quantitative skills and pursuing higher mathematics and research as well.

**CO2:** By the time students complete the course they will have wide ranging application of the subject and have the knowledge of real valued functions such as sequence and series. They will also be able to know about convergence of sequence and series. Also, they have knowledge about curvature, envelope and evolutes and trace curve in polar, Cartesian as well as parametric curves.

**CO3:** The main objective of the course is to equip the student with necessary analytic and technical skills. By applying the principles of integral he learns to solve a variety of practical problems in science and engineering.

**CO4:** The student is equipped with standard concepts and tools at an intermediate to advance level that will serve him well towards taking more advanced level course in mathematics.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: I / Semester: I**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. **Class:B.Sc. (PSM)** | **Year: I** **Semester**: I |
| **Credits: 04** Theory: **04** Practical: 0 | **Subject: Statistics** |
| **Course Code: BSST-111** | **Title: Descriptive Statistics (Univariate) and Theory of Probability** |

**Course Objectives:**
1. Introduction to Statistics.
2. Graphical representation of data
3. Understanding the concept of Probability

**Nature of Paper:** Core

**Minimum Passing Marks/Credits: 40% Marks**

L: 4
T:
P: (In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | Introduction to Statistics, Meaning of Statistics, Importance of Statistics, Scope of Statistics in Industry, Introduction and contribution of Indian Scholars in Statistics. ConceptofStatisticalpopulation,AttributesandVariables (Discrete and Continuous), Different types of scales – Nominal, Ordinal, Ratio and Interval, Primary data – designing a questionnaire and schedule, collection of primary data, checking their consistency, Secondarydata. | **06** |
| II | Presentation of data : Classification, Tabulation, Diagrammatic & Graphical Representation of Grouped data, Frequency distributions, Cumulative frequency distributions and their graphical representations, Histogram, Frequency polygon and Ogives, Stem and Leaf plot, BoxPlot. | **08** |
| III | Measures of Central tendency and Dispersion and their properties, Merits and Demerits of these Measures. | **10** |
| IV | Moments, Shephard’s correction for moments, Measures of Skewness and Kurtosis and their significance, Measures based on quartiles. | **06** |
| V | Random experiment, Trial, Sample point and Sample space, Events, | |

| | | |
|---|---|---|
| | Operations of events, concept of equally likely, Mutually exclusive and Exhaustive events.<br>Definition of Probability: Classical, Relative frequency and Axiomatic approaches. | **04** |
| VI | Discrete Probability Space, Properties of Probability under Set Theory Approach, Independence of Events, Conditional Probability, Total and Compound Probability theorems, Bayes theorem and its Applications. | **09** |
| VII | Random Variables – Discrete and Continuous, Probability Mass Function (pmf) and Probability density function (pdf), Cumulative distribution function (cdf).<br>Joint distribution of two random variables, Marginal and Conditional distributions, Independence of random variables. | **08** |
| VIII | Expectation of a random variable and its properties, Expectation of sum of random variables and product of independent random variables, Conditional expectation and related problems.<br>Moments, Moment generating function (m.g.f.) & their properties, Continuity theorem for m.g.f. (without proof). Chebyshev's inequality, Weak law of large numbers for a sequence of independently and identically distributed random variables and their applications. (Statement Only) | **09** |

**Reference / Text Books:**


1. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2013). Fundamental of Statistics, Vol I, World Press,Kolkata.
2. Gupta, S.C. and Kapoor, V.K. (2000). Fundamentals of Mathematical Statistics (10th ed.), Sultan Chand and Sons.
3. Hanagal, D. D. (2009). Introduction to Applied Statistics: A Non-Calculus Based Approach. Narosa Publishing Comp. New Delhi.
4. David, S. (1994) : Elementary Probability, Cambridge University Press. Dudewicz, E.J. and Mishra, S.N. (2008). Modern Mathematics Statistics, Wiley.
5. Gupta, S.C. and Kapoor, V.K. (2000). Fundamentals of Mathematical Statistics (10th ed.), Sultan Chand and Sons.
6. Hanagal, D. D. (2009). Introduction to Applied Statistics: A Non-Calculus Based Approach. Narosa Publishing Comp. New Delhi.


If the course is available as Generic Elective then the students of following departments may opt it.

This course can be opted as a minor elective by the students. Open to all ( Other Faculty )

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1. Class tasks/ Sessional Examination | 10+10 = 20 |
| 2. Assignments | 5 |
| 3. ESE | 75 |
| **Total:** | 100 |

Prerequisites for the course: $12^{th}$ Mathematics

**Course Learning Outcomes:**

- Knowledge of Statistics, its scope and importance in various fields.
- Ability to understand concepts of sample vs. population and difference between different types of data.
- Knowledge of methods for summarising data sets, including common graphical tools (such as boxplots, histograms and stem plots). Interpret histograms and boxplots.
- Ability to describe data with measures of central tendency and measures of dispersion.
- Ability to understand measures of skewness and kurtosis and their utility and significance.
- Ability to understand the concept of probability along with basic laws and axioms of probability.
- Ability to understand the terms mutually exclusive and independence and their relevance.
- Ability to identify the appropriate method (i.e. union, intersection, conditional, etc.) for solving a problem.
- Ability to apply basic probability principles to solve real life problems.
- Ability to understand the concept of random variable (discrete and continuous), concept of probabilitydistribution.

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: I / Semester: I**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D.<br>**Class:B.Sc. (PSM)** | Year: **I**<br><br>Semester: **I** |
| **Credits: 02**<br>Theory:<br>Practical: **02** | **Subject: Statistics** |
| **Course Code: BSST-111P** | **Title: Descriptive Data Analysis Lab (Univariate)** |

**Course Objectives:**
These concepts will be verified by experimental means:
1. Introduction to Statistics.
2. Graphical representation of data
3. Understanding the concept of Probability

**Nature of Paper:** Core

**Minimum Passing Marks/Credits: 50% Marks**

L:
T:
P: 4 (In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| Unit | List of Practicals | No. of Lectures Allotted |
|---|---|---|
| | 1. Problems based on graphical representation of data by Histogram, Frequency polygons, frequency curves and Ogives, Stem and Leaf Plot, Box Plot.<br>2. Problems based on calculation of Measures of Central Tendency.<br>3. Problems based on calculation of Measures of Dispersion.<br>4. Problems based on calculation of Moments, Measures of Skewness and Kurtosis.<br>5. Computation of conditional probabilities based on Bayestheorem | **20** |

**Reference / Text Books:**
**Suggested Readings:**
**As suggested for paper code BSST-111.**

If the course is available as Generic Elective then the students of following departments may opt it.
1. This course can be opted as a minor elective by the students. Open to all (Other Faculty )

| Evaluation/Assessment Methodology | |
|---|---|
| Continuous Internal Evaluation shall be based on Practical File/Record, Class Activities and Overall performance. The marks shall be as follows: | **Max. Marks** |
| 1. Practical File/Record | 5 |
| 2. Class Interaction | 10 |
| 3. Practical Exam | 35 |
| **Total:** | 50 |
| Prerequisites for the course: $12^{th}$ Mathematics | |

**Course Learning Outcomes:**

After completing this course a student will have:

- Ability to represent/summarise the data/information using appropriate Graphical methods including common graphical tools (such as boxplots, histograms and stem plots) and also to draw inferences from thesegraphs
- Acquire the knowledge to identify the situation to apply appropriate measure of central tendency as per the nature and need of the data and draw meaningful conclusions regarding behavior of thedata.
- Acquire the knowledge to identify the situation to apply appropriate measure of dispersion as per the nature and need of the data and draw meaningful conclusions regarding heterogeneity of thedata.
- Ability to measure skewness and kurtosis of data and define their significance.
- Acquire the knowledge to compute conditional probabilities based on Bayes Theorem.

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: I / Semester: II**

| | |
|---|---|
| **Programme: Certificate/Diploma/Degree/ UG(R)/PG/Ph.D.**<br>**Class:B.Sc. (PCM/PSM)** | **Year: I**<br><br>**Semester:I** |
| **Credits: 03**<br>**Theory:03**<br>**Practical:** | **Subject:Environment and ecology** |
| **Course Code: NHU-112** | **Title: Environment and ecology** |

**Course Objectives:**

1. To understand the factors affecting ecosystem.
2. To provide knowledge of bio-geochemical and sedimentary cycles and its importance.
3. To understand about population and community ecology.

**Nature of Paper: Core**

**Minimum Passing Marks/Credits: 40% Marks**

L: 3
T:
P:(In Hours/Week)
Theory - 3 Hr. = 3 Credit
Practical- 0

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | **Introduction to environmental studies**<br>Multidisciplinary nature of environmental studies;<br>Scope and importance; Concept of sustainability and sustainable development. | 12 |
| II | **Ecosystems**<br>What is an ecosystem? Structure and function of ecosystem; Energy flow in an ecosystem: food chains, food webs and ecological succession. Case studies of the following ecosystems:<br>Forest ecosystem<br>Grassland ecosystem<br>Desert ecosystem<br>Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) | 11 |
| III | **Natural Resources: Renewable and Non---renewable Resources**<br>Land resources and landuse change; Land degradation, soil erosion and desertification.<br>Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations.<br>Water: Use and over---exploitation of surface and ground water, floods, | 11 |

| | | |
|---|---|---|
| | droughts, conflicts over water (international & interstate).<br>Energy resources: Renewable and non-renewable energy sources, use of alternate energy sources, growing energy needs, case studies. | |
| IV | **Biodiversity and Conservation**<br>Levels of biological diversity: genetic, species and ecosystem diversity; Biogeographic zones of India; Biodiversity patterns and global biodiversity hot spotsIndia as a mega---biodiversity nation; Endangered and endemic species of IndiaThreats to biodiversity: Habitat loss, poaching of wildlife, man---wildlife conflicts, biological invasions; Conservation of biodiversity: In---situ and Ex---situ conservation of biodiversity.<br>Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value. | 11 |
| V | **Environmental Pollution**<br>Environmental pollution: types, causes, effects and controls; Air, water, soil and noise pollution<br>Nuclear hazards and human health risks<br>Solid waste management: Control measures of urban and industrial waste.<br>Pollution case studies. | 12 |
| VI | **Environmental Policies & Practices**<br>Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture<br>Environment Laws: Environment Protection Act; Air (Prevention & Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act. International agreements: Montreal and Kyoto protocols and Convention on Biological Diversity (CBD).<br>Nature reserves, tribal populations and rights, and human wildlife conflicts in Indian context. | 11 |
| VII | **Human Communities and the Environment**<br>Human population growth: Impacts on environment, human health and welfare.<br>Resettlement and rehabilitation of project affected persons; case studies.<br>Disaster management: floods, earthquake, cyclones and landslides.<br>Environmental movements: Chipko, Silent valley, Bishnois of Rajasthan.<br>Environmental ethics: Role of Indian and other religions and cultures in environmental conservation.<br>Environmental communication and public awareness, case studies (e.g., CNG vehicles in Delhi). | 11 |
| If the course is available as Generic Elective then the students of following departments may opt it.<br>1. Engg. and Tech. (UG),<br>2. B.Sc.(C.S.) | | |

| Evaluation/Assessment Methodology | |
|---|---|
| | **Max. Marks** |
| 1) Class tasks/ Sessional Examination<br>2) Presentations /Seminar<br>3) Assignments<br>4) Research Project Report<br>Seminar On Research Project Report<br>5) ESE | 10<br>5<br>5<br>5<br><br>**75** |
| **Total:** | 100 |
| Prerequisites for the course: 12th | |
| **Course Learning Outcomes:** | |
| The course will enable the students to gather in-depth knowledge on the basic concepts of ecology. | |

**IIMTU-NEP IMPLEMENTATION**
**Year: I / Semester: II**

| | |
|---|---|
| **Programme: B.Sc. (PCM/PSM)**<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>Class: **Certificate** | Year: **I**<br><br>Semester: **II** |
| Credits: **04**<br>Theory:**04**<br>Practical: | **Subject: Physics** |
| **Course Code: BSPH-121** | **Title: Thermal Physics & Semiconductor Devices** |
| **Course Objectives:**<br>The purpose of the undergraduate Physics program at the university level is to provide the key knowledge of the fact of science understanding of the law of physics and laboratory resources to prepare students for careers as professionals in various industries and research institutions. | |
| **Nature of Paper: Core** | |
| **Minimum Passing Marks/Credits: 40% Marks** | |
| L: 04<br>T: 00<br>P: 00 (In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits) | |

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| | **Part A: Thermodynamics & Kinetic Theory of Gases** | |
| I | **0th & 1st Law of Thermodynamics:**<br>State functions and terminology of thermodynamics. Zeroth law and temperature. First law, internal energy, heat and work done. Work done in various thermodynamically processes. Enthalpy, relation between CP and CV. Carnot's engine, efficiency and Carnot's theorem. | **09** |
| II | **2nd & 3rd Law of Thermodynamics:**<br>Different statements of second law, Clausius inequality, entropy and its physical significance. Entropy changes in various thermo-dynamical processes. Third law of thermodynamics and unattainability of absolute zero. Thermo-dynamical potentials, Maxwell's Relations | **08** |
| III | **Kinetic Theory of Gases:**<br>Kinetic model and deduction of gas laws. Derivation of Maxwell's law of distribution of velocities and its experimental verification. Degrees of freedom, law of equipartition of energy (no derivation) and its application to specific heat of gases (mono and di atomic). | **07** |

| | | |
|---|---|---|
| IV | **Theory of Radiation:**<br>Blackbody radiation, spectral distribution, concept of energy density. Derivation of Planck's law, deduction of Wien's distribution law, Rayleigh-Jeans law, Stefan- Boltzmann law and Wien's displacement law from Planck's law. | **06** |
| **PART B: Circuit Fundamentals & Semiconductor Devices** | | |
| V | **DC & AC Circuits:**<br>Growth and decay of currents in RL circuit. Charging and discharging of capacitor in RC, LC and RCL circuits. AC Bridges - measurement of inductance (Maxwell's, Owen's and Anderson's bridges) and measurement of capacitance (Schering's, Wein's and de Sauty's bridges). | **08** |
| VI | **Semiconductors & Diodes:**<br>P and N type semiconductors, qualitative idea of Fermi level. Formation of depletion layer in PN junction diode, field & potential at the depletion layer. Qualitative idea of current flow mechanism in forward & reverse biased diode. Diode fabrication. PN junction diode and its characteristics, static and dynamic resistance. Principle, structure, characteristics and applications of Zener, Tunnel, Light Emitting, Photo diodes. Half and Full wave rectifiers, calculation of ripple factor, rectification efficiency and voltage regulation. | **08** |
| VII | **Transistors:**<br>Bipolar Junction PNP and NPN transistors. Study of CB, CE & CC configurations w.r.t. characteristics; active, cutoff & saturation regions; current gains & relations between them | **06** |
| VIII | **Electronic Instrumentation:**<br>Multimeter: Principles of measurement of dc voltage, dc current, ac voltage, ac current and resistance. Cathode Ray Oscilloscope: Block diagram of basic CRO. Applications of CRO to study the waveform and measurement of voltage, current, frequency & phase difference. | **08** |

**Suggested Readings:**

**PART A**


1. M.W. Zemansky, R. Dittman, "Heat and Thermodynamics", McGraw Hill, 1997, 7e.
2. F.W. Sears, G.L. Salinger, "Thermodynamics, Kinetic theory & Statistical thermodynamics", Narosa Publishing House, 1998.
3. Enrico Fermi, "Thermodynamics", Dover Publications, 1956.
4. S. Garg, R. Bansal, C. Ghosh, "Thermal Physics", McGraw Hill, 2012, 2e.
5. MeghnadSaha, B.N. Srivastava, "A Treatise on Heat", Indian Press, 1973, 5e.


**PART B**


1. R.L. Boylestad, L. Nashelsky, "Electronic Devices and Circuit Theory", Prentice-Hall of India Pvt. Ltd., 2015, 11e.
2. J. Millman, C.C. Halkias, Satyabrata Jit, "Electronic Devices and Circuits", McGraw Hill, 2015, 4e
3. B.G. Streetman, S.K. Banerjee, "Solid State Electronic Devices", Pearson Education India,

| | |
|---|---|
| 2015, 7e<br>4. J.D. Ryder, "Electronic Fundamentals and Applications", Prentice-Hall of India Private Limited, 1975, 5e.<br>5. A. Sudhakar, S.S. Palli, "Circuits and Networks: Analysis and Synthesis", McGraw Hill, 2015, 5e.<br>6. S.L. Gupta, V. Kumar, "Hand Book of Electronics", Pragati Prakashan, Meerut, 2016, 43e | |
| If the course is available as Generic Elective then the students of following departments may opt it.<br>Yes open to all | |
| **Evaluation/Assessment Methodology** | |
| | **Max. Marks** |
| 1. Class tasks/ Sessional Examination<br>2. Assignments<br>3. ESE | 10 + 10<br>5<br>75 |
| **Total:** | **100** |
| Prerequisites for the course: Physics and Mathematics in 12$^{th}$ | |
| **Course Learning Outcomes:**<br>• Recognize the difference between reversible and irreversible processes.<br>• Understand the physical significance of thermo-dynamical potentials.<br>• Comprehend the kinetic model of gases w.r.t. various gas laws.<br>• Study the implementations and limitations of fundamental radiation laws.<br>• Utility of AC bridges.<br>• Recognize the basic components of electronic devices.<br>• Design simple electronic circuits.<br>• Understand the applications of various electronic instruments. | |

**Format-3**

## IIMTU-NEP IMPLEMENTATION
## Year: I / Semester: II

| | |
|---|---|
| **Programme:**<br>Certificate/Diploma/ Degree/ UG(R)/PG/Ph.D.<br>Class:**B.Sc (PCM/PSM)** | **Year: I**<br><br>**Semester: II** |
| Credits: **02**<br>Theory:**0**<br>Practical:**02** | **Subject: Physics** |
| **Course Code: BSPH-121P** | **Title: Thermal Properties of Matter & Electronic Circuits** |

**Course Objectives:**
The purpose of the undergraduate Physics program at the university level is to provide the key knowledge of the fact of science understanding of the law of physics and laboratory resources to prepare students for careers as professionals in various industries and research institutions.

Nature of Paper: **Core**

**Minimum Passing Marks/Credits: 50% Marks**

L: 00
T: 00
P: 04 (In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| | **Lab Experiment List** | |
| | 1. Mechanical Equivalent of Heat by Callender and Barne's method.<br>2. Coefficient of thermal conductivity of copper by Searle's apparatus.<br>3. Coefficient of thermal conductivity of rubber.<br>4. Coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method.<br>5. Value of Stefan's constant.<br>6. Verification of Stefan's law.<br>7. Variation of thermo-emf across two junctions of a thermocouple with temperature.<br>8. Temperature coefficient of resistance by Platinum resistance thermometer<br>9. Charging and discharging in RC and RCL circuits.<br>10. A.C. Bridges: Various experiments based on measurement of L and C.<br>11. Resonance in series and parallel RCL circuit. | **20** |

12. Characteristics of PN Junction, Zener, Tunnel, Light Emitting and Photo diode.
13. Characteristics of a transistor (PNP and NPN) in CE, CB and CC configurations.
14. Half wave & full wave rectifiers and Filter circuits.
15. Unregulated and Regulated power supply.
16. Various measurements with Cathode Ray Oscilloscope (CRO)

**Suggested Readings:**

1. B.L. Worsnop, H.T. Flint, "Advanced Practical Physics for Students", Methuen & Co., Ltd., London, 1962, 9e
2. S. Panigrahi, B. Mallick, "Engineering Practical Physics", Cengage Learning India Pvt. Ltd., 2015, 1e
3. R.L. Boylestad, L. Nashelsky, "Electronic Devices and Circuit Theory", Prentice-Hall of India Pvt. Ltd., 2015, 11eA.
4. Sudhakar, S.S. Palli, "Circuits and Networks: Analysis and Synthesis", McGraw Hill, 2015, 5e

If the course is available as Generic Elective then the students of following departments may opt it.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1. Record File | 15 |
| 2. Viva Voce | 5 |
| 3. Class Interaction | 10 |
| **Total:** | **30** |

Prerequisites for the course:

- The course can be opted by Botany / Chemistry / Computer Science / Mathematics / Statistics / Zoology
- **PREREQUISITE:** Opted / Passed Semester I, Theory Paper-1 (**BSPH-121**)

**Course Learning Outcomes:**

**Course outcomes:**

- Experimental physics has the most striking impact on the industry wherever the instruments are used to study and determine the thermal and electronic properties.
- Measurement precision and perfection is achieved through Lab Experiments.
- Online Virtual Lab Experiments give an insight in simulation techniques and provide a basis for modeling.

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: I / Semester: II**

| | |
|---|---|
| **Programme: Certificate/Diploma/Degree/ UG(R)/PG/Ph.D.**<br>**Class:B.Sc. (PCM/PSM)** | **Year: I**<br><br>**Semester: II** |
| **Credits: 06**<br>**Theory: 06**<br>**Practical:** | **Subject: Mathematics** |
| **Course Code:BSMT-121** | **Title: Matrices and Differential Equations& Geometry** |

**Course Objectives:**

1. The primary objective of this course is to gain proficiency in matrix and differential equations and Geometry and introduce the basic tools of matrices and differential equations which are used to solveapplication problems in a variety of settings ranging from chemistry andphysics to business andeconomics.
2. Matrix, Differential Equations and Geometry develops the concepts of numerical ability and problem-solving attitude and isfundamental for many fields of mathematics.

**Nature of Paper:** Core

**Minimum Passing Marks/Credits: 40% Marks**

L:6
T:
P:(In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical-

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | Rank of a Matrix, Echelon and Normal form of a Matrix, Inverseof a Matrix by elementary operations, System of linear homogeneous and non-homogeneous equations, Theorems on consistency of a system of linear equations. | 12 |
| II | Eigen values, Eigen vectors and characteristic equation of a matrix, Caley-Hamilton theorem and its use in finding inverse of a matrix.<br>Complex functions and separation into real and imaginary parts, Exponential and Logarithmic functions Inverse trigonometric andhyperbolic functions. | 11 |
| III | Formation of differential equations, Geometrical meaning of a differential equation, Equation of first order and first degree, Equationin which the variables are separable, Homogeneous equations, Exact differential equations and equations reducible to the exact form,Linear equations. | 11 |
| IV | First order higher degree equations solvable for $x, y, p$, Clairaut's | 11 |

| | | |
|---|---|---|
| | equation and singular solutions, orthogonal trajectories, Lineardifferential equation of order greater than one with constant coefficients, Cauchy- Euler form. | |
| V | General equation of second degree, System of conics, Tracing of conics, Polar equation of conics and its properties. | 12 |
| VI | Three-Dimensional Coordinates, Projection and Direction Cosine, Plane (Cartesian and vector form), Straight line in three dimension(Cartesian and vector form). | 11 |
| VII | Sphere, Cone and Cylinder. | 11 |
| VIII | Central conicoids, Paraboloids, Plane section of conicoids, Generating lines, Reduction of second degreeequations. | 11 |

**Suggested Readings: (PART-A Matrices and Differential Equations):**

1. Stephen H. Friedberg, A.J Insel & L.E. Spence, Linear Algebra, Person
2. B. Rai, D.P. Choudhary & H. J. Freedman, A Course in Differential Equations, Narosa 3. D.A. Murray, Introductory Course in Differential Equations, Orient Longman
3. Suggested digital plateform: NPTEL / SWAYAM / MOOCs
4. Course Books published in Hindi may be prescribed by the Universities.

**Suggested Readings (Part-B Geometry):**

1. Robert J.T Bell, Elementary Treatise on Coordinate Geometry of three dimensions, Macmillan India Ltd.
2. P.R. Vittal, Analytical Geometry 2d&3D, Pearson.
3. S.L. Loney, The Elements of Coordinate Geometry, Mc.Millan and Company, London.
4. R.J.T. Bill, Elementary Treatise on Coordinate Geometry of Three Dimensions, McMillan India Ltd., 1994.
5. Suggested digital plateform: NPTEL / SWAYAM / MOOCs

If the course is available as Generic Elective then the students of following departments may opt it.

1. Engg. and Tech. (UG),
2. B.Sc. (C.S.)

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 10 |
| 2) Presentations /Seminar | 5 |
| 3) Assignments | 5 |
| 4) Research Project Report<br>Seminar On Research Project Report | 5 |
| 5) ESE | **75** |
| **Total:** | 100 |

| |
|---|
| Prerequisites for the course: 12th Mathematics |
| **Course Learning Outcomes:**<br>CO1: The subjects of the course are designed in such a way that they focus on developing mathematical skills in algebra, calculus and analysis and give ij depth knowledge of geometry, calculus, algebra and other theories.<br>CO2: The student will be able to find the rank, eigen values of matrices and study the linear homogeneous and non-homogeneous equations. The course i1 differential equation intends to develop problem solving skills for solving various types of differential equation and geometrical meaning of differentia equation.<br>CO3: The subjects learn and visualize the fundamental ideas about coordinate geometry and learn to describe some of the surface by using analytical geometry.<br>CO4: On successful completions of the course students have gained knowledge about regular geometrical figures and their properties. They have the foundation for higher course in Geometry. |

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: I / Semester: II**

| | |
|---|---|
| **Programme: Certificate/Diploma/Degree/ UG(R)/PG/Ph.D.**<br>**Class:B.Sc. (PSM)** | **Year: I**<br>**Semester: II** |
| **Credits: 04**<br>**Theory: 04**<br>**Practical:** | **Subject: Statistics** |
| **Course Code:BSST-121** | **Title: Descriptive Statistics (Bivariate) and Probability Distributions** |

**Course Objectives:**
1. To familiar with basic concepts of Mathematical Statistics.
2. To understand the nature of data with the help of various statistical tools.

**Nature of Paper:** Core

**Minimum Passing Marks/Credits: 40% Marks**

L: 4
T:
P: (In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | Bivariate data, Principles of least squares, Most plausible values, Meaning of curve fitting, Fitting of straight line, parabola, logarithmic, power curves and other simple forms by method of leastsquares. | **08** |
| II | Bi-variate frequency table, Correlation, Types of relationships, Scatter diagram, Karl-Pearson's Correlation Coefficient and its properties. | **08** |
| III | Spearman Rank correlation and its coefficient, Regression analysis through both types of regression equations for X and Y variables. | **08** |
| IV | Attributes: Notion and Terminology, Contingency table, Class frequencies and Ultimate class frequencies, Consistency, Association of Attributes, Independence, Measures of association for 2X2 table, Chi-square and Karl Pearson's Coefficient of Association. | **06** |
| V | Discrete Probability Distributions: Binomial distribution, Poisson distribution (as limiting case of Binomial distribution) and their properties in detail. Introduction to Geometric, Negative Binomial, Hypergeometric, and Uniform distributions. | **10** |
| VI | Continuous Probability Distributions: Exponential, Gamma, Beta | |

| | | |
|---|---|---|
| | and Cauchy distributions with their basic properties. | **06** |
| VII | Normal distribution and its properties, Standard Normal variate, Normal distribution as limiting case of Binomial distribution. | **08** |
| VIII | Fitting of Binomial and Poisson distributions. Introduction to Order Statistics, Distributions of minimum and maximum order statistics. | **06** |

**Reference / Text Books:**

1. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2013). Fundamental of Statistics, Vol I, World Press,Kolkata.
2. Gupta, S.C. and Kapoor, V.K. (2000). Fundamentals of Mathematical Statistics ($10^{th}$ed.), Sultan Chand and Sons.
3. Hanagal, D. D. (2009). Introduction to Applied Statistics: A Non-Calculus Based Approach. Narosa Publishing Comp. New Delhi.
4. David, S. (1994) : Elementary Probability, Cambridge University Press. Dudewicz, E.J. and Mishra, S.N. (2008). Modern Mathematics Statistics, Wiley.
5. Gupta, S.C. and Kapoor, V.K. (2000). Fundamentals of Mathematical Statistics ($10^{th}$ ed.), Sultan Chand and Sons.
6. Hanagal, D. D. (2009). Introduction to Applied Statistics: A Non-Calculus Based Approach. Narosa Publishing Comp. New Delhi.

If the course is available as Generic Elective then the students of following departments may opt it.

1. BBA
2. MBA
3. B.Sc. (Ag.)
4. B.Com.
5. B.Tech.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 10+10 =20 |
| 2) Assignments | 5 |
| 3) ESE | 75 |
| **Total:** | 100 |

Prerequisites for the course: Knowledge of Statistics taught in the preceding semester.

**Course Learning Outcomes:**

- Knowledge of the method of least squares for curve fitting to theoretically describe experimental data with a functionorequation and to find the parameter associated with the model.
- Knowledge of the concepts of correlation and simple line a regression and Perform correlation and regression analysis.
- Ability to interpret results from correlation andregression.
- Ability to compute and interpret rank correlation..
- Ability to understand concept of qualitative data and itsanalysis.
- Knowledge of discrete distributions. Discuss appropriate distribution negative binomial, Poisson, etc. with their properties and application of discrete distribution models to

solveproblems.

- Knowledge of continuous distributions. Discuss the appropriate distribution (i.e. uniform, exponential, normal, etc.) with their properties and application of continuous distribution models to solveproblems.
- Knowledge of the formal definition of orderstatistics.
- Ability to identify the application of the oryoforder statisticsinreal life problems.

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: I / Semester: II**

<table>
<tr><td colspan="2">Programme:<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>Class:B.Sc. (PSM)</td><td colspan="2">Year: I<br><br>Semester: II</td></tr>
<tr><td colspan="2">Credits: 02<br>Theory:<br>Practical: 02</td><td colspan="2">Subject: Statistics</td></tr>
<tr><td colspan="2">Course Code:BSST-121P</td><td colspan="2">Title: Descriptive Data Analysis Lab (Bivariate)</td></tr>
<tr><td colspan="4">Course Objectives:<br>These concepts will be verified by experimental means:<br>1. To familiar with basic concepts of Mathematical Statistics.<br>2. To understand the nature of data with the help of various statistical tools.</td></tr>
<tr><td colspan="4">Nature of Paper: Core</td></tr>
<tr><td colspan="4">Minimum Passing Marks/Credits: 50% Marks</td></tr>
<tr><td colspan="4">L:<br>T:<br>P: 4 (In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)</td></tr>
<tr><th>Unit</th><th colspan="2">List of Practicals</th><th>No. of Lectures Allotted</th></tr>
<tr><td>I</td><td colspan="2">1. Problems based on fitting of curves by Method of least squares e.g. fitting of straight line, second degree polynomial, power curve, exponential curve etc.<br>2. Problems based on determination of Regression lines and calculation of Correlation coefficient–grouped and ungrouped data.<br>3. Problems based on determination of Rank correlation.<br>4. Fitting of Binomial and Poisson distribution.</td><td>60</td></tr>
<tr><td colspan="4">Reference / Text Books:<br>Suggested Readings:<br>As suggested for paper code BSST-121.</td></tr>
<tr><td colspan="4">If the course is available as Generic Elective then the students of following departments may opt it.<br>1. BBA<br>2. MBA<br>3. BSc(Ag.)<br>4. B.Com<br>5. B.Tech.</td></tr>
</table>

| **Evaluation/Assessment Methodology** | |
|---|---|
| Continuous Internal Evaluation shall be based on Practical File/Record, Class Activities and Overall performance. The marks shall be as follows: | **Max. Marks** |
| 1) Practical File/Record | 5 |
| 2) Class Interaction | 10 |
| 3) Practical Exam | 35 |
| **Total:** | 50 |
| Prerequisites for the course: Knowledge of Statistics taught in the preceding semester. | |
| **Course Learning Outcomes:**<br>After completing this course a student will have:<br>1. Ability to deal with the problems based on fitting of curves by Method of least squares e.g. itting of straight line, second degree polynomial, power curve, exponential curve etc.<br>2. Ability to deal with problems based on determination of Regression lines and calculation of Correlation coefficient – grouped and ungroupeddata.<br>3. Ability to deal with the problems based on determination of Rank correlation.<br>4. Ability to fit Binomial and Poisson distribution for given data. | |

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: II / Semester: III**

<table>
<tr><td colspan="2">Programme:<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>Class:B.Sc (PCM/PSM)</td><td colspan="2">Year: II<br><br>Semester: III</td></tr>
<tr><td colspan="2">Credits:4<br>Theory:4<br>Practical:</td><td colspan="2">Subject: Physics</td></tr>
<tr><td colspan="2">Course Code:BSPH-231</td><td colspan="2">Title: Electromagnetic Theory & Modern Optics</td></tr>
<tr><td colspan="4">Course Objectives:<br>The purpose of the undergraduate Physics program at the university level is to provide the key knowledge of the fact of science understanding of the law of physics and laboratory resources to prepare students for careers as professionals in various industries and research institutions.</td></tr>
<tr><td colspan="4">Nature of Paper: Core</td></tr>
<tr><td colspan="4">Minimum Passing Marks/Credits: 40% Marks</td></tr>
<tr><td colspan="4">L: 04<br>T: 00<br>P: 00(In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)</td></tr>
<tr><td>Unit</td><td colspan="2">Contents</td><td>No. of Lectures Allotted</td></tr>
<tr><td colspan="4">Part A: Electromagnetic Theory</td></tr>
<tr><td>I</td><td colspan="2">Electrostatics:<br>Electric charge & charge densities, electric force between two charges. General expression for Electric field in terms of volume charge density (divergence & curl of Electric field), general expression for Electric potential in terms of volume charge density and Gauss law (applications included). Study of electric dipole. Electric fields in matter, polarization, auxiliary field D (Electric displacement), electric susceptibility and permittivity.</td><td>08</td></tr>
<tr><td>II</td><td colspan="2">Magnetostatics:<br>Electric current & current densities, magnetic force between two current elements. General expression for Magnetic field in terms of volume current density (divergence and curl of Magnetic field), General expression for Magnetic potential in terms of volume current density and Ampere's circuital law (applications included). Study of magnetic dipole (Gilbert & Ampere model). Magnetic fields in matter, magnetization, auxiliary field H, magnetic susceptibility and permeability.</td><td>08</td></tr>
</table>

| | | |
|---|---|---|
| III | **Time Varying Electromagnetic Fields:**<br>Faraday's laws of electromagnetic induction and Lenz's law. Displacement current, equation of continuity and Maxwell-Ampere's circuital law. Self and mutual induction (applications included). Derivation and physical significance of Maxwell's equations. Theory and working of moving coil ballistic galvanometer (applications included). | **07** |
| IV | **Electromagnetic Waves:**<br>Electromagnetic energy density and Poynting vector. Planeelectromagnetic waves in linear infinite dielectrics, homogeneous & inhomogeneous plane waves and dispersive & non-dispersive media. Reflection and refraction of homogeneous plane electromagnetic waves, law of reflection, Snell's law, Fresnel's formulae (only for normal incidence & optical frequencies) and Stoke's law. | **07** |
| | **PART B: Physical Optics & Lasers** | |
| V | **Interference:**<br>Conditions for interference and spatial & temporal coherence. Division of Wavefront - Fresnel's Biprism and Lloyd's Mirror. Division of Amplitude - Parallel thin film, wedge shaped film and Newton's Ring experiment. Interferometer - Michelson and Fabry-Perot. | **08** |
| VI | **Diffraction:**<br>Distinction between interference and diffraction. Fresnel's and Fraunhofer's class of diffraction. Fresnel's Half Period Zones and Zone plate. Fraunhofer diffraction at a single slit, n slits and Diffracting Grating. Resolving Power of Optical Instruments - Rayleigh's criterion and resolving power of telescope, microscope & grating. | **08** |
| VII | **Polarization:**<br>Polarization by dichroic crystals, birefringence, Nicol prism, retardation plates and Babinet's compensator. Analysis of polarized light. Optical Rotation - Fresnel's explanation of optical rotation and Half Shade & Biquartzpolarimeters. | **07** |
| VIII | **Lasers:**<br>Characteristics and uses of Lasers. Quantitative analysis of Spatial and Temporal coherence. Conditions for Laser action and Einstein's coefficients. Three and four level laser systems qualitative discussion). Types of lasers and laser. | **07** |

**Suggested Readings:**

**PART A**

1. H. K. Malik and A.K. Singh "Engineering Physics", McGraw Hill Education (India) Private Limited, 2018, 2e.
2. Richard P. Feynman, Robert B. Leighton, Matthew Sands, "The Feynman Lectures on

Physics - Vol. 2”, Pearson Education Limited, 2012
3. D. J. Griffiths, “Introduction to Electrodynamics”, Prentice-Hall of India Private Limited, 2002, 3e
4. E. M. Purcell, “Electricity and Magnetism (In SI Units): Berkeley Physics Course Vol 2”, McGraw Hill, 2017, 2e
5. D.C. Tayal, “Electricity and Magnetism”, Himalaya Publishing House Pvt. Ltd., 2019, 4e

**PART B**

1. H. K. Malik, “Engineering Physics”, McGraw Hill Education (India) Private Limited, 2018, 2e.
2. Francis A. Jenkins, Harvey E. White, “Fundamentals of Optics”, McGraw Hill, 2017, 4e
3. Samuel Tolansky, “An Introduction to Interferometry”, John Wiley & Sons Inc., 1973, 2e
4. A. Ghatak, “Optics”, McGraw Hill, 2017, 6e

If the course is available as Generic Elective then the students of following departments may opt it.

1. Yes Open to all

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1. Class tasks/ Sessional Examination | 10 + 10 |
| 2. Assignments | 5 |
| 3. ESE | 75 |
| **Total:** | **100** |

Prerequisites for the course: Physics and Mathematics in $12^{th}$

**Course Learning Outcomes:**

- Better understanding of electrical and magnetic phenomenon in daily life.
- To troubleshoot simple problems related to electrical devices.
- Comprehend the powerful applications of ballistic galvanometer.
- Study the fundamental physics behind reflection and refraction of light (electromagnetic waves).
- Study the working and applications of Michelson and Fabry-Perot interferometers.
- Recognize the difference between Fresnel’s and Fraunhofer’s class of diffraction.
- Comprehend the use of polarimeters.
- Study the characteristics and uses of lasers.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: II / Semester: III**

<table>
<tr><td colspan="2">Programme:<br>Certificate/Diploma/ Degree/ UG(R)/PG/Ph.D.<br>Class:B.Sc (PCM/PSM)</td><td colspan="2">Year: II<br><br>Semester: III</td></tr>
<tr><td colspan="2">Credits: 02<br>Theory:<br>Practical:02</td><td colspan="2">Subject: Physics</td></tr>
<tr><td colspan="2">Course Code: BSPH-231P</td><td colspan="2">Title: Demonstrative Aspects of Electricity & Magnetism</td></tr>
<tr><td colspan="4">Course Objectives:<br>The purpose of the undergraduate Physics program at the university level is to provide the key knowledge of the fact of science understanding of the law of physics and laboratory resources to prepare students for careers as professionals in various industries and research institutions.</td></tr>
<tr><td colspan="4">Nature of Paper: Core</td></tr>
<tr><td colspan="4">Minimum Passing Marks/Credits: 50% Marks</td></tr>
<tr><td colspan="4">L: 00<br>T: 00<br>P: 04 (In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)</td></tr>
<tr><td>Unit</td><td colspan="2">Contents</td><td>No. of Lectures Allotted</td></tr>
<tr><td colspan="4">Lab Experiment List</td></tr>
<tr><td></td><td colspan="2">1. Variation of magnetic field along the axis of single coil.<br>2. Variation of magnetic field along the axis of Helmholtz coil.<br>3. Ballistic Galvanometer: Ballistic constant, current sensitivity and voltage sensitivity.<br>4. Ballistic Galvanometer: High resistance by Leakage method.<br>5. Ballistic Galvanometer: Low resistance by Kelvin’s double bridge method.<br>6. Ballistic Galvanometer: Self-inductance of a coil by Rayleigh’s method.<br>7. Ballistic Galvanometer: Comparison of capacitances.<br>8. Carey Foster Bridge: Resistance per unit length and low resistance.<br>9. Deflection and Vibration Magnetometer: Magnetic moment of a magnet and horizontal component of earth’s magnetic field.<br>10. Earth Inductor: Horizontal component of earth’s magnetic field.<br>11. Newton’s Rings: Wavelength of sodium light.<br>12. Plane Diffraction Grating: Spectrum of mercury light.<br>13. Spectrometer: Refractive index of the material of a prism using</td><td>20</td></tr>
</table>

| | | |
|---|---|---|
| | sodium light.<br>14. Spectrometer: Dispersive power of the material of a prism using mercury light.<br>15. Polarimeter : Specific rotation of sugar solution | |

**Suggested Readings:**


1. B.L. Worsnop, H.T. Flint, "Advanced Practical Physics for Students", Methuen & Co., Ltd., London, 1962, 9e
2. S. Panigrahi, B. Mallick, "Engineering Practical Physics", Cengage Learning India Pvt. Ltd., 2015, 1e
3. R.K. Agrawal, G. Jain, R. Sharma, "Practical Physics", Krishna Prakashan Media (Pvt.) Ltd., Meerut, 2019
4. S.L. Gupta, V. Kumar, "Practical Physics", Pragati Prakashan, Meerut, 2014, 2e


If the course is available as Generic Elective then the students of following departments may opt it.

1. Yes Botany/Chem./Comp. Sc./Maths/Stat./Zool.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1. Record File | 15 |
| 2. Viva Voce | 5 |
| 3. Class Interaction | 10 |
| **Total:** | **30** |

Prerequisites for the course:

- The course can be opted by Botany / Chemistry / Computer Science / Mathematics / Statistics / Zoology
- **PREREQUISITE:** Opted / Passed Semester I, Theory Paper-1 (**BSPH-231**)

**Course Learning Outcomes:**

- Experimental physics has the most striking impact on the industry wherever the instruments are used to study and determine the electric and magnetic properties.
- Measurement precision and perfection is achieved through Lab Experiments.
- Online Virtual Lab Experiments give an insight in simulation techniques and provide a basis for modeling.

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: II / Semester: III**

| | | |
|---|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. **Class:B.Sc. (PCM/PSM)** | | Year: **II** Semester: **III** |
| **Credits: 06** Theory: 06 Practical: 0 | **Subject: Mathematics** | |
| **Course Code:BSMT-231** | **Title: Algebra & Mathematical Methods** | |

**Course Objectives:**

1. Objective of this course is to introduce students to basic concepts of Group, Ring theory and their properties.
2. On successful completion of the course students should have knowledge about higher different mathematical methods and will help him in going to higher studies and research.

**Nature of Paper:** Core

**Minimum Passing Marks/Credits: 40% Marks**

L: 6
T:
P:
Theory - 1 Hr. = 1 Credit
Practical-

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | Equivalence relations and partitions, Congruence module, Definition of a group with examples and simple properties, Subgroups, Generators of a group, Cyclic groups. | 12 |
| II | Permutation groups, Even and odd permutations, The alternating group, Cayley's theorem, Direct products, Coset decomposition, Lagrange's theorem and its consequences, Fermat and Euler theorems. | 11 |
| III | Normal subgroups, Quotient groups, Homomorphism and isomorphism, Fundamental theorem of homomorphism, Theorems on isomorphism. | 11 |
| IV | Rings, Subrings, Integral domains and fields, Characteristic of a ring, Ideal and quotient rings, Ring homomorphism, Field of quotient of an integral domain. | 11 |
| V | Limit and Continuity of functions of two variables, Differentiation of function of two variables, Necessary and sufficient condition for differentiability of functions two variables, Taylor's theorem for functions of two variables with examples, Maxima and minima for | 12 |

| | | |
|---|---|---|
| | functions of two variables, Lagrange multiplier method, Jacobians. | |
| VI | Existence theorems for Laplace transforms, Linearity of Laplace transform and their properties, Laplace transform of the derivatives and integrals of a function, Convolution theorem, inverse Laplace transforms, Solution of the differential equations using Laplace transforms. | 11 |
| VII | Fourier series, Fourier expansion of piecewise monotonic functions, Half and full range expansions, Fourier transforms, Fourier integral. | 11 |
| VIII | Calculus of variations-Variational problems with fixed boundaries. The topic "Indian Ancient Mathematics and Mathematicians should be covered under Continuous Internal Evaluation (CIE). | 11 |

**Reference / Text Books:** (Part-A Algebra):

1. J.B. Fraleigh, A first course in Abstract Algebra, Addison-weley
2. I. N. Herstein, Topics in Algebra, John Wiley & Sons
3. Suggested digital plateform: NPTEL/SWAYAM/MOOCS
4. Course Books (text/reference) published in Hindi may be prescribed by the Universities at local levels.

**Suggested Readings (Part- B Mathematical Methods):**

1. T.M. Apostal, Mathematical Analysis, Person
2. G.F. Simmons, Differential Equations with Application and Historical Notes, Tata - McGraw Hill.
3. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons.
4. Suggested digital plateform : NPTEL/SWAYAM/MOOCs

If the course is available as Generic Elective, then the students of following departments may opt it.

1. Engg. and Tech. (UG)
2. B.Sc. (C.S.)

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 10 |
| 2) Presentations /Seminar | 5 |
| 3) Assignments | 5 |
| 4) Research Project Report<br>Seminar On Research Project Report | 5 |
| 5) ESE | **75** |
| **Total:** | 100 |

Prerequisites for the course: Certificate Course in Mathematics

**Course Learning Outcomes:**

CO1: Group theory is one of the building blocks of modern algebra. Objective of this course is to introduce students to basic concepts of Group, Ring theory and their properties.

CO2: A student learning this course gets a concept of Group, Ring, Integral Domain and their properties. This course will lead the student to basic course in advanced mathematics and Algebra.

CO3: The course gives emphasis to enhance students' knowledge of functions of two variables, Laplace Transforms, Fourier Series.

CO4: On successful completion of the course students should have knowledge about higher different mathematical methods and will help him in going to higher studies and research.

Formate-3

# IIMTU-NEP IMPLEMENTATION
## Year: II / Semester: III

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. **Class:B.Sc. (PSM)** | Year: II<br><br>Semester: III |
| **Credits: 04** Theory: 04 Practical: | **Subject: Statistics** |
| **Course Code: BSST-231** | **Title: Theory of Estimation and Sampling Survey** |

**Course Objectives:**
1. Concept of small sample and large sample tests.
2. Concept of Testing of hypothesis and estimation theory.
3. To analyze and interpret the data vis-à-vis statistical inference.
4. To make students aware of estimation (point, as well as, interval) andtesting (simple, as well as, composite hypotheses) procedures

**Nature of Paper:** Core

**Minimum Passing Marks/Credits: 40% Marks**

L: 4
T:
P: (In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | Types of population, Sample, Principal Steps in Sample Survey, Benefit of Sampling Survey, Sampling vs. Complete enumeration: Sampling units and Sampling frame, Precision and efficiency of estimators. Types of Sampling Methods: Probability Sampling, Non- Probability Sampling: Convenience, Purposive, Quota, Voluntary and Snowball Sampling. | **06** |
| II | Simple Random sampling with and without replacement, Use of random number tables in selection of simple random sample, Estimation of population mean and proportion, Derivation of expression for variance of these estimators, Estimation of variances. | **08** |
| III | Stratified random sampling, Problem of allocation, proportional allocation, optimum allocation. Derivation of the expressions for the standard error of the usual estimators when these allocations are used. Comparison between SRS & Stratified Sampling in terms of Variance | **08** |
| IV | Systematic Sampling: Estimation of Population mean and Population total, standard errors of these estimators. | **08** |

| | | |
|---|---|---|
| V | Sampling Distributions: The concept of sampling distribution, Parameter, Statistic and Standard error. The sampling distribution for the sum of independent random variables of Binomial, Poisson and Normal distributions. | **04** |
| VI | Central limit theorem (Statement only), Sampling distribution of Z, t, F, and chi-square without derivations, Simple properties of these distributions and their interrelationship. | **08** |
| VII | Point estimation: Characteristics of a good estimator: Unbiasedness, consistency, sufficiency and efficiency. Problems and examples, Interval estimation. | **10** |
| VIII | Method of Maximum Likelihood and properties of maximum likelihood estimators (without proof), Method of least squares and methods of moments for estimation of parameters. | **08** |

**Reference / Text Books:**

1. Ardilly, P. and Yves T. (2006). Sampling Methods: Exercise and Solutions.
2. Springer. Cochran, W.G. (2007). Sampling Techniques. (Third Edition). John Wiley & Sons, New Delhi.
3. Cochran, W.G. (2008). Sampling Techniques (3rd ed.), Wiley India.
4. Des Raj. (1976). Sampling Theory. Tata McGraw Hill, New York. (Reprint 1979). Des Raj and Chandhok, P. (1998). Sample Survey Theory, Narosa Publishing House.
5. Ferund J.E (2001) : Mathematical Statistics, Prentice Hall of India.
6. Freedman, D., Pisani, R. and Purves, R. (2014). Statistics. 4th Edition.
7. Norton & Comp. Goon, A.M., Gupta, M.K. & Dasgupta, B. (2002). Fundamentals of Statistics, Vol. I., Kolkata, The World Press.
8. Gupta, S.C. and Kapoor, V.K. (2000). Fundamentals of Mathematical Statistics (10th ed.), Sultan Chand and Sons.

If the course is available as Generic Elective then the students of following departments may opt it.

1. B.Pharma
2. M.Pharma

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 10+10=20 |
| 2) Assignments | 5 |
| 3) ESE | 75 |
| **Total:** | 100 |

Prerequisites for the course: Knowledge of Statistics taught in the preceding semester.

**Course Learning Outcomes:**

After completion student will have these knowledge:

- Knowledge of the concept of Samplingdistributions.
- Ability to understand the difference between parameter & statistic and standard error & standarddeviation.
- Knowledge of the sampling distribution of the sum andmean.
- Ability to understand the t, f and chi-square distribution and to identify the main

characteristics of thesedistributions.

- Knowledge of the concept of Point and Interval Estimation and discuss characteristics of a goodestimator.
- Ability to understand and practice various methods of estimations ofparameters.
- Ability to understand the concept of sampling and how it is different from complete enumeration.
- Knowledge of various probability and non-probability sampling methods along with estimates of populationparameters
- Ability to identify the situations where the various sampling techniques shall be used.
- Knowledge of sampling and non-sampling errors.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: II/ Semester: III**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D.<br>**Class:**B.Sc. (PSM) | Year: II<br><br>Semester: III |
| **Credits: 02**<br>Theory:<br>Practical: **02** | **Subject: Statistics** |
| **Course Code: BSST-231P** | **Title: Sampling Survey Lab** |

**Course Objectives:**
These concepts will be verified by experimental means:
1. Concept of small sample and large sample tests.
2. Concept of Testing of hypothesis and estimation theory.
3. To analyze and interpret the data vis-à-vis statistical inference.
4. To make students aware of estimation (point, as well as, interval) and testing (simple, as well as, composite hypotheses) procedures

**Nature of Paper:** Core

**Minimum Passing Marks/Credits: 50% Marks.**

L:
T:
P: 4 (In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| Unit | List of Practicals | No. of Lectures Allotted |
|---|---|---|
| | *1.* Problems based on drawing a simple random sample with the help of table of randomnumbers.<br>*2.* Problems based on estimation of population means and variance in simple randomsampling.<br>*3.* Problems based on Stratified random sampling for population means (proportional and optimum allocation).<br>*4.* Problems based on Systematic randomsampling | **60** |

**Reference / Text Books:**
**Suggested Readings:**
**As suggested for paper code BSST-231.**

If the course is available as Generic Elective then the students of following departments may opt it.
1. B.Pharma
2. M.Pharma

| Evaluation/Assessment Methodology | |
|---|---|
| Continuous Internal Evaluation shall be based on Practical File/Record, Class Activities and Overall performance. The marks shall be as follows: **Max. Marks** | |
| 1) Practical File/Record<br>2) Class Interaction<br>3) Practical Exam | 5<br>10<br>35 |
| **Total:** | 50 |
| Prerequisites for the course: Knowledge of Statistics taught in the preceding semester. | |

**Course Learning Outcomes:**

After completing this course a student will have these skills:

1. Ability to draw a simple random sample with the help of table of random numbers.
2. Ability to estimate population means and variance in simple random sampling.
3. Ability to deal with problems based on Stratified random sampling for population means (proportional and optimum allocation).
4. Ability to deal with problems based on Systematic random sampling

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: II / Semester: IV**

| | |
|---|---|
| **Programme:**<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>Class:**B.Sc (PCM/PSM)** | Year: II<br><br>Semester: IV |
| Credits: **04**<br>Theory: 0**4**<br>Practical: | **Subject: Physics** |
| **Course Code:**<br>**BSPH-241** | **Title: Perspectives of Modern Physics & Basic Electronics** |

**Course Objectives:**
The purpose of the undergraduate Physics program at the university level is to provide the key knowledge of the fact of science understanding of the law of physics and laboratory resources to prepare students for careers as professionals in various industries and research institutions.

Nature of Paper: **Core**

Minimum Passing Marks/Credits: **40% Marks**

L: 04
T: 00
P: 00(In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| | **Part A: Perspectives of Modern Physics** | |
| I | **Relativity-Experimental Background:**<br>Structure of space & time in Newtonian mechanics and inertial & non-inertial frames. Galilean transformations. Galilean transformation. Attempts to locate the Absolute Frame: Michelson-Morley experiment and significance of the null result. Einstein's postulates of special theory of relativity. | **07** |
| II | **Relativity-Relativistic Kinematics:**<br>Structure of space & time in Relativistic mechanics and derivation of Lorentz transformation equations Transformation of Simultaneity (Relativity of simultaneity); Transformation of Length (Length contraction); Transformation of Time (Time dilation); Transformation of Velocity (Relativistic velocity addition); Transformation of Acceleration; Transformation of Mass (Variation of mass with velocity). Relation between Energy & Mass (Einstein's mass & energy relation) and Energy & Momentum. | **08** |

| | | |
|---|---|---|
| III | **Inadequacies of Classical Mechanics:**<br>Particle Properties of Waves: Photoelectric effect, Compton Effect and their explanations based on Max Planck's Quantum hypothesis. Wave Properties of Particles: Louis de Broglie's hypothesis of matter waves and their experimental verification by Davisson-Germer's experiment. | 08 |
| IV | **Introduction to Quantum Mechanics:**<br>Matter Waves: Mathematical representation, Wavelength, Concept of Wave group, Group (particle) velocity, Phase (wave) velocity and relation between Group & Phase velocities. Wave Function: Functional form, Normalisation of wave function and Probabilistic interpretation of wave function. | 07 |
| **PART B: Basic Electronics & Introduction to Fiber Optics** | | |
| V | **Transistor Biasing:**<br>Faithful amplification & need for biasing. Stability Factors and its calculation for transistor biasing circuits for CE configuration: Fixed Bias (Base Resistor Method), Emitter Bias (Fixed Bias with Emitter Resistor), Collector to Base Bias (Base Bias with Collector Feedback) &, Voltage Divider Bias. Discussion of Emitter-Follower configuration. | 07 |
| VI | **Amplifiers:**<br>Classification of amplifiers based on Mode of operation (Class A, B, AB, C & D), Stages (single & multi stage, cascade & cascode connections), Coupling methods (RC, Transformer, Direct & LC couplings), Nature of amplification (Voltage & Power amplification) and Frequency capabilities (AF, IF, RF & VF). Theory & working of RC coupled voltage amplifier (Uses of various resistors & capacitors, and Frequency response) and Transformer coupled power amplifier (calculation of Power, Effect of temperature, use of heat sink & Power dissipation). Calculation of Amplifier Efficiency (power efficiency) for Class A Series-Fed, Class A Transformer Coupled, Class B Series-Fed and Class B Transformer Coupled amplifiers. | 08 |
| VII | **Feedback & Oscillator Circuits:**<br>Feedback Circuits: Effects of positive and negative feedback. Voltage Series, Voltage Shunt, Current Series and Current Shunt feedback connection types and their uses for specific amplifiers. Estimation of Input Impedance, Output Impedance, Gain, Stability, Distortion, Noise and Band Width for Voltage Series negative feedback. Oscillator Circuits: Use of positive feedback for oscillator operation. Barkhausen criterion for self-sustained oscillations. Feedback factor and frequency of oscillation for RC Phase Shift oscillator and Wein Bridge oscillator. Qualitative discussion of Reactive Network feedback oscillators (Tuned oscillator circuits): Hartley &Colpitts oscillators. | 09 |
| VIII | **Introduction to Fiber Optics:**<br>Basics of Fiber Optics, step index fiber, graded index fiber, light | 06 |

| | | |
|---|---|---|
| | propagation through an optical fiber, acceptance angle & numerical aperture, qualitative discussion of fiber losses and applications of optical fibers. | |

**Suggested Readings:**

**PART A**

1. Beiser, Shobhit Mahajan, “Concepts of Modern Physics: Special Indian Edition”, McGraw Hill, 2009, 6e
2. H. K. Malik and A.K. Singh “Engineering Physics”, McGraw Hill Education (India) Private Limited, 2018, 2e.
3. John R. Taylor, Chris D. Zafiratos, Michael A. Dubson, “Modern Physics for Scientists and Engineers”, Prentice-Hall of India Private Limited, 2003, 2e
4. R.A. Serway, C.J. Moses, and C.A. Moyer, “Modern Physics”, Cengage Learning India Pvt. Ltd, 2004, 3e
5. R. Resnick, “Introduction to Special Relativity”, Wiley India Private Limited, 2007
6. R. Murugeshan, Kiruthiga Sivaprasath, “Modern Physics”, S. Chand Publishing, 2019, 18e

**PART B**

1. H. K. Malik and A.K. Singh “Engineering Physics”, McGraw Hill Education (India) Private Limited, 2018, 2e.
2. R.L. Boylestad, L. Nashelsky, “Electronic Devices and Circuit Theory”, Prentice-Hall of India Pvt. Ltd., 2015, 11e
3. J. Millman, C.C. Halkias, SatyabrataJit, “Electronic Devices and Circuits”, McGraw Hill, 2015, 4e
4. B.G. Streetman, S.K. Banerjee, “Solid State Electronic Devices”, Pearson Education India, 2015, 7e
5. J.D. Ryder, “Electronic Fundamentals and Applications”, Prentice-Hall of India Private Limited, 1975, 5e
6. John M. Senior, “Optical Fiber Communications: Principles and Practice”, Pearson Education Limited, 2010, 3e
7. John Wilson, John Hawkes, “Optoelectronics: Principles and Practice”, Pearson Education Limited, 2018, 3e
8. S.L. Gupta, V. Kumar, “Hand Book of Electronics”, Pragati Prakashan, Meerut, 2016, 43e

If the course is available as Generic Elective then the students of following departments may opt it.

1. Yes open to all

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1. Class tasks/ Sessional Examination | 10 + 10 |
| 2. Assignments | 5 |
| 3. ESE | 75 |
| **Total:** | **100** |

Prerequisites for the course: Passed Semester I, Theory Paper-1 (BSPH-111)

**Course Learning Outcomes:**

- Recognize the difference between the structure of space & time in Newtonian & Relativistic mechanics.
- Understand the physical significance of consequences of Lorentz transformation equations.
- Comprehend the wave-particle duality.
- Develop an understanding of the foundational aspects of Quantum Mechanics.
- Study the working and applications of Michelson and Fabry-Perot interferometers.
- Recognize the difference between Fresnel's and Fraunhofer's class of diffraction.
- Comprehend the use of polarimeters. Study the characteristics and uses of lasers.

**IIMTU-NEP IMPLEMENTATION**
**Year: II / Semester: IV**

| | |
|---|---|
| **Programme:**<br>Certificate/Diploma/ Degree/ UG(R)/PG/Ph.D.<br>Class:**B.Sc (PCM/PSM)** | Year: **II**<br><br>Semester: **IV** |
| Credits:**02**<br>Theory:<br>Practical:**02** | **Subject: Physics** |
| **Course Code: BSPH-241P** | **Title: Basic Electronics Instrumentation** |

**Course Objectives:**
The purpose of the undergraduate Physics program at the university level is to provide the key knowledge of the fact of science understanding of the law of physics and laboratory resources to prepare students for careers as professionals in various industries and research institutions.

Nature of Paper: **Core**

**Minimum Passing Marks/Credits: 50% Marks**

L: 00
T: 00
P: 04 (In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| | **Lab Experiment List** | |
| | 1. Transistor Bias Stability.<br>2. Comparative Study of CE, CB and CC amplifier.<br>3. Clippers and Clampers.<br>4. Study of Emitter Follower.<br>5. Frequency response of single stage RC coupled amplifier.<br>6. Frequency response of single stage Transformer coupled amplifier.<br>7. Effect of negative feedback on frequency response of RC coupled amplifier.<br>8. Study of Schmitt Trigger.<br>9. Study of Hartley oscillator.<br>10. Study of Wein Bridge oscillator. | **20** |

**Suggested Readings:**

1. R.L. Boylestad, L. Nashelsky, "Electronic Devices and Circuit Theory", Prentice-Hall of India Pvt. Ltd., 2015, 11e
2. J. Millman, C.C. Halkias, SatyabrataJit, "Electronic Devices and Circuits", McGraw Hill, 2015, 4e

3. B.G. Streetman, S.K. Banerjee, "Solid State Electronic Devices", Pearson Education India, 2015, 7e
4. J.D. Ryder, "Electronic Fundamentals and Applications", Prentice-Hall of India Private Limited, 1975, 5e
5. John M. Senior, "Optical Fiber Communications: Principles and Practice", Pearson Education Limited, 2010, 3e
6. John Wilson, John Hawkes, "Optoelectronics: Principles and Practice", Pearson Education Limited, 2018, 3e
7. S.L. Gupta, V. Kumar, "Hand Book of Electronics", Pragati Prakashan, Meerut, 2016, 43e

If the course is available as Generic Elective then the students of following departments may opt it.

2. Yes Botany/Chem./Comp. Sc./Maths/Stat./Zool.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1. Record File | 15 |
| 2. Viva Voce | 5 |
| 3. Class Interaction | 10 |
| **Total:** | **30** |

Prerequisites for the course:

- The course can be opted by Botany / Chemistry / Computer Science / Mathematics / Statistics / Zoology
- **PREREQUISITE:** Opted / Passed Semester I, Theory Paper-1 (**BSPH-241**)

**Course Learning Outcomes:**

- Basic Electronics instrumentation has the most striking impact on the industry wherever the components / instruments are used to study determine the electronic properties.
- Measurement precision and perfection is achieved through Lab Experiments.
- Online Virtual Lab Experiments give an insight in simulation techniques and provide a basis for modeling.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: II / Semester: IV**

| | |
|---|---|
| **Programme: B.Sc. (PCM/PSM)**<br>Certificate/Diploma/Degree/ UG(R)/PG/Ph.D.<br>Class:**Graduation (UG)** | Year: II<br><br>Semester: IV |
| Credits: **06**<br>Theory: **06**<br>Practical: | **Subject: Mathematics** |
| Course Code:**BSMT-241** | **Title: Differential Equations & Mechanics** |

**Course Objectives:**

1. The objective of this course is to familiarize the students with various methods of solving differential equations, partial differential equations of firs order and second order and to have qualitative applications
2. The student, after completing the course can go for higher problems in mechanic such as Hydrodynamics, this will be helpful in getting employment in industry.

**Nature of Paper: Core**

**Minimum Passing Marks/Credits: 40% Marks**

L:6
T:
P:(In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical-

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | Second order linear differential equations with variable coefficients: Use of a known solution to find another, normal form, method of undetermined coefficient, variation of parameters, Series solutions of differential equations, Power series method. | 12 |
| II | Bessel, Legendre and Hypergeometric functions and their properties, recurrence and generating relations. | 11 |
| III | Origin of first order partial differential equations. Partial differential equations of the first order and degree one, Lagrange's solution, Partial differential equation of first order and degree greater than one. Charpit's method of solution, Surfaces Orthogonal to the given system of surfaces. | 11 |
| IV | Origin of second order PDE, Solution of partial differential equations of the second and higher order with constant coefficients, Classification of linear partial differential equations of second order, Solution of second order partial differential equations with variable coefficients. | 11 |

| | | |
|---|---|---|
| V | Frame of reference, work energy principle, Forces in three dimensions, Poinsot's central axis, Wrenches, Null lines and planes. | 12 |
| VI | Virtual work, Stable and Unstable equilibrium, Catenary, Catenary of uniform strength. | 11 |
| VII | Velocities and accelerations along radial and transverse directions, and along tangential and normal directions, Simple Harmonic motion, Motion under other law of forces. Motion in resisting medium, Constrained motion, Motion on smooth and rough plane curves. | 11 |
| VIII | Central orbit, Kepler's laws of motion, Motion of particle in three dimensions, Rotating frame of reference, Rotating Earth, Acceleration in terms of different coordinates systems. | 11 |

**Reference / Text Books:**

**(Part-A Differential Equations):**


1. G.F. Simmons, Differential Equations with Application and Historical Notes, Tata - Mc. Graw Hill.
2. B. Rai, D.P. Choudhary & H. J. Freedman, A Course of Ordinary Differential Equations, Narosa
3. Ian N. Snedden, Elements of Partial Differential Equations, Dover Publication
4. L.E. Elsgolts, Differential Equation and Calculus of variations, University Press of the Pacific.
5. Suggested digital plateform: NPTEL / SWAYAM / MOOCs
6. Course Books (text/reference) published in Hindi may be prescribed by the Universities at local levels.


**Suggested Readings(Part-B Mechanics):**


1. R.C. Hibbeler, Engineering Mechanics-Statics, Prentics Hall Publishers.
2. R.C. Hibbeler, Engineering Mechanics-Dynamics, Prentics Hall Publishers.
3. A. Nelson, Engineering Mechanics Statics and Dynamics, Tata Mc. Graw Hill.
4. J.L. Synge & B.A. Griffith, Principles of Mechanics, Tata Mc. Graw Hill.
5. Suggested digital plateform: NPTEL/SWAYAM/MOOCs.


If the course is available as Generic Elective then the students of following departments may opt it.

1. Engg. and Tech. (UG)
2. Economics (UG/PG)
3. B.Sc. Physics
4. B.Sc. (C.S.)

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 10 |
| 2) Presentations /Seminar | 5 |
| 3) Assignments | 5 |
| 4) Research Project Report<br>Seminar On Research Project Report | 5 |
| 5) ESE | 75 |
| **Total:** | **100** |

Prerequisites for the course: Certificate Course in Mathematics

**Course Learning Outcomes:**

CO1: The objective of this course is to familiarize the students with various methods of solving differential equations, partial differential equations of firs order and second order and to have qualitative applications.

CO2: A student doing this course is able to solve differential equations and is able to model problems in nature using ordinary differential equations. After completing this course, a student will be able to take more courses on wave equation, heat equation, diffusion equation, gas dynamics, non-linear evolution equation etc. These entire courses are important in engineering and industrial applications for solving boundary value problem.

CO3: The object of the paper is to give students knowledge of basic mechanics such as simple harmonic motion, motion under other laws and forces.

CO4: The student, after completing the course can go for higher problems in mechanic such as Hydrodynamics, this will be helpful in getting employment in industry.

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: II/ Semester: IV**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. Class:**B.Sc. (PSM)** | Year: II<br>Semester: IV |
| Credits: **04**<br>Theory: **04**<br>Practical: | **Subject: Statistics** |
| **Course Code:BSST-241** | **Title: Testing of Hypothesis and Applied Statistics** |

**Course Objectives:**

1. To define steps of testing of hypothesis.
2. To differentiate between large and small sample tests.
3. To find expected frequency and test the goodness of fit.
4. Differentiate between parametric and non parametric tests.
5. This course will give exposure to four applied fields of statistics viz. Time Series, Index Numbers, Statistical Quality Control and Demographic methods.
6. They will be having hands on practice of working on the data related to above mentioned fields.

**Nature of Paper: Core**

**Minimum Passing Marks/Credits: 40% Marks.**

L: 4
T:
P: (In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| **Unit** | **Contents** | **No. of Lectures Allotted** |
|---|---|---|
| I | Statistical Hypothesis (Simple an Composite), Testing of hypothesis. Type –I and Type – II errors, Significance level, p-values. | 08 |
| II | Neyman-Pearson Lemma, Power of a test, Definitions of Most Powerful (MP), Uniformly Most Powerful (UMP) and Uniformly Most Powerful Unbiased (UMPU) tests. | 08 |
| III | Test of significance: Large sample tests for (Attributes and Variables) proportions and means (i) for one sample (ii) for two samples. | 06 |
| IV | Small sample test based on t, F and chi-square distributions. | 08 |
| V | Introduction & Definition of Time Series, its different components, illustrations, additive and multiplicative models. Determination of trend by free hand curve, semi average method, moving average method, method of least squares, Analysis of Seasonal Component by Simple average method, Ratio to moving Average, Ratio to Trend, Link relative method. | 09 |

| | | |
|---|---|---|
| VI | Index number – its definition, application of index number, price relative and quantity or volume relatives, link and chain relative, problem involved in computation of index number, use of averages, simple aggregative and weighted average method. Laspeyre's, Paasche's and Fisher's index number, time and factor reversal tests of index numbers, consumer price index. | 09 |
| VII | Vital Statistics: Measurement of Fertility–Crude birth rate, general fertility rate, age-specific birth rate, total fertility rate, gross reproduction rate, net reproduction rate, standardized death rates Complete life table, its main features and construction. | 06 |
| VIII | Introduction to Statistical Quality Control, Process control, tools of statistical quality control, $3\sigma$ control limits, Principle underlying the construction of control charts. Control charts for variables, ‘ $X$ ’ and ‘R’ charts, construction and interpretation, Control charts for attributes ‘p’ and ‘c’ charts, construction and interpretation. | 06 |

**Reference / Text Books:**

1. Ferund J.E (2001) : Mathematical Statistics, Prentice Hall of India.
2. Freedman, D., Pisani, R. and Purves, R. (2014). Statistics. 4th Edition. Norton & Comp.
3. Goon, A.M., Gupta, M.K. & Dasgupta, B. (2002). Fundamentals of Statistics, Vol. I., Kolkata, The World Press.
4. Gupta, S.C. and Kapoor, V.K. (2000). Fundamentals of Mathematical Statistics ($10^{th}$ ed.), Sultan Chand and Sons.
5. Hangal, D. D. (2009). Introduction to Applied Statistics: A Non-Calculus Based Approach. Narosa Publishing Comp. New Delhi.
6. Hogg, R.V., McKean, J.W. & Craig, A.T. (2009). Introduction to Mathematical Statistics ($6^{th}$ ed.), Pearson.
7. Gupta, S.C. and Kapoor, V.K. (2008). Fundamentals of Applied Statistics ($4^{th}$ ed.), Sultan Chand and Sons.

If the course is available as Generic Elective then the students of following departments may opt it.

1. B.A. in Economics
2. M.Com.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 10+10=20 |
| 2) Assignments | 5 |
| 3) ESE | **75** |
| **Total:** | **100** |

Prerequisites for the course: Knowledge of Statistics taught in the preceding semester.

**Course Learning Outcomes:**

- Knowledge of the terms like null and alternative hypotheses, two-tailed and one- tailed alternative hypotheses, significant and insignificant, level of significance and confidence, p value etc.
- Ability to understand the concept of MP, UMP and UMPU tests
- Ability to understand under what situations one would conduct the small sample and large sample tests (in case of one sample and two sample tests).
- Familiarity with different aspects of Applied Statistics and their use in real life situations.
- Ability to understand the concept of Time series along with its different components.
- Knowledge of Index numbers and their applications along with different types of Index numbers.
- Familiarity with various demographic methods and different measures of mortality and fertility.
- Ability to understand the concept of life table and its construction.
- Knowledge to understand the concept of statistical quality control and different control charts for variables and attributes.

**IIMTU-NEP IMPLEMENTATION**
**Year: II/ Semester: IV**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D.<br>**Class:**B.Sc. (PSM) | Year: **II**<br>Semester: **IV** |
| **Credits: 02**<br>Theory:<br>Practical: **02** | **Subject: Statistics** |
| **Course Code:BSST-241P** | **Title: Tests of Significance and Applied Statistics Lab** |

**Course Objectives:**
These concepts will be verified by experimental means:
1. To define steps of testing of hypothesis.
2. To differentiate between large and small sample tests.
3. To find expected frequency and test the goodness of fit.
4. Differentiate between parametric and non parametric tests.
5. This course will give exposure to four applied fields of statistics viz. Time Series, Index Numbers, Statistical Quality Control and Demographic methods.
6. They will be having hands on practice of working on the data related to above mentioned fields.

**Nature of Paper:** Core

**Minimum Passing Marks/Credits: 50% Marks**

L:
T:
P: 4 (In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| Unit | List of Practicals | No. of Lectures Allotted |
|---|---|---|
| I | *1.* Problems based on t – test.<br>*2.* Problems based on F-test.<br>*3.* Problems based on Chi-square test.<br>*4.* Problems based on calculation of power function.<br>*5.* Problems based on large sample tests.<br>*6.* Problems based on time series and its different components<br>*7.* Problems based on Index number.<br>*8.* Problems based on measurement of mortality and fertility.<br>*9.* Problems based on life table.<br>*10.* Problems based on control charts for variables and attributes | **20** |

If the course is available as Generic Elective then the students of following departments may opt it.
1. Economics
2. B.Com.
3. M.Com.

**Evaluation/Assessment Methodology**

Continuous Internal Evaluation shall be based on Practical File/Record, Class Activities and Overall performance. The marks shall be as follows:

| | **Max. Marks** |
|---|---|
| 1) Practical File/Record | 5 |
| 2) Class Interaction | 10 |
| 3) Practical Exam | 35 |
| **Total:** | 50 |

Prerequisites for the course: Knowledge of Statistics taught in the preceding semester.

**Course Learning Outcomes:**

After completing this course a student will have these skills:
1. Ability to conduct test of significance based on t, F tests and Chi-square test.
2. Ability to deal with problems based on large sample tests.
3. Ability to deal with problems based on time series and calculation of its different components for forecasting.
4. Ability to deal with problems based on Index number.
5. Acquire knowledge about measurement of mortality and fertility.
6. Ability to deal with problems based on life table.
7. Ability to work with control charts for variables and attributes and draw inferences.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: III / Semester: V**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. Class:**B.Sc (PCM/PSM)** | Year: III<br><br>Semester: V |
| Credits: **04**<br>Theory: **04**<br>Practical:**0** | **Subject: Physics** |
| **Course code**: **BSPH-352** | **Title: Quantum Mechanics & Spectroscopy** |
| **Course Objectives:**<br>The purpose of the undergraduate Physics program at the university level is to provide the key knowledge of the fact of science understanding of the law of physics and laboratory resources to prepare students for careers as professionals in various industries and research institutions. | |
| Nature of Paper: **DSC** | |
| Minimum Passing Marks/Credits: **40% Marks** | |
| L: 04<br>T: 00<br>P: 00 (In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits) | |

| **Unit** | **Contents** | **No. of Lectures Allotted** |
|---|---|---|
| | **Part A: Introduction to Quantum Mechanics** | |
| I | **Formulation of quantum mechanics & Operators:**<br>Basic idea about particle aspect of radiation, wave aspect of particles and wave particle duality; Double slit experiment, Probabilistic interpretation, wave packet, observables and operators, Hermitian operator (Definition, Proof, properties), commutative and simultaneous operators, Wave function, Orthonormalization condition of wave function, Swartz inequality. Review of matrix algebra, definition of an operator, special operators, operator algebra and operators. | 07 |
| II | **Eigen & Expectation Values and Uncertainty Principle:**<br>Eigen & Expectation Values: Eigen equation for an operator, eigen state (value) and eigen functions. Linear superposition of eigen functions and Non-degenerate & Degenerate eigen states. Expectation value pertaining to an operator and its physical interpretation. Heisenberg uncertainty principle: Commutativity & simultaneity (theorems with proofs). Non commutativity of operators as the basis for uncertainty principle and derivation of general form of uncertainty principle through Schwarz inequality. Uncertainty principle for various | 07 |

| | | |
|---|---|---|
| | conjugate pairs of physical-dynamical parameters and its applications. | |
| III | **Quantum Postulates and Schrodinger Equation:** Postulates of quantum mechanics: statements and their physical interpretation. Hamiltonian operator. Schrodinger Equation: formulation (time independent & time dependent forms), Schrodinger equation as an eigen equation, Deviation & interpretation of equation of continuity in Schrodinger representation, and Equation of motion of an operator in Schrodinger representation. Free particle solution of Schrödinger equation. | 07 |
| IV | **Applications of Schrodinger Equation:** Application to 1D Problems: Infinite Square well potential (Particle in 1D box), Finite Square well potential, Potential step, Rectangular potential barrier and 1D Harmonic oscillator. Application to 3D Problems: Infinite Square well potential (Particle in a 3D box) and the Hydrogen atom (radial distribution function and radial probability included). (Direct solutions of Hermite, Associated Legendre and Associated Laguerre differential equations to be substituted). | 09 |
| **PART B: Introduction to Spectroscopy** | | |
| V | **Vector Atomic Model:** Inadequacies of Bohr and Bohr-Sommerfeld atomic models w.r.t. spectrum of Hydrogen atom (fine structure of H-alpha line). Modification due to finite mass of nucleus and Deuteron spectrum. Vector atomic model (Stern-Gerlach experiment included) and physical & geometrical interpretations of various quantum numbers for single & many valence electron systems. LS & JJ couplings, spectroscopic notation for energy states, selection rules for transition of electrons and intensity rules for spectral lines. Fine structure of H-alpha line on the basis of vector atomic model. | 10 |
| VI | **Spectra of Alkali & Alkaline Elements:** Spectra of alkali elements: Screening constants for s, p, d & f orbitals;sharp, principle, diffuse & fundamental series; doublet structure of spectra and fine structure of Sodium D line. Spectra of alkaline elements: Singlet and triplet structure of spectra. | 06 |
| VII | **X-Rays & X-Ray Spectra:** Nature & production, Continuous X-ray spectrum & Duane-Hunt's law, Characteristic X-ray spectrum & Mosley's law, Fine structure of Characteristic X-ray spectrum, and X-ray absorption spectrum. | 07 |
| VIII | **Molecular Spectra:** Discrete set of energies of a molecule, electronic, vibrational and rotational energies. Quantisation of vibrational energies, transition rules and pure vibrational spectra. Quantisation of rotational energies, transition rules, pure rotational spectra and determination of inter nuclear distance. Basics of UV Visible & photoluminescence spectroscopy | 07 |

**Suggested Readings:**

**PART A**
1. D.J. Griffiths, "Introduction to Quantum Mechanics", Pearson Education, India, 2004, 2e
2. H. K. Malik and A.K. Singh "Engineering Physics", McGraw Hill Education (India) Private Limited, 2018, 2e.
3. N. Zettili, "Quantum Mechanics, Concepts and Applications", ohn Wiley and Sons, Ltd., Publication 2009.
4. E. Wichmann, "Quantum Physics (In SI Units): Berkeley Physics Course Vol 4", McGraw Hill, 2017
5. Richard P. Feynman, Robert B. Leighton, Matthew Sands, "The Feynman Lectures on Physics - Vol. 3", Pearson Education Limited, 2012
6. R Murugeshan, Kiruthiga Sivaprasath, "Modern Physics", S. Chand Publishing, 2019, 18e

**PART B**
1. H.E. White, "Introduction to Atomic Spectra", McGraw Hill, 1934
2. C.N. Banwell, E.M. McCash, "Fundamentals of Molecular Spectroscopy", McGraw Hill, 2017, 4e
3. R Murugeshan, Kiruthiga Sivaprasath, "Modern Physics", S. Chand Publishing, 2019, 18e
4. S.L. Gupta, V. Kumar, R.C. Sharma, "Elements of Spectroscopy", Pragati Prakashan, Meerut, 2015, 27e

If the course is available as Generic Elective then the students of following departments may opt it.
1. Yes Chem./ Comp. Sc./ Maths/ Stats

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1. Class tasks/ Sessional Examination | 10 + 10 |
| 2. Assignments | 5 |
| 3. ESE | 75 |
| **Total:** | **100** |

Prerequisites for the course: Passed Semester I, Theory Paper-1 (BSPH-111)

**Course Learning Outcomes:**
- Understand the significance of operator formalism in Quantum mechanics.
- Study the eigen and expectation value methods.
- Understand the basis and interpretation of Uncertainty principle.
- Develop the technique of solving Schrodinger equation for 1D and 3D problems.
- Comprehend the success of Vector atomic model in the theory of Atomic spectra.
- Study the different aspects of spectra of Group I & II elements.
- Study the production and applications of X-rays.
- Develop an understanding of the fundamental aspects of Molecular spectra.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: III / Semester: V**

<table>
<tr><td colspan="2">Programme:<br>Certificate/Diploma/ Degree/<br>UG(R)/PG/Ph.D.<br>Class:B.Sc (PCM/PSM)</td><td colspan="2">Year: III<br><br>Semester: V</td></tr>
<tr><td colspan="2">Credits:02<br>Theory:<br>Practical:02</td><td colspan="2">Subject: Physics</td></tr>
<tr><td colspan="2">Course Code:BSPH-351P</td><td colspan="2">Title: Demonstrative Aspects of Optics & Lasers</td></tr>
<tr><td colspan="4">Course Objectives:<br>The purpose of the undergraduate Physics program at the university level is to provide the key knowledge of the fact of science understanding of the law of physics and laboratory resources to prepare students for careers as professionals in various industries and research institutions.</td></tr>
<tr><td colspan="4">Nature of Paper: Core</td></tr>
<tr><td colspan="4">Minimum Passing Marks/Credits: 50% Marks</td></tr>
<tr><td colspan="4">L: 00<br>T: 00<br>P: 04 (In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)</td></tr>
<tr><th>Unit</th><th colspan="2">Contents</th><th>No. of Lectures Allotted</th></tr>
<tr><th colspan="4">Lab Experiment List</th></tr>
<tr><td></td><td colspan="2">1. Fresnel Biprism: Wavelength of sodium light<br>2. Fresnel Biprism: Thickness of mica sheet)<br>3. Wavelength of Laser light using diffraction by single slit.<br>4. Study of Spectra of Hydrogen & Deuterium (Rydberg Constant).<br>5. Laser – Wavelength of Laser light using diffraction by single slit..<br>6. Study of polarization of light by simple reflection & variation of degree of polarization.<br>7. Study of Absorption spectrum of Iodine Vapour<br>8. Laser beam divergence & spot size.<br>9. Newton’s Rings: Refractive index of liquid<br>10. Plane Diffraction Grating: Resolving power</td><td>20</td></tr>
<tr><td colspan="4">Suggested Readings:<br>1. B.L. Worsnop, H.T. Flint, “Advanced Practical Physics for Students”, Methuen & Co., Ltd., London, 1962, 9e<br>2. S. Panigrahi, B. Mallick, “Engineering Practical Physics”, Cengage Learning India Pvt.</td></tr>
</table>

Ltd., 2015, 1e
3. R.K. Agrawal, G. Jain, R. Sharma, "Practical Physics", Krishna Prakashan Media (Pvt.) Ltd., Meerut, 2019
4. S.L. Gupta, V. Kumar, "Practical Physics", Pragati Prakashan, Meerut, 2014, 2e

If the course is available as Generic Elective then the students of following departments may opt it.

1. Yes Botany/Chem./Comp. Sc./Maths/Stat./Zool.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1. Record File | 15 |
| 2. Viva Voce | 5 |
| 3. Class Interaction | 10 |
| **Total:** | **30** |

Prerequisites for the course:

- The course can be opted by Botany / Chemistry / Computer Science / Mathematics / Statistics / Zoology
- **PREREQUISITE:** Opted / Passed Semester I, Theory Paper-1 (**BSPH-351 and BSPH-352**)

**Course Learning Outcomes:**

- Experimental physics has the most striking impact on the industry wherever the instruments are used to study and determine the optical properties.
- Measurement precision and perfection is achieved through Lab Experiments.
- Online Virtual Lab Experiments give an insight in simulation techniques and provide a basis for modeling.

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: III / Semester: V**

| | |
|---|---|
| **Programme:**<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>**Class:B.Sc. (PCM/PSM)** | Year: III<br><br>Semester: V |
| **Credits: 04**<br>Theory: **04**<br>Practical: | **Subject: Mathematics** |
| **Course Code:BSMT-351** | **Title: Group and Ring Theory & Linear Algebra** |

**Course Objectives:**

1. Linear algebra is a basic course in almost all branches of science. The objective of this course is to introduce a student to the basics of linear algebra and some of its applications.
2. The student will use this knowledge in computer science, finance mathematics, industrial mathematics and bio mathematics. After completion of this course students appreciate its interdisciplinary nature.

**Nature of Paper:** Core

**Minimum Passing Marks/Credits: 40% Marks**

L: 5
T:
P: (In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical-

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | Automorphism, inner automorphism, Automorphism groups, Automorphism groups of finite and infinite cyclic groups, Characteristic subgroups, Commutator subgroup and its properties; Applications of factor groups to automorphism groups. | 10 |
| II | Conjugacy classes, The class equation, □-groups, The Sylow theorems and consequences, Finite simple groups, Generalized Cayley's theorem, Index theorem, Embedding theorem and applications. | 10 |
| III | Polynomial rings over commutative rings, Division algorithm and consequences, Principal ideal domains, Factorization of polynomials, Reducibility tests, Irreducibility tests. | 9 |
| IV | Divisibility in integral domains, Irreducibles, Primes, Unique factorization domains, Euclidean domains. | 9 |
| V | Vector spaces, Subspaces, Linear independence and dependence of vectors, Basis and Dimension, Quotient space. | 10 |
| VI | Linear transformations, The Algebra of linear transformations, rank | 9 |

| | | |
|---|---|---|
| | nullity theorem, their representation as matrices. | |
| VII | Linear functionals, Dual space, Characteristic values, Cayley Hamilton Theorem.<br>Inner product spaces and norms, Cauchy-Schwarz inequality, Orthogonal vectors, | 9 |
| VIII | Orthonormal sets and bases, Bessel's inequality for finite dimensional spaces, Gram-Schmidt orthogonalization process, Bilinear and Quadratic forms.<br>The topic "Indian Ancient Mathematics and Mathematicians" should be covered under Continuous Internal Evaluation (CIE). | 9 |

**Reference / Text Books:**

1. Topics in Algebra by I. N. Herstein.
2. Linear Algebra by K. Hoffman and R. Kunze.
3. Suggested digital plateform: NPTEL/SWAYAM/MOOCS

If the course is available as Generic Elective, then the students of following departments may opt it.

1. Engg. and Tech. (UG)
2. Economics (UG/PG)
3. B.Sc. (C.S.)

| **Evaluation/Assessment Methodology** | |
|---|---|
| | **Max. Marks** |
| 1) Class tasks/ Sessional Examination<br>2) Presentations /Seminar<br>3) Assignments<br>4) Research Project Report<br>Seminar On Research Project Report<br>5) ESE | 10<br>5<br>5<br>5<br><br>**75** |
| **Total:** | 100 |

Prerequisites for the course: Diploma in Mathematics

**Course outcomes:**

CO1: Linear algebra is a basic course in almost all branches of science. The objective of this course is to introduce a student to the basics of linear algebra and some of its applications.

CO2: The student will use this knowledge in computer science, finance mathematics, industrial mathematics and bio mathematics. After completion of this course students appreciate its interdisciplinary nature.

**IIMTU-NEP IMPLEMENTATION**
**Year: III / Semester: V**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. **Class:B.Sc. (PSM)** | Year: **III** Semester: **V** |
| **Credits: 04** Theory: **04** Practical: | **Subject: Statistics** |
| **Course Code:BSST-351** | **Title: Multivariate Analysis and Non-parametric Methods** |

**Course Objectives:**
To make aware the students of parametric, non-parametric and sequential estimation (point, as well as, interval) and testing (simple, as well as, composite hypotheses) procedures.

**Nature of Paper:** DSE

**Minimum Passing Marks/Credits: 40% Marks**

L: 4
T:
P: (In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | Elementary operations on Matrices, Rank of Matrix, Row and Column Rank, Inverse of a matrix. Eigen values and Eigenvectors. | **08** |
| II | Introduction to multivariate analysis, Uses and Applications of multivariate analysis, Bivariate normal distribution: definition and Simple properties. | **07** |
| III | Multivariate Normal Distribution, Marginal and Conditional Distributions, Characteristics functions | **08** |
| IV | Maximum Likelihood Estimation of Mean vector and Dispersion matrix and their Independence sufficient statistics of these estimates. | **07** |
| V | Concepts and definitionsofMultiple and Partial correlations and Multiple Regressions for three variables only (with their practical applications) | **08** |
| VI | Non-parametric tests, Tests for location and symmetry, One sample tests: Sign test, Wilcoxon Signed rank tests. | **07** |
| VII | Tests for randomness: Run test, Test for goodness of fit. | **07** |
| VIII | Two sample tests: Median Test, Kolmogorov – Smirnov's test and Mann-Whitney U test. | **08** |

**Reference / Text Books:**

1. Anderson, T.W. (2003): An Introduction to Multivariate Statistical Analysis, 3rd Edn., John Wiley
2. Muirhead, R.J. (1982): Aspects of Multivariate Statistical Theory, John Wiley.
3. Kshirsagar, A.M. (1972): Multivariate Analysis, 1stEdn. Marcel Dekker.
4. Johnson, R.A. And Wichern, D.W. (2007): Applied Multivariate Analysis, 6thEdn., Pearson & Prentice Hall, Mukhopadhyay, P.: Mathematical Statistics.
5. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2002): Fundamentals of Statistics, Vol. I, 8th Edn. The World Press, Kolkata.
6. Gibbons, J. D. and Chakraborty, S (2003): Nonparametric Statistical Inference. 4th Edition. Marcel Dekker, CRC.
7. Rohatgi, V. K. and Saleh, A.K. Md. E. (2009): An Introduction to Probability and Statistics. 2nd Edn. (Reprint) John Wiley and Sons.

If the course is available as Generic Elective then the students of following departments may opt it.

1. Not applicable

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 10+10=20 |
| 2) Assignments | 5 |
| 3) ESE | 75 |
| **Total:** | 100 |

Prerequisites for the course: Knowledge of Statistics taught in the preceding semester.

**Course Learning Outcomes:**

- Ability to understand the basic concepts of matrices in order to study multivariatedistribution.
- Ability to understand bivariate normal distribution and itsapplications
- Knowledge of the applications of multivariate normal distribution and Maximum Likelihood estimates of mean vector and dispersionmatrix.
- Ability to apply distribution free tests (Non-parametric methods) for one and two sample cases.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: III / Semester: V**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. **Class:B.Sc. (PSM)** | Year: **III** Semester: **V** |
| **Credits** Theory: 4 Practical: 2 | **Subject: Statistics** |
| **Course Code: BSST-352** | **Title: Analysis of Variance and Design of Experiment** |
| **Course Objectives:** This course provides the students the ability to understand the design and conduct experiments, as well as to analyze and interpret data. | |
| **Nature of Paper:** DSE | |
| **Minimum Passing Marks/Credits: 40% Marks** | |
| L: 4<br>T:<br>P: (In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits) | |

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | Definition of Analysis of Variance, Assumptions and Limitations of ANOVA, One way classification. | **08** |
| II | Two way classification with one observation per cell. Multiple comparison tests using critical difference criteria. | **08** |
| III | Principles of Design of Experiment: Randomization, Replication and Local Control, Choice of size and type of a plot using uniformity trials. | **07** |
| IV | Completely Randomized Design (CRD), Concept and definition, statistical analysis of CRD, Merits and demerits. | **07** |
| V | Randomized Block Design (RBD), Concept and definition of efficiency of design, Comparison of efficiency between CRD and RBD. | **07** |
| VI | Latin Square Design (LSD), Lay-out, ANOVA table, Comparison of efficiencies between LSD and RBD; LSD and CRD | **08** |
| VII | Missing plot technique: Estimation of missing plots by minimizing error sum of squares in RBD and LSD with one missing observation. | **07** |
| VIII | Factorial Experiments: General description of factorial experiments, $2^2$, $2^3$ and $2^n$ factorial experiments arranged in RBD and LSD, Definition of Main effects and Interactions in $2^2$ and $2^3$ factorial | **08** |

| | | |
|---|---|---|
| | experiments, | |

**Reference / Text Books: S**


1. Cochran, W. G. and Cox, G. M. (1957). Experimental Design. John Wiley & Sons, New York. Cochran, W.G. and Cox, G.M. (1959). Experimental Design, Asia Publishing House
2. Das, M. N. and Giri, N. S. (1986). Design and Analysis of Experiments (2ndEdition). Wiley.
3. Dean, A. and Voss, D. (1999). Design and Analysis of Experiments. Springer-Verlag, New York.
4. Federer, W.T. (1955). Experimental Design: Theory and Applications. Oxford & IBH
5. Publishing Company, Calcutta, Bombay and New Delhi.
6. Joshi, D.D. (1987). Linear Estimation and Design of Experiments. New Age International(P) Ltd. New Delhi.
7. Kempthorne, O. (1965). The Design and Analysis of Experiments, John 7. 7. Wiley Montgomery, D.C. (2008). Design and Analysis of Experiments, John Wiley
8. Montgomery, D.C. (2017). Design and analysis of Experiments, 9ThEdition. John Wiley & Sons.


If the course is available as Generic Elective then the students of following departments may opt it.

1.BSc(Ag)

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 10+10=20 |
| 2) Assignments | 5 |
| 3) ESE | 75 |
| **Total:** | 100 |

Prerequisites for the course: Knowledge of Statistics taught in the preceding semester.

**Course Learning Outcomes:**

After completion of this course, students will have these knowledge:

- Knowledge of the concept of Analysis of Variance(ANOVA).
- Ability to carry out the ANOVA for One way and Two wayClassification.
- Ability to carry out the post-hocanalysis.
- Knowledge of the concept of Design of experiment and its basicprinciples.
- Ability to perform the basic symmetric designs CRD, RBD and LSD with and without missingobservations.
- Knowledge of the concept of factorial experiments and their practical applications.

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: III / Semester: V**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. **Class:B.Sc. (PSM)** | Year: **III** <br> Semester: **V** |
| **Credits 2** <br> Theory: <br> Practical: 2 | **Subject:** Statistics |
| **Course Code:BSST-351P** | **Title: Non-parametric Methods and DOE Lab** |

**Course Objectives:**
These concepts will be verified by experimental means:

1. To make aware the students of parametric, non-parametric and sequential estimation (point, as well as, interval) and testing (simple, as well as, composite hypotheses) procedures.
2. This course provides the students the ability to understand the design and conduct experiments, as well as to analyze and interpret data.

**Nature of Paper:** DSE

**Minimum Passing Marks/Credits: 50% Marks**

L:
T:
P: 4 (In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| Unit | List of Practicals | No. of Lectures Allotted |
|---|---|---|
| | 1. Problems based on Non-parametric tests for one sample.<br>2. Problems based on Non-parametric tests for two samples.<br>3. Problems based on Rank and Inverse of a matrix.<br>4. Problems based on Mean vector and Dispersion matrix of a multivariate normaldistribution.<br>5. Problems based on Analysis of variance in one-way and two-way classification.<br>6. Problems based on Analysis of a Latin squaredesign.<br>7. Problems based on Analysis of variance in RBD and LSD with one missingobservation. | **20** |

**Reference / Text Books:**
**Suggested Readings:**
**As suggested for paper code BSST-351 and BSST-352.**

If the course is available as Generic Elective then the students of following departments may opt it.

1. BSc(Ag)

| Evaluation/Assessment Methodology | |
|---|---|
| Continuous Internal Evaluation shall be based on Practical File/Record, Class Activities and Overall performance. The marks shall be as follows: | **Max. Marks** |
| 1) Practical File/Record | 5 |
| 2) Class Interaction | 10 |
| 3) Practical Exam | 35 |
| **Total:** | 50 |
| Prerequisites for the course: Knowledge of Statistics taught in the preceding semester. | |

**Course Learning Outcomes:**

After completing this course a student will have these skills:

1. Ability to conduct test of significance based non-parametrictests.
2. Ability to deal with multivariatedata.
3. Ability to perform ANOVA for one way and twoclassification.
4. Ability to perform post-hocanalysis.
5. Ability to conduct analysis of CRD, RBD and LSD with and without missing observations.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: III / Semester: VI**

<table>
<tr><td colspan="2">Programme:<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>Class:B.Sc (PCM/PSM)</td><td colspan="2">Year: III<br><br>Semester: VI</td></tr>
<tr><td colspan="2">Credits: 04<br>Theory:04<br>Practical:</td><td colspan="2">Subject: Physics</td></tr>
<tr><td colspan="2">Course Code:<br>BSPH-361</td><td colspan="2">Title: Solid State & Nuclear Physics</td></tr>
<tr><td colspan="4">Course Objectives:<br>The purpose of the undergraduate Physics program at the university level is to provide the key knowledge of the fact of science understanding of the law of physics and laboratory resources to prepare students for careers as professionals in various industries and research institutions.</td></tr>
<tr><td colspan="4">Nature of Paper: DSC</td></tr>
<tr><td colspan="4">Minimum Passing Marks/Credits: 40% Marks</td></tr>
<tr><td colspan="4">L: 04<br>T: 00<br>P: 00 (In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)</td></tr>
<tr><th>Unit</th><th colspan="2">Contents</th><th>No. of Lectures Allotted</th></tr>
<tr><td colspan="4">Part A: Introduction to Solid State Physics I</td></tr>
<tr><td>I</td><td colspan="2">Crystal Structure:<br>Lattice, Basis & Crystal structure. Lattice translation vectors, Primitive & non-primitive cells. Symmetry operations. 2D & 3D Bravais lattice. Parameters of cubic lattices. Lattice planes and Miller indices. Simple crystal structures - Sodium Chloride.</td><td>07</td></tr>
<tr><td>II</td><td colspan="2">Diffraction:<br>X-ray diffraction and Bragg's law. Experimental diffraction methods - Laue, Rotating crystal and Powder methods. Derivation of scattered wave amplitude. Reciprocal lattice, Reciprocal lattice vectors and relation between Direct & Reciprocal lattice. Reciprocal lattice to SC, BCC & FCC lattices.</td><td>07</td></tr>
<tr><td>III</td><td colspan="2">Crystal Bindings:<br>Classification of Crystals on the Basis of Bonding - Ionic, Covalent, Metallic, van der Waals Molecular) and Hydrogen bonded. Crystals of inert gases, Attractive interaction (van der Waals-London) & Repulsive interaction, Equilibrium lattice</td><td>07</td></tr>
</table>

| | | |
|---|---|---|
| | constant, Cohesive energy and Compressibility & Bulk modulus. Ionic crystals, Cohesive energy, Madelung energy and evaluation of Madelung constant. | |
| IV | **Lattice Vibrations:**<br>Lattice Vibrations: Lattice vibrations for linear mono & di atomic chains. Qualitative description of Phonons in solids. Free Electron Theory: Fermi energy, Density of states, Heat capacity of conduction electrons, and Paramagnetic susceptibility of conduction electrons and Hall Effect in metals. Band Theory: Origin of band theory, Qualitative idea of Bloch theorem, Kronig-Penney model, Effectice mass of an electron & Concept of Holes and Classification of solids on the basis of band theory. | 09 |
| | **Part B: Introduction to Nuclear Physics** | |
| V | **Nuclear Forces & Radioactive Decays:**<br>General Properties of Nucleus: Mass, binding energy, angular momentum, magnetic dipole moment vector. Nuclear Forces: General characteristic of nuclear force and Deuteron ground state properties. | 08 |
| VI | **Nuclear Models & Nuclear Reactions:**<br>Nuclear Models: Liquid drop model Nuclear Reactions: types of nuclear reaction, Conservation laws, Cross-section of nuclear reaction, Theory of nuclear fission (qualitative), Nuclear reactors and Nuclear fusion. | 08 |
| VII | **Accelerators & Detectors:**<br>Accelerators: Theory, working and applications of Van de Graaff accelerator, Cyclotron and Synchrotron. | 06 |
| VIII | **Elementary Particles:**<br>Fundamental interactions & their mediating quanta. Concept of antiparticles. Classification of elementary particles based on intrinsicspin, mass, interaction & lifetime. Families of Leptons, Mesons, Baryons & Baryon Resonances. Conservation laws for mass-energy, linear momentum, angular momentum, electric charge, baryonic charge, leptonic charge, isospin& strangeness. Concept of Quark model. | 08 |

**Suggested Readings**

**PART A**


1. Charles Kittel, "Introduction to Solid State Physics", Wiley India Private Limited, 2004, 8e
2. J.P. Srivastava, "Elementa of Solid State Physics", Prentice-Hall of India Private Limited, 2014, 4e
3. R.K. Puri, V.K. Babbar, "Solid State Physics", S. Chand Publishing, 2015


**PART B**


1. Kenneth S. Krane, "Introductory Nuclear Physics", Wiley India Private Limited, 2008
2. Bernard L. Cohen, "Concepts of Nuclear Physics", McGraw Hill, 2017
3. D.C. Tayal, "Nuclear Physics", Himalaya Publishing House Pvt. Ltd., 2011, 5e

| | |
|---|---|
| If the course is available as Generic Elective then the students of following departments may opt it.<br>1. Chem./Comp. Sc/ Maths/ Stat. | |
| **Evaluation/Assessment Methodology** | |
| | **Max. Marks** |
| 1. Class tasks/ Sessional Examination<br>2. Assignments<br>3. ESE | 10 + 10<br>5<br>75 |
| **Total:** | **100** |
| Prerequisites for the course: Passed Semester I, Theory Paper-1 (BSPH-111) | |

**Course Learning Outcomes:**

- Understand the crystal geometry w.r.t. symmetry operations.
- Comprehend the power of X-ray diffraction and the concept of reciprocal lattice.
- Study various properties based on crystal bindings.
- Recognize the importance of Free Electron & Band theories in understanding the crystal properties.
- Study the salient features of nuclear forces & radioactive decays.
- Understand the importance of nuclear models & nuclear reactions.
- Comprehend the working and applications of nuclear accelerators and detectors.
- Understand the classification and properties of basic building blocks of nature.

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: III / Semester: VI**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D.<br>Class:**B.Sc (PCM/PSM)** | Year: **III**<br><br>Semester: **VI** |
| Credits: **04**<br>Theory: **04**<br>Practical: | **Subject: Physics** |
| **Course Code:BSPH-362** | **Title: Analog & Digital Principles & Applications** |
| **Course Objectives:**<br>The purpose of the undergraduate Physics program at the university level is to provide the key knowledge of the fact of science understanding of the law of physics and laboratory resources to prepare students for careers as professionals in various industries and research institutions. | |
| Nature of Paper: **DSC** | |
| Minimum Passing Marks/Credits: **40% Marks** | |
| L: 04<br>T: 00<br>P: 00(In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits) | |

| **Unit** | **Contents** | **No. of Lectures Allotted** |
|---|---|---|
| | **Part A: Analog Electronic Circuits** | |
| I | **Semiconductor Junction:**<br>Expressions for Fermi energy, Electron density in conduction band, Hole density in valence band, Drift of charge carriers (mobility & conductivity), Diffusion of charge carries and Life time of charge carries in a semiconductor. Work function in metals and semiconductors. Expressions for Barrier potential, Barrier width and Junction capacitance (diffusion & transition) for depletion layer in a PN junction. Expressions for Current (diode equation) and Dynamic resistance for PN junction. | 09 |
| II | **Transistor Modeling:**<br>Transistor as Two-Port Network. Notation for dc & ac components of voltage & current. Quantitative discussion of Z, Y & h parameters and their equivalent two-generator model circuits. h-parameters for CB, CE & CC configurations. Analysis of transistor amplifier using the hybrid equivalent model and estimation of Input Impedance, Output Impedance and Gain (current, voltage & power). | 08 |

| | | |
|---|---|---|
| III | **Field Effect Transistors:**<br>JFET: Construction (N channel & P channel); Configuration (CS, CD & CG); Operation in different regions (Ohmic or Linear, Saturated or Active or Pinch off & Break down); Important Terms (Shorted Gate Drain Current, Pinch Off Voltage & Gate Source Cut-Off Voltage); Expression for Drain Current (Shockley equation); Characteristics (Drain & Transfer); Parameters (Drain Resistance, Mutual Conductance or Transconductance & Amplification Factor); Biasing w.r.t. CS configuration (Self Bias & Voltage Divider Bias); Amplifiers (CS & CD or Source Follower); Comparison (N & P channels and BJTs & JFETs). MOSFET: Construction and Working of D-MOSFET (N channel & P channel) and E-MOSFET (N channel & P channel); Characteristics (Drain & Transfer) of D-MOSFET and E-MOSFET; Comparison of JFET and MOSFET. | 08 |
| IV | **Other Devices:**<br>SCR: Construction; Equivalent Circuits (Two Diodes, Two Transistors & One Diode-One Transistor); Working (Off state & On state); Characteristics; Applications (Static switch, Phase control system & Battery charger). UJT: Construction; Equivalent Circuit; Working (Cutoff, Negative Resistance & Saturation regions); Characteristics (Peak & Valley points); Applications (Trigger circuits, Relaxation oscillators & Sawtooth generators). | 05 |
| | **PART B: Digital Electronics** | |
| V | **Number System:**<br>Number Systems: Binary, Octal, Decimal & Hexadecimal number systems and their inter conversion. Binary Codes: BCD, Excess-3 (XS3), Parity, Gray, ASCII & EBCDIC Codes and their advantages & disadvantages. Data representation. | 06 |
| VI | **Binary Arithmetic:**<br>Binary Addition, Decimal Subtraction using 9's & 10's complement, Binary Subtraction using 1's & 2's compliment, Multiplication and Division. | 05 |
| VII | **Logic Gates:**<br>Truth Table, Symbolic Representation and Properties of OR, AND, NOT, NOR, NAND, EX-OR & EX-NOR Gates. Implementation of OR, AND & NOT gates (realization using diodes & transistor). De Morgan's theorems. NOR & NAND gates as Universal Gates. Application of EX-OR & EX-NOR gates as pairty checker. Boolean Algebra. Karnaugh Map. | 09 |
| VIII | **Combinational & Sequential Circuits:**<br>Combinational Circuits: Half Adder, Full Adder, Parallel Adder, Half Substractor, Full Substractor. Data Processing Circuits: Multiplexer, Demultiplexer, Decoders & Encoders. Sequential Circuits: SR, JK & D Flip-Flops, Shift Register (transfer operation of Flip-Flops), and | 10 |

| | | |
|---|---|---|
| | Asynchronous & Synchronous counters. | |

**Suggested Readings**

**PART A**

1. R.L. Boylestad, L. Nashelsky, "Electronic Devices and Circuit Theory", Prentice-Hall of India Pvt. Ltd., 2015, 11e
2. J. Millman, C.C. Halkias, SatyabrataJit, "Electronic Devices and Circuits", McGraw Hill, 2015, 4e
3. B.G. Streetman, S.K. Banerjee, "Solid State Electronic Devices", Pearson Education India, 2015, 7e
4. J.D. Ryder, "Electronic Fundamentals and Applications", Prentice-Hall of India Private Limited, 1975, 5e
5. S.L. Gupta, V. Kumar, "Hand Book of Electronics", Pragati Prakashan, Meerut, 2016, 43e

**PART B**

1. D. Leach, A. Malvino, GoutamSaha, "Digital Principles and Applications", McGraw Hill, 2010, 7e
2. William H. Gothmann, "Digital Electronics: An Introduction to Theory and Practice", Prentice-Hall of India Private Limited, 1982, 2e
3. R.P. Jain, "Modern Digital Electronics", McGraw Hill, 2009, 4e

If the course is available as Generic Elective then the students of following departments may opt it.

1. Chem./Comp. Sc/ Maths/ Stat.

| Evaluation/Assessment Methodology | |
|---|---|
| | **Max. Marks** |
| 1. Class tasks/ Sessional Examination | 10 + 10 |
| 2. Assignments | 5 |
| 3. ESE | 75 |
| **Total:** | **100** |

Prerequisites for the course: Passed Semester I, Theory Paper-1 (BSPH-111)

**Course outcomes:**

- Study the drift and diffusion of charge carriers in a semiconductor.
- Understand the Two-Port model of a transistor.
- Study the working, properties and uses of FETs.
- Comprehend the design and operations of SCRs and UJTs.
- Understand various number systems and binary codes.
- Familiarize with binary arithmetic.
- Study the working and properties of various logic gates.
- Comprehend the design of combinational and sequential circuits.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: III / Semester: VI**

| | | |
|---|---|---|
| **Programme:** Certificate/Diploma/ Degree/ UG(R)/PG/Ph.D. **Class:B.Sc (PCM/PSM)** | | Year: **III** Semester: **VI** |
| Credits: **02** Theory: Practical:**02** | **Subject: Physics** | |
| **Course Code: BSPH-361P** | **Title:Title: Analog & Digital Circuits** | |
| **Course Objectives:** The purpose of the undergraduate Physics program at the university level is to provide the key knowledge of the fact of science understanding of the law of physics and laboratory resources to prepare students for careers as professionals in various industries and research institutions. | | |
| Nature of Paper: **DSE** | | |
| **Minimum Passing Marks/Credits: 50% Marks** | | |
| L: 00<br>T: 00<br>P: 04 (In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits) | | |

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| | **Lab Experiment List** | |
| | 1. Energy band gap of semiconductor by reverse saturation current method.<br>2. Energy band gap of semiconductor by four probe method.<br>3. Hybrid parameters of transistor.<br>4. Characteristics of FET, MOSFET, SCR, UJT.<br>5. FET Conventional Amplifier<br>6. FET as VVR and VCA.<br>7. Study and Verification of AND gate using TTL IC 7408.<br>8. Study and Verification of OR gate using TTL IC 7432.<br>9. Study and Verification of NAND gate and use as Universal gate using TTL IC 7400.<br>10. Study and Verification of NOR gate and use as Universal gate using TTL IC 7402.<br>11. Study and Verification of NOT gate using TTL IC 7404.<br>12. Study and Verification of Ex-OR gate using TTL IC 7486 | **20** |

**Suggested Readings:**


1. R.L. Boylestad, L. Nashelsky, “Electronic Devices and Circuit Theory”, Prentice-Hall of India Pvt. Ltd., 2015, 11e
2. J. Millman, C.C. Halkias, SatyabrataJit, “Electronic Devices and Circuits”, McGraw Hill, 2015, 4e.
3. B.G. Streetman, S.K. Banerjee, “Solid State Electronic Devices”, Pearson Education India, 2015, 7e.
4. J.D. Ryder, “Electronic Fundamentals and Applications”, Prentice-Hall of India Private Limited, 1975, 5e.
5. S.L. Gupta, V. Kumar, “Hand Book of Electronics”, Pragati Prakashan, Meerut, 2016, 43e
6. D. Leach, A. Malvino, Goutam Saha, “Digital Principles and Applications”, McGraw Hill, 2010, 7e.
7. William H. Gothmann, “Digital Electronics: An Introduction to Theory and Practice”, Prentice-Hall of India Private Limited, 1982, 2e.
8. R.P. Jain, “Modern Digital Electronics”, McGraw Hill, 2009, 4e


If the course is available as Generic Elective then the students of following departments may opt it.

1. Yes Chem./Comp. Sc./Maths/Stat.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1. Record File | 15 |
| 2. Viva Voce | 5 |
| 3. Class Interaction | 10 |
| **Total:** | **30** |

Prerequisites for the course:

- The course can be opted by Botany / Chemistry / Computer Science / Mathematics / Statistics / Zoology
- **PREREQUISITE:** Opted / Passed Semester I, Theory Paper-1 (**BSPH-361 and BSPH-362**)

**Course Learning Outcomes:**

- Analog & digital circuits have the most striking impact on the industry wherever the electronics instruments are used to study and determine the electronic properties.
- Measurement precision and perfection is achieved through Lab Experiments.
- Online Virtual Lab Experiments give an insight in simulation techniques and provide a basis for modeling.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: III / Semester: VI**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D.<br>**Class:**B.Sc. (PCM/PSM) | Year: **III**<br><br>Semester: **VI** |
| **Credits: 04**<br>Theory: **04**<br>Practical: | **Subject: Mathematics** |
| **Course Code: BSMT-361** | **Title: Metric Spaces & Complex Analysis** |

**Course Objectives:**
1. The course is aimed at exposing the students to foundations of analysis which will be useful in understanding various physical phenomena and gives th1 student the foundation in mathematics.
2. The student will be able to solve various problems based on linear programming. After successful completion of this paper will enable the students to apply th1

**Nature of Paper:** Core

**Minimum Passing Marks/Credits: 40% Marks**

L: 4
T:
P: (In Hours/Week)
Theory - 1 Hr. = 1 Credit

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | Metric spaces: Definition and examples, Sequences in metric spaces, Cauchy sequences, Complete metric space. | 10 |
| II | Open and closed ball, Neighborhood, Open set, Interior of a set, limit point of a set, derived set, closed set, closure of a set, diameter of a set. | 9 |
| III | Continuous mappings, Sequential criterion and other characterizations of continuity, Uniform continuity, Homeomorphism, Contraction mapping, Banach fixed point theorem. | 9 |
| IV | Connectedness, Connected subsets of $\mathbb{R}$, Connectedness and continuous mappings, Compactness, Compactness and boundedness, Continuous functions on compact spaces. | 9 |
| V | Functions of complex variable, Mappings; Mappings by the exponential function, Limits, Limits involving the point at infinity, Continuity, Derivatives, Differentiation formulae, Cauchy-Riemann equations, Sufficient conditions for differentiability; Analytic functions and their examples. | 10 |
| VI | Exponential function, Logarithmic function, Branches of logarithms, Trigonometric function, Derivatives of functions, Definite integrals of | 9 |

| | | |
|---|---|---|
| | functions, Contours, Contour integrals and its examples, Upper bounds. | |
| VII | Ant derivatives, Proof of ant derivative theorem, Cauchy-Goursat theorem, Cauchy integral formula; An extension of Cauchy integral formula, Consequences of Cauchy integral formula, Liouville's theorem and the fundamental theorem of algebra. | 9 |
| VIII | Convergence of sequences and series, Taylor series and its examples; Laurent series and its examples. Isolated singular points, Residues, Cauchy's residue theorem, residue at infinity; Types of isolated singular points, Residues at poles and its examples. | 9 |

**Reference / Text Books:**
**(Part-A Metric Space):**

1. Mathematical Analysis by Shanti Narain.
2. Shirali, Satish & Vasudeva, H. L. (2009). Metric Spaces, Springer, First Indian Print.
3. Kumaresan, S. (2014). Topology of Metric Spaces (2nd ed.). Narosa Publishing House. New Delhi.
4. Simmons, G. F. (2004). Introduction to Topology and Modern Analysis.Tata McGraw Hill. New Delhi. 5. Suggested digital plateform: NPTEL/SWAYAM/MOOCS.
5. Course Books (text/reference) published in Hindi may be prescribed by the Universities at local levels.

**Suggested Readings (Part-B Complex Analysis):**

6. Function of Complex Variable by Shanti Narain.
7. Complex variable and applications by Brown & Churchill.
8. Suggested digital plateform: NPTEL/SWAYAM/MOOCS.

If the course is available as Generic Elective, then the students of following departments may opt it.

1. Engg. and Tech. (UG)
2. B.Sc. (C.S.)

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 10 |
| 2) Presentations /Seminar | 5 |
| 3) Assignments | 5 |
| 4) Research Project Report<br>Seminar On Research Project Report | 5 |
| 5) ESE | **75** |
| **Total:** | 100 |

Prerequisites for the course: Diploma in Mathematics

**Course outcomes:**

CO1: Thecourse is aimed at exposing the students to foundations of analysis which will be useful in understanding various physical phenomena and gives the student the foundation in mathematics.

CO2: After completion of this course the student will have rigorous and deeper understanding of fundamental concepts in Mathematics. This will be helpful the student in understanding pure mathematics and in research.

CO3: The student will be able to solve various problems based on linear programming.

**IIMTU-NEP IMPLEMENTATION**
**Year: III / Semester: VI**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. **Class:B.Sc. (PCM/PSM)** | Year: III<br><br>Semester: VI |
| **Credits: 04**<br>Theory: **04**<br>Practical: | **Subject: Mathematics** |
| **Course Code: BSMT-362** | **Title: Operation Research & Numerical Analysis** |

**Course Objectives:**

1. The aim of this course is to teach the student the application of various numerical technique for variety of problems occurring in daily life. At the end 01he course the student will be able to understand the basic concept of Numerical Analysis and to solve algebraic and differential equation.
2. The student will be able to solve various problems based on linear programming. After successful completion of this paper will enable the students tt apply the basic concepts of operations research.

**Nature of Paper:** Core

**Minimum Passing Marks/Credits:40% Marks**

L: 4
T:
P: (In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical-

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | Solution of equations: bisection, Secant, Regular Falsi, Newton Raphson's method, Interpolation, Lagrange, Difference schemes, Divided differences, Interpolation formula using differences. | 8 |
| II | Numerical differentiation, Numerical Quadrature: Newton Cotes Formulas.<br>System of Linear equations: Direct method for solving systems of linear equations,<br>Iterative methods. The Algebraic Eigen value problem: Jacobi's method, Givens method, Power method. | 8 |
| III | Numerical solution of Ordinary differential equations: Euler method, single step methods, Runge-Kutta method, Multi-step methods: Milne-Simpson method, Difference Equations and their solutions. | 7 |
| IV | Types of approximation: Last Square polynomial approximation, Uniform approximation, Legendre's approximation, Chebyshev | 7 |

| | | |
|---|---|---|
| | polynomial approximation. | |
| V | Introduction, Linear programming problems, statement and formation of general linear programming problems, graphical method, standard and matrix forms of linear programming problem, basic feasible solution. | 8 |
| VI | Convex sets, fundamental theorem of linear programming, basic solution, Simplex method, introduction to artificial variables, two phase method, Big-M method. | 8 |
| VII | Resolution of degeneracy, duality in linear programming problems, primal dual relationships, revised simplex method, sensitivity analysis. | 7 |
| VIII | Transportation problems, assignment problems. | 7 |

**Suggested Readings (Part-A Numerical Analysis):**

1. Numerical Methods for Engineering and scientific computation by M. K. Jain, S.R.K. Iyengar& R.K. Jain.
2. Suggested digital plateform:NPTEL/SWAYAM/MOOCs
3. Course Books(text/reference) published in Hindi may be prescribed by the Universities at local levels.

**Suggested Readings (Part-B Operation Research):**

1. Introductory methods of Numerical Analysis by S. S. Sastry
2. Taha, Hamdy Opearations Research- An Introduction†', Pearson Education.
3. Gupta, Prem Kumar, Initials, Operations Research, Chand (S) & Co Ltd, India
4. Hillier Frederick S and Lieberman Gerald J., "Operations Research", McGraw Hill Publication.
5. Winston Wayne L., "Operations Research: Applications and Algorithms", Cengage Learning, 4th Edition.
6. Hira D.S. and Gupta Prem Kumar, "Problems in Operations Research: Principles and Solutions", S Chand & Co Ltd.
7. Kalavathy S., "Operations Research", S Chand.
8. Suggested digital platform: NPTEL/SWAYAM/MOOCs.

If the course is available as Generic Elective, then the students of following departments may opt it.

1. Engg. and Tech. (UG)
2. Economics (UG/PG)
3. BCA/BBA
4. B.Sc.(C.S.)

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 10 |
| 2) Presentations /Seminar | 5 |
| 3) Assignments | 5 |
| 4) Research Project Report<br>Seminar On Research Project Report | 5 |
| 5) ESE | **75** |
| **Total:** | 100 |

| Prerequisites for the course: Diploma in Mathematics |
| --- |

**Course Learning Outcomes:**

CO1: The aim of this course is to teach the student the application of various numerical techniques for variety of problems occurring in daily life. At the end 01he course the student will be able to understand the basic concept of Numerical Analysis and to solve algebraic and differential equation.

CO2: The main outcome will be that students will be able to handle problems and finding approximated solution. Later he can opt for advance course ij umerical Analysis in higher Mathematics.

CO3: The student will be able to solve various problems based on linear programming. After successful completion of this paper will enable the students tt apply the basic concepts of operations research.

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UGC Approved Section 2f & 12B

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: III / Semester: VI**

<table>
<tr><td colspan="2">Programme:<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>Class:B.Sc. (PCM/PSM)</td><td colspan="2">Year: III<br><br>Semester: VI</td></tr>
<tr><td colspan="2">Credits: 02<br>Theory:<br>Practical: 02</td><td colspan="2">Subject: Mathematics</td></tr>
<tr><td colspan="2">Course Code: BSMT-361P</td><td colspan="2">Title: Practical (Practicals to be done using Mathematica /MATLAB /Maple /Scilab/Maxima etc.)</td></tr>
<tr><td colspan="4">Course Objectives: The main objective of the course is to equip the student to solve the transcendental and algebraic equations, system of linear equations, ordinary differentia equations, Interpolation, Numerical Integration, Method of finding Eigenvalue by Power method (up to 4 × 4 ), Fitting a Polynomial Function (up to third degree).</td></tr>
<tr><td colspan="4">Nature of Paper: Core</td></tr>
<tr><td colspan="4">Minimum Passing Marks/Credits: 50% Marks</td></tr>
<tr><td colspan="4">L:<br>T:<br>P: 4 (In Hours/Week)<br>Theory -<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)</td></tr>
<tr><td>Unit</td><td colspan="2">Contents</td><td>No. of Lectures Allotted</td></tr>
<tr><td>I</td><td colspan="2">List of the practicals to be done using computer algebra software (CAS), for example R/Python/Mathematica/MATLAB/Maple/ Maxima/Scilabetc<br>1. Solution of transcendental and algebraic equations.<br>2. Solution of system of linear equations.<br>3. Interpolation.<br>4. Numerical Integration.<br>5. Method of finding Eigenvalue by Power method (up to 4 × 4 )<br>6. Fitting a Polynomial Function (up to third degree).<br>7. Solution of ordinary differential equations.</td><td>20</td></tr>
<tr><td colspan="4">Reference / Text Books:</td></tr>
<tr><td colspan="4">If the course is available as Generic Elective, then the students of following departments may opt it.<br>1. Engg. and Tech. (UG)<br>2. B.Sc. (C.S.)</td></tr>
</table>

| Evaluation/Assessment Methodology | |
|---|---|
| | **Max. Marks** |
| 1) Class tasks/ Sessional Examination<br>2) Presentations /Seminar<br>3) Assignments<br>4) Research Project Report<br>Seminar On Research Project Report<br>5) ESE | 10<br>5<br>5<br><br><br>5 |
| **Total:** | 25 |
| Prerequisites for the course: 12th Mathematics | |
| **Course outcomes:**<br>The main objective of the course is to equip the student to solve the transcendental and algebraic equations, system of linear equations, ordinary differentia equations, Interpolation, Numerical Integration, Method of finding Eigenvalue by Power method (up to $4 \times 4$ ), Fitting a Polynomial Function (up to third degree). | |

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: III / Semester: VI**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D.<br>**Class:B.Sc. (PSM)** | Year: III<br><br>Semester: VI |
| **Credits: 04**<br>Theory: **04**<br>Practical: | **Subject: Statistics** |
| **Course Code:BSST-361** | **Title: Statistical Computing and Introduction to Statistical Software** |
| **Course Objectives:**<br>The goal of this course is to enable students to do essential computations and statistical analysis using commonly used statistical software. | |
| **Nature of Paper: Core** | |
| **Minimum Passing Marks/Credits: 40% Marks** | |
| L: 4<br>T:<br>P:(In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits) | |

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | Introduction to Computer: Generation of Computer, Basic Structure of Computer, Digital computer and its peripherals, number systems (Binary, Octal,Hexadecimal Systems). Flow chart for simple statistical problems. | **08** |
| II | Solid Understanding of Basics Excel:- Getting Start with Excel, Working with Cell and Ranges, Data Entry & Editing, Number formatting, delete, insert and adjust cells, columns and rows, Preview and print workbook. | **06** |
| III | Custom Fill, Autofill, Flash Fill, Date & Time, Data Formatting, Sort & Filter, Grouping Sheets, Managing worksheets- Changing Name, Colour, Add, Delete, Hide/Unhide, Worksheet Views-Comparing Sheet Side by Side, Splitting Sheet into Panes, freezing Panes, | **06** |
| IV | Using Excel: Basic Mathematical functions, Graphs, Descriptive Statistics, Analysis of Variance (One-way & Two way ANOVA), Karl Pearson correlation coefficient, Regression Analysis. | **10** |
| V | Introduction to R Programming and R Studio, Installing R, Rasa calculator. Creating a dataset, Understanding a data set, Data | **08** |

| | | |
|---|---|---|
| | structure: Vectors, Matrices, Arrays, Data Frames, Factors andLists | |
| VI | Data inputs: Entering data from the keyboard, Importing Data, creating new variables, recoding variable, renaming ariables, | **07** |
| VII | Graphs using R, Inferential Statistics- Parametric test: Test for Normality, t-test for single mean, t-test for difference between means, paired t-test. | **08** |
| VIII | Using R: Wilcoxon signed rank sum test, Mann Whitney U test, Kolmogorov-Smirnov Test for normality, Analysis of Variance (One-way & Twoway ANOVA), Karl Pearson correlation coefficient, Regression Analysis. | **07** |

**Reference / Text Books:**


1. Chambers, J. (2008). Software for Data Analysis: Programming with R, Springer. Crawley, M.J. (2017). The R Book, John Wiley & Sons.
2. Eckhouse, R.H. and Morris, L.R. (1975). Minicomputer Systems Organization, Programming and Applications, Prentice-Hall.
3. Matloff, N. (2011). The Art of R Programming, No Starch Press, Inc.
4. Eckhouse, R.H. and Morris, L.R. (1975). Minicomputer Systems Organization, Programming and Applications, Prentice-Hall.
5. Great Harvey (2019): Excel 2019 all in one, John Wiley & b Sons.


If the course is available as Generic Elective then the students of following departments may opt it.

1. BSc(CS)
2. BCA
3. MBA

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 10+10=20 |
| 2) Assignments | 05 |
| 3) ESE | 75 |
| **Total:** | 100 |

Prerequisites for the course: Knowledge of Statistics taught in the preceding semester.

**Course Learning Outcomes:**

After completion of this course, students will have these knowledge:

- Basic Knowledge of Excel and R programming with some basic notions for developingtheir own simple programs and visualizing graphics in R andExcel.
- AbilitytoperformdataanalysisforbothunivariateandmultivariatedatasetsusingRaswellas Excel.

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: III / Semester: VI**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. **Class:B.Sc. (PSM)** | **Year: III** **Semester: VI** |
| **Credits: 04** Theory: **04** Practical: | **Subject: Statistics** |
| **Course Code:BSST-362** | **Title: Operations Research** |

**Course Objectives:**

1. Ability to understand and analyze managerial problems in industry so that they are able to use resources (capitals, materials, staffing, and machines) more effectively.
2. Knowledge of formulating mathematical models for quantitative analysis of managerial problems in industry.
3. Skills in the use of Operations Research approaches and computer tools in solving real problems in industry.
4. Mathematical models for analysis of real problems in Operations Research.

**Nature of Paper: Core**

**Minimum Passing Marks/Credits: 40% Marks**

L: 4
T:
P: (In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | History & back ground of OR, Applications and uses of OR indifferent fields, General line are programming problems and their formulations. | **06** |
| II | Solving LPP by Graphical Method Solving LPP by Simplex method. | **10** |
| III | Method Solving LPP by Big–M method and Two phase Method. | **08** |
| IV | Transportation problem: North-west corner rule, Least cost method, Vogel's approximation method. Optimum solution: Modi method. | **10** |
| V | Assignment Problem: Hungarian Method, Travelling Salesman Problem, | **06** |
| VI | Job sequencing: n jobs – 2 machines, n jobs – k machines, 2 jobs – n machines. | **06** |
| VII | Game theory: Introduction, Competitive Situations, Characteristics of Competitive Games. Rectangular game, Two-Person Zero-Sum game, minimax-maximin principle, Solution to rectangular game using graphical method | **08** |

| | | |
|---|---|---|
| VIII | Dominance rule to reduce the game matrix and solution of Payoff matrix with mixed strategy. | **06** |

**Reference / Text Books:**

1. Swarup, K., Gupta P.K. and Man Mohan (2007). *Operations Research* ($13^{th}$ed.) , Sultan Chand & Sons.
2. Taha, H.A. (2007). *Operations Research*: *An Introduction ($8^{th}$ed.)*, Prentice Hall of India. Hadley, G: (2002) : Linear Programming, Narosa Publications
3. Hillier, F.A and Lieberman, G.J. (2010): Introduction to Operations Research- Concepts and cases, 9th Edition, Tata McGraw Hill.
4. Prabhakar, P. (2013): Operations Research: Principles and Practice, Oxford University Press.
5. Gupta, R. K. (2018): Operations Research, Krishna Publication.

If the course is available as Generic Elective then the students of following departments may opt it.

1. BBA
2. MBA

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 10+10=20 |
| 2) Assignments | 5 |
| 3) ESE | 75 |
| **Total:** | 100 |

Prerequisites for the course: Knowledge of Statistics taught in the preceding semester.

**Course Learning Outcomes:**

- An idea about the historical background and need of Operations research.
- Ability to identify and develop operational research models from the verbal description of the real lifeproblems.
- Knowledge of the mathematical tools that are needed to solve optimization problems.
- Ability of solving Linear programming problem, Transportation and Assignment problems, Job sequencing,etc.
- Ability to solve the problems based on GameTheory.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: III / Semester: VI**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. **Class:**B.Sc. (PSM) | Year: **III** Semester: **VI** |
| **Credits : 02** Theory: Practical: **02** | **Subject: Statistics** |
| **Course Code:BSST-361P** | **Title: Operations Research and Statistical Computing Lab** |

**Course Objectives:**
These concepts will be verified by experimental means:
1. The goal of this course is to enable students to do essential computations and statistical analysis using commonly used statistical software.
2. Mathematical models for analysis of real problems in Operations Research.

**Nature of Paper:** Core

**Minimum Passing Marks/Credits: 50% Marks**

L:
T:
P: 4 (In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| Unit | List of Practical | No. of Lectures Allotted |
|---|---|---|
| | 1. Problem based on Mathematical formulation ofL.P.P<br>2. Problem based on solving LPP using Graphical Method<br>3. Problem based on solving LPP using SimplexMethod<br>4. Problem based on solving LPP using Big Mmethod involving artificialvariables.<br>5. Allocation Problem based on Transportationmodel.<br>6. Allocation Problem based on Assignmentmodel.<br>7. Problems based on Game payoffmatrix.<br>8. Problem based on solving Graphical solution to mx2/ 2xn rectangular game.<br>9. Problem based on solving mixed strategygame.<br>10. Problem based on application of R as Calculator.<br>11. Problem based on application of R in simple data analysis<br>12. Problem based on application of Excel in dataanalysis | **20** |

**Reference / Text Books:**
**Suggested Readings:**
**As suggested for paper code BSST-361 and BSST-362.**

If the course is available as Generic Elective then the students of following departments may opt it.
1. BSc(CS)
2. BCA
3. MBA

**Evaluation/Assessment Methodology**

Continuous Internal Evaluation shall be based on Practical File/Record, Class Activities and Overall performance. The marks shall be as follows:

| | **Max. Marks** |
|---|---|
| 1) Practical File/Record | 5 |
| 2) Class Interaction | 10 |
| 3) Practical Exam | 35 |
| **Total:** | 50 |

Prerequisites for the course: Knowledge of Statistics taught in the preceding semester.

**Course Learning Outcomes:**

After completion of this course, students will have these skills:
1. Knowledge of mathematical formulation ofL.P.P
2. Ability of solving LPP using differentmethods.
3. Ability to solve Allocation Problem based on Transportation and Assignmentmodels.
4. Ability to solve problems based on GameTheory.
5. Ability to use programming language R asCalculator.
6. Knowledge of using R in simple dataanalysis.
7. Able to perform statistical functions, creating graphs and statistical analysis byusing Excel.

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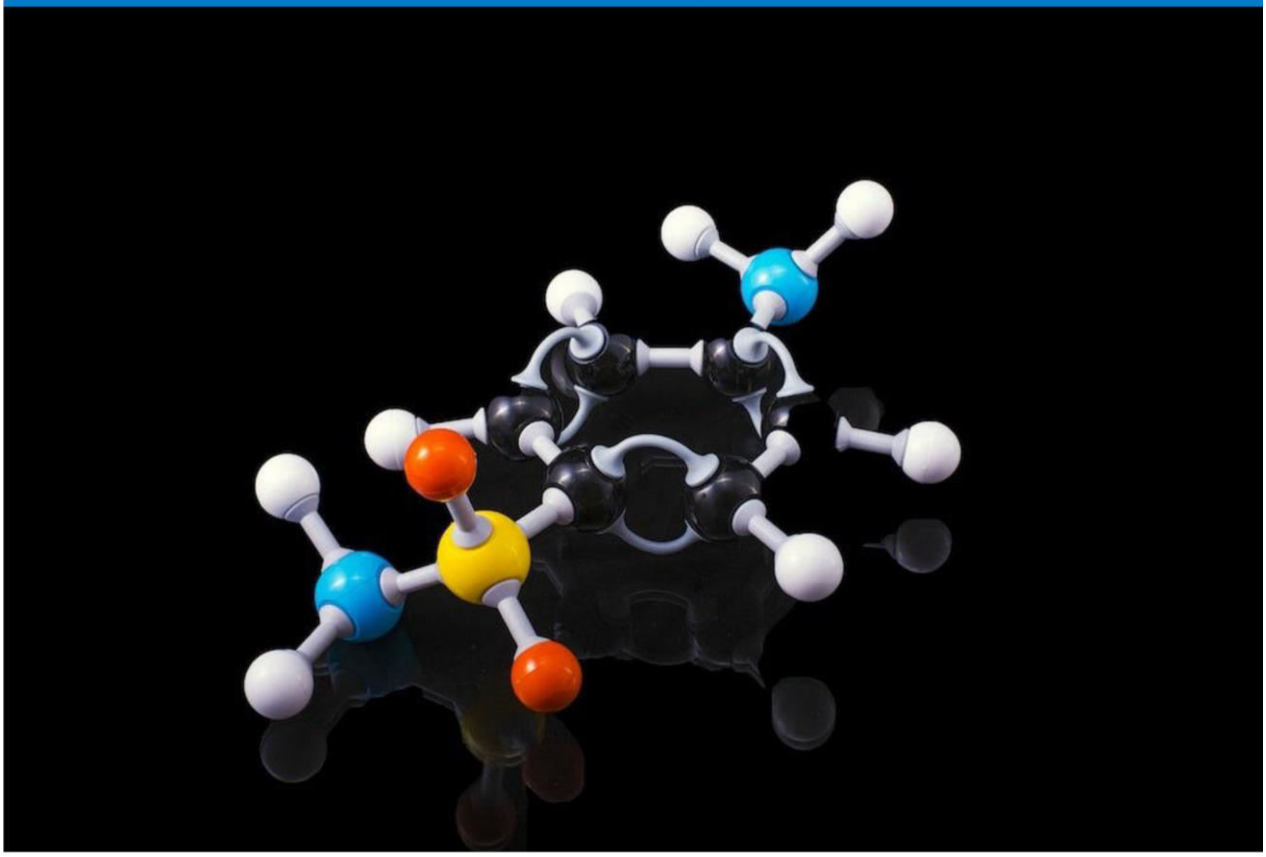
Section 2f & 12B

# School of Basic Sciences

## ACADEMIC HAND BOOK



**ORDINANCE & ACADEMIC REGULATIONS**
**MASTER OF SCIENCE**
**PHYSICS, CHEMISTRY, MATHEMATICS, STATISTICS**

| S.No. | INDEX Descriptions |
|---|---|
| 1. | Preamble |
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| 3. | Vision and mission of the School |
| 4. | Program Educational obectives |
| 5. | Program outcome |
| 6. | Program Specific outcome |
| 7. | Admission |
| 8. | Eligibility in all year as NEP (entry & exit) as per NEHQF and NSQF (if applicable) |
| 9. | Curriculum |
| 10. | Medium of Instruction |
| 11. | Choice base Credit system (CBCS)/LOCF/OBE |
| 12. | Registration for course in a semester |
| 13. | Attendance<br>13.1 Condonation of medical cases<br>13.2 Additional Condonation |
| 14. | Assessment procedure<br>14.1 Internal Assessment (IA) (External Assessment (EA)<br>14.2 Practical Assessment<br>Internal Assessment (IA) (External Assessment (EA) |
| 15. | Research Project/Semester Project Assessment Criteria |
| 16. | Internship – Research / Industrial Internship |
| 17. | Fornon – credit courses / audit courses |
| 18. | Credit weightage |
| 19. | Maximum duration of programme/promotion policy |
| 20. | Maximum gaps between semester/year |
| 21. | Credit system & grading CGPA/SGPA |
| 22. | Class / division |
| 23. | Transfer of credit /Academic Credit Bank |
| 24. | Change of discipline |
| 25. | Use of technological intervention |
| 26. | Student Discipline |
| 27. | Student Welfare |
| 28. | Ragging |
| 29. | Power of modify |
| 30. | Exit point |
| 31. | NC/Credit Course |
| 32. | Any other heading as per your program |

**IIMT UNIVERSITY, MEERUT**
**SCHOOL OF BASIC SCIENCES & TECHNOLOGY**

# ORDINANCE FOR MASTER OF SCIENCE (M.Sc.) PROGRAMME

## 1. PREAMBLE

School of Basic Sciences and Technology was founded in 2017 with an aim to provide top-notch education in the fields of fundamental sciences and technology. The school started with the introduction of the undergraduate courses B.Sc. (PCM) and B.Sc. (PSM) in 2017, and then M.Sc. in Physics, Chemistry, Mathematics, and Statistics, as well as Doctoral programme in Physics, Chemistry, Mathematics, and Statistics.

The goal of our school is to give intermediate and graduate students, who come from various educational boards/universities, a solid foundation that will help them succeed in various professional and educational programme. When students graduate from our programme, they will be ready for diverse academic professions and positions in industry. The School of Basic Sciences and Technology supports research-based methodologies by harnessing the skills and capabilities of top-tier faculty members and cutting-edge buildings, enabling us to provide fascinating programme in both traditional and multidisciplinary fields of science and technology. The school currently features departments that are well-established, well equipped, and going forward with a strong team of highly trained and experienced faculty members.

Under the skilled guidance of subject professors and mentors, students enrolling in the School of Basic Sciences and Technology in a variety of disciplines succeed in achieving their individual academic objectives. Additionally, many seminars, conferences, workshops, and educational and professional tours are all encouraged for students to take part in.

To prepare students for many academic areas including competitive exams like NET, JRF, GATE, and PSUs, regular extracurricular activities and career development activities are offered. The institution provides PhD programmes in a number of fields, including chemistry, physics, mathematics, and statistics, in addition to U.G. and P.G. courses. Numerous career prospects are available after completing a PhD degree, including those in pharmaceutical synthesis, academic teaching, economic research, cutting-edge laboratories, and market research and development companies.

By offering students a superior educational opportunity and supporting all facets of teaching, learning, and research, the School of Basic Sciences and Technology contributes to the university's purpose of academic eminence in teaching, scholarship, and service.

## 2. DEFINITIONS

1. Student- a student registered for the undergraduate program for a full time study leading to Bachelor's Degree.
2. Academic Council- the Academic Council of the University, as defined in the Statutes.
3. CGPA- The cumulative grade point average of a student.
4. Core Courses- courses which are considered mandatory to be taken by students at departmental level and must be passed by students to fulfill the degree requirement. The courses need to be repeated by students in case of "fail" grade.
5. Course- a subject or curricular component identified by a designated code number and a title.
6. Course Description- shall comprise details such as Curricular Content, Course Code, Course Title, Brief Syllabus, Course Learning Outcomes, Pre-requisites, if any, special teaching methodology, Evaluation Methodology etc.
7. Course Coordinator- a faculty member who shall have full responsibility for the course, coordinating the work of other faculty member(s) involved in that course, including setting up of course syllabus, timeline for conduct of various component of the course, Examinations and the award of grades. In case of any difficulty, the student is expected to approach the course coordinator for advice and clarification.
8. Curricula- the program structure duly filled with titles and code numbers of the courses in a program for a discipline.
9. Degree- Bachelor's degree viz. BSc and such other degrees of the University as may be approved by the Executive Council.
10. Elective Courses- courses subscribed by a student to have flexibility to pursue their interest in different areas of science. The elective courses are expected to help a student to gain deeper knowledge and skills in specific/chosen areas in science. They may be interchanged and shall not count as essential for the award of degree so long as credit and other requirements are fulfilled.
11. Equivalent Course(s)- wherever made applicable, through regulations or laid down in the curriculum for a given course an equivalent course(s) may be identified for any other course, which is being discontinued, or not done as essential part of curriculum to be completed by a student. Department may use the equivalent course(s) for meeting degree / pre-requisite requirement in special circumstances.

12. Executive Council- the Executive Council of the University, as defined in the Act.
13. Faculty Mentor- a faculty member nominated by the Department to advise / counsel/mentor a student on matters related to the academic program, of the student. He/she shall be responsible for acting as an interface between student, University and parents / guardians, as required.
14. Foundation Courses- courses aimed at building the foundation in the science Programs and are common across all the streams within the School. These courses are designed for providing basic conceptual knowledge and analytical tools. The courses need to be repeated by students in case of "fail" grade.

15. Pre-requisite- a course which a student must pass before taking another course which has it as a pre-requisite.
16. Program Structure- to be used for defining semester wise credits and contact hours (distribution allotted to various types of courses in a program) like Theory, Labs and Seminars etc. mentioning their status as core or elective).
17. SGPA- the semester grade point average.

## 3. VISION AND MISSION

We aim to help our students to develop the competencies and essential proficiency necessary for success and leadership in the emerging creative economy and to improve the conditions for communities in the field of science and technology.

At school of Basic sciences and Technology we have a mission to develop a strong research oriented scientific foundation to pursue an emerging carrier in the field of basic sciences and technology. We aim to develop a logical and analytical approach among the students to prepare them for future professional endeavors'.

## 4. Program Educational Objectives

The Objective of the Master of Science is to help Students become highly skilled, versatile, independent thinkers with the research experience, information literacy, communication and interpersonal skills necessary for an advanced professional career or further academic study at the Ph.D level.

## 5. Program Outcome:

The Programme Outcomes for Master of Science are as follow:

- The Master of Science programme provides the candidate with knowledge, general competence, and analytical skills on an advanced level, needed in industry, consultancy, education, research, or public administration.
- The Candidate is familiar with contemporary research within various fields.
- The Candidate has the ability to successfully carry out advanced tasks and projects, both independently and in collaboration with others, and also across disciplines.
- The Candidate can disseminate subject matter and results to both specialists and a broader audience.

## 5. Program Specific Outcome:

The students upon completion of M.Sc. (chemistry) Programme will be able:

- Present scientific and technical information resulting from laboratory experimentation in both written and oral formats.
- Work effectively and safely in a laboratory environment.
- Think critically and analyze chemical problems.

The students upon completion of M.Sc.(mathematics) Programme will be able:

- Solve problems in the advanced areas of (a) numerical analysis, (b) linear algebra, (c) real analysis, and (d) statistics.
- Read, analyze, and write logical arguments to prove mathematical concepts.
- Communicate mathematical ideas with clarity and coherence, both written and verbally.
- Perform research in conjunction with others as well as individually.

The students upon completion of M.Sc. (Statistics) Programme will be able:

- To cultivate a mathematical attitude and nurture the interests,
- To motivate for research in mathematical and statistical sciences,
- To train computational scientists who can work on real life challenging problems

The students upon completion of M.Sc.(Physics) Programme will be able:

- Apply theoretical knowledge of principles and concepts of Physics to practical problems.
- Use mathematical techniques and interpret mathematical models of physical behavior.
- Demonstrate the ability to plan, undertake, and report on a programme of original work; including the planning and execution of experiments, the analysis and interpretation of experimental results.
- Assess the errors involved in an experimental work and make recommendations based on the results in an effective manner.
- Develop communication skills, both written and oral, for specialized and non-specialized audiences.

**7. Admission**

Candidate seeking admission in Mater of science courses must have passed basic eligibility criteria i.e. Graduation with minimum 45% Marks or its equivalent from any recognized Central / State university with any relevant subject.

**8. Eligibility in all years NEP (entry & exit) as per NEHQF and NSQF (if applicable)**

In Master of Science NEP 2020 System is proposed and will be implemented soon.

**9. Curriculum**

The curriculum of Post Graduate Programme allows students to choose elective courses from a set of courses with contemporary relevance, thereby offering students the flexibility to prepare for careers in academia. The programme is consistent with global standards in the different discipline. IIMT University, Meerut hopes that the choice of subjects on the basis of Graduate Subjects will help students in making an informed decision regarding the goals that they wish to pursue in further education and life.

**10. Medium of Instruction:**

The medium of instructions will be English.

**11. Choice base Credit system (CBCS)/LOCF/OBE**

- **a.** The course curriculum and syllabus of Post Graduate Programme shall be developed by the concerned School Board of Studies/Department Board of Studies / Board of Post Graduate Programme of the University and they shall be implemented after obtaining approval from the Academic Board/Council.
- **b.** IIMT University, Meerut offers a number of choices for the papers under Generic Elective Courses (GEC), Discipline Specific Elective (DSE) courses, & Ability Enhancement Curriculum Course (AECC) as per the availability of the courses and faculty.
- **c.** The University may evolve a system/policy about Extra Curricular Activities/ General Interest and Hobby Courses/Sports.
- **d.** Dissertation/Project Work/Internship is Mandatory for the Final Year Students and it may be offered in lieu of a discipline specific elective paper in $4^{th}$ Semester.
- **e.** The curriculum of Post Graduate Programme shall be in conformity with the University Grants Commission's Guidelines for the Learning Outcomes- based Curriculum Framework (LOCF) under the Choice Based Credit System (CBCS).

**The following mechanism shall be adopted for computation of work-load as per the credit system for theory and practical both.**

- **(a)** 1Credit =1Theory period of one hour duration/week/semester;
- **(b)** 1Credit =1Tutorial period of one hour duration/week/semester;
- **(c)** 1Credit =1Practical period of two hours duration/week/semester;
- **(d)** 1Credit = Internship of 1 week/semester.

**12. Registration for course in a semester**

- The students can register themselves by filling the application form available at the IIMT University reception or through online mode.
- To register online, a registration fee is payable at the time of registration. The payment can be made through paytm, bank draft, NEFT and other online payment services.
- The application form should be duly filled and complete in all aspects. The completed application form can be submitted online. The Candidate can also send the hard copy of the downloaded filled application form along with the bank draft or the proof of payment (if paid through any other mode) to the University address.
- The candidates are shortlisted based on the eligibility criteria of the course applied for and called for a Personal Interview (PI).
- Admission is granted based on the final evaluation done by the PI team that includes members from the respective programs as well.

**13. Attendance**

As per IIMT University norms 75% attendance is mandatory to appear in the examinations.

**13.1 Condonation of medical cases**

The condonation on medical grounds shall be granted only when the student is incapacitated, such that he/she cannot attend classes. IIMT University, Meerut shall verify the same. No condonation will be granted if the doctor/hospital fails to certify such illness.

**13.2 Additional Condonation**

Additional Condonation may be given as per the term and condition of the students. Competent authority will look after the entire process of attendance.

**14. Assessment procedure**

**14.1 Internal Assessment (IA)**

Internal Assessment is done by conducting minimum two Sessional Examinations and Practical. Class test, assignment and presentation are also key part of the internal Assessment.

**External Assessment (EA)**

The external assessment is done by conducting the End term Examinations as per Evaluation scheme. After this proper evaluation will be done by the external examiners.

**14.2 Practical Assessment**

Practical Assessment plays a pivotal role in Academics. The school conducts Practical on Internal and external basis as per the evaluation scheme particularly in Psychology Subject.

In other subjects Project/Viva-Voce is the integral part of the syllabus.

**Internal Assessment (IA)**

The internal assessment is done on the basis of Assignments, Quiz, files and presentation.

**External Assessment (EA)**

The external assessment is done on the basis of files, presentation and viva-voce assessed by the external examiners.

**15. Research Project/Semester project Assessment Criteria**

In School of Basic Sciences & Technology particular research project are the integral part of the Curriculum. The research projects may be extended or forwarded to the research works as per the discrimination of the concerned subject Experts.

**16. Internship-Research/Industrial Internship**

In School of Basic Sciences & Technology particular Internship-Research/Industrial Internship are Integral parts of Curriculum. The research activities related to the subjects are Conducted by the School Of Basic Sciences & Technology time to time.

**17. For Non-Credit Course/Audit Course**

The Non Credits Courses/Audit Courses will be implemented as per NEP 2020 soon.

**18. Credit Weightage**

Candidates will be offered Credits for Core Courses, Ability Enhancement Compulsory Course (AECC), Discipline Specific Elective (DSE), Generic Elective (GE).The credits are well defined in the evaluation scheme as per the weightage of the course.

**19. Maximum Duration of Progrmame/Promotion Policy**

The duration of Post Graduate Programme is of two years which is divided into the Semesters from 1st Semester up to the 4th Semesters.

**20. Maximum gaps between semester/year**

It is usually a constructive 24 month break taken from study or work in order for the Individual to pursue other interests, generally markedly different from their regular life or line of work. At least two years gap may be considered as per the norms of IIMT University, Meerut.

**21. Credit System & grading CGPA/SGPA**

**Credit:** Credit defines the quantum of work-load for a course. Generally, one hour of theory or one hour of tutorial or two hours of laboratory work, per week for duration of a semester result in the award of one credit. Credits for internship shall be one credit per one week of internship, subject to a maximum of six credits.

**Credit Point:** It is the product of grade point and number of credits for a course.

**Semester Grade Point Average (SGPA):** It is a measure of performance of work done in a semester. It is ratio of total credit points secured by a student in various courses registered in a semester to the total course credits taken during that semester. It shall be expressed up to two decimal places.

**Cumulative Grade Point Average (CGPA):** It is a measure of overall cumulative performance of a student over all semesters. The CGPA is the ratio of total credit points secured by a student in various courses in all semesters to the sum of the total credits of all courses in all the semesters. It is expressed up to two decimal places.

**Transcript or Grade Card or Certificate**: Based on the grades earned, a grade certificate shall be issued to all the registered students after every semester. The grade certificate will display the course details (code, title, number of credits, grade secured) along with SGPA of that semester and CGPA earned till that semester.

All these Credit System & grading, CGPA/SGPA will be finally implemented As per the norms of IIMT University, Meerut.

22. **Class/Division**
Class/Division may be done as per the choice of subject by the students. Subject may be classified as per the evaluation scheme for further study.

23. **Transfer of Credit/Academic Credit Bank**
A candidate who has earned the minimum number of credits prescribed in the concerned Syllabi and Scheme of Teaching and Examination, either entirely from the School Of Basic Sciences & Technology, IIMT University, Meerut credits which have been transferred after earning them for one semester/ semesters from any other University operating in and outside India and with which MoU has been entered by the IIMT University, shall be declared to have passed the programme, and shall be eligible for the award of the relevant degree. The Syllabi and Scheme of Teaching and Examination shall clearly specify the minimum credits to be earned to qualify for master degree. The credits included in the Syllabi and Scheme of Teaching and Examination of a programme shall generally be 5 – 10% more than such minimum specified credits, subject to prescribed guidelines of the concerned authority of IIMT University, Meerut.

24. **Change of Discipline**
After taking the admission in any course Students can change the discipline as per own choice under the rules and regulation of IIMT University, Meerut. Change of Discipline is the right of Students as per IIMT University, Meerut.

25. **Use of technological Intervention**

- SoBST has been currently using technology for teaching the students, conducting the regular classes, scheduling meeting, organizing webinars, and conducting all academic and cultural activities.
- All the students have been taught through various technological apps such as Google classroom, Zoom, Google Meet, Microsoft team etc…
- Faculties as well as Students have been given regular training to acquaint with technology, its use and functions to work in a friendly manner.
- We are also promoting students for online courses like NPTEL/SWAYAM/MOOCS.
- Students have been trained for giving presentations through technology.

26. **Student Discipline**
School of Basic Sciences & Technology believes in providing professional education with human values. Ragging is form of brutality that can never be tolerated in an educational institution with ethics. It is the practice of the faculty members as well as the Proctorial board to guide the Students about the disciplined activities In – Campus and out Side Campus.

**27. Student Welfare**

School of Basic Sciences & Technology believes in providing a great learning atmosphere where students can generate, enable and progress inspiration. Students are also supported for everything that works well for their welfare. Our Vision is to follow and provide professionalism, Positive Attitude towards Growth and enable the students to achieve 100 % Placement with the support of advanced way of learning.

**28. Ragging**

School of Basic Sciences & Technology provides learning in ragging free atmosphere to our Students as ragging is strictly prohibited in the campus. The Students follow the guidelines properly regarding the same.

**29. Power of modify**

School of Basic Sciences & Technology of IIMT University, Meerut has the power to modify the syllabus/Curriculum as per the guidelines of Academic counsel instruction of the competent authority as per the need to modify the same.

**30. Exit Point**

After the completion of Post Graduate Programme students can exit from the university after receiving the degree of Post-Graduation Programme.

**31. NC/Credit Course**

**NC**

The Non Credits Courses/Audit Courses will be implemented as per NEP 2020 (Proposed) and will be implemented soon.

**Credit Course**

Candidates will be offered Credits for Core Courses, Ability Enhancement Compulsory Course (AECC), Discipline Specific Elective (DSE), Generic Elective (GE).The credits are well defined in the evaluation scheme as per the weightage of the course.

**NOTE:** Any dispute arising on account of implementation of this ordinance shall be referred to a committee of three members to be appointed by the Vice-Chancellor and its decision shall be final and binding on all.

# EVALUATION SCHEME

| Master of Science (CHEMISTRY)<br>Semester - I | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **S. No.** | **Course Category** | **Subject** | **Course Code** | **Periods** | | | **Evaluation Scheme** | | | **Credit** |
| | | | | **L** | **T** | **P** | **IA** | **EA** | **Total** | |
| 1 | Core Theory-1 | Inorganic Chemistry-I | MSCY-111 | 4 | 0 | 0 | 30 | 70 | 100 | 4 |
| 2 | Core Theory-2 | Organic Chemistry-I | MSCY-112 | 4 | 0 | 0 | 30 | 70 | 100 | 4 |
| 3 | Core Theory-3 | Physical Chemistry–I | MSCY-113 | 4 | 0 | 0 | 30 | 70 | 100 | 4 |
| 4 | SEC | Mathematics for Chemists* / Biology for Chemists* | MSCY-114M/ MSCY-114B | 2 | 0 | 0 | 15 | 35 | NC | Non Credit* |
| 5 | Core Lab-1 | Inorganic Chemistry Lab-I | MSCY-111P | - | - | 4 | 20 | 30 | 50 | 2 |
| 6 | Core Lab-2 | Organic Chemistry Lab-I | MSCY-112P | - | - | 4 | 20 | 30 | 50 | 2 |
| 7 | CoreLab-3 | Physical Chemistry Lab–I | MSCY-113P | - | - | 4 | 20 | 30 | 50 | 2 |
| 8 | Non Credit | Industrial Visit/ Seminar Or Presentation Based On The Report Of Visits | NECC-121 | | | | 25 | 0 | NC | 0 |
| 9 | Non Credit | University Social Responsibility | NECC-122 | | | | 25 | 0 | NC | 0 |
| 10 | ECC | Spoken Tutorial Certification | NECC-123 | | | 2 | 25 | 0 | 25 | 1 |
| 11 | ECC | Moocs/ Swayam | NECC-124 | | | 2 | 25 | 0 | 25 | 1 |
| 12 | Non Credit | Sports | SPT-121 | | | | 50 | 0 | NC | 0 |
| | | **Total** | | **14** | **0** | **14** | | | 500 | **20** |

| Master of Science (CHEMISTRY)<br>Semester - II | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **S. No.** | **Course Category** | **Course Name** | **Course Code** | **Periods** | | | **Evaluation Scheme** | | | **Credit** |
| | | | | **L** | **T** | **P** | **IA** | **EA** | **Total** | |
| 1 | Core Theory-4 | Inorganic Chemistry – II | MSCY-121 | 4 | 0 | 0 | 30 | 70 | 100 | 4 |
| 2 | Core Theory-5 | Organic Chemistry – II | MSCY-122 | 4 | 0 | 0 | 30 | 70 | 100 | 4 |
| 3 | Core Theory-6 | Physical Chemistry – II | MSCY-123 | 4 | 0 | 0 | 30 | 70 | 100 | 4 |
| 4 | SEC | Computer for Chemists | MSCY-124 | 2 | 0 | 0 | 15 | 35 | NC | Non Credit* |
| 5 | CoreLab-4 | Inorganic Chemistry Lab – II | MSCY-121P | 0 | 0 | 4 | 20 | 30 | 50 | 2 |
| 6 | CoreLab-5 | Organic Chemistry Lab – II | MSCY-122P | 0 | 0 | 4 | 20 | 30 | 50 | 2 |
| 7 | CoreLab-6 | Physical ChemistryLab – II | MSCY-123P | 0 | 0 | 4 | 20 | 30 | 50 | 2 |
| 8 | Non Credit | Industrial Visit/ Seminar Or Presentation Based On The Report Of Visits | NECC-121 | | | | 25 | 0 | NC | 0 |
| 9 | Non Credit | University Social Responsibility | NECC-122 | | | | 25 | 0 | NC | 0 |
| 10 | ECC | Spoken Tutorial Certification | NECC-123 | | | 2 | 25 | 0 | 25 | 1 |
| 11 | ECC | Moocs/ Swayam | NECC-124 | | | 2 | 25 | 0 | 25 | 1 |
| 12 | Non Credit | Sports | SPT-121 | | | | 50 | 0 | NC | 0 |
| | | **Total** | | **14** | **0** | **16** | | | **500** | **20** |

## Master of Science (CHEMISTRY)
## Semester - III

| S. No. | Course Category | Course Name | Course Code | Periods | | | Evaluation Scheme | | | Credit |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | IA | EA | Total | |
| 1 | Core Theory-7 | Inorganic Chemistry - III | MSCY-231 | 4 | 0 | 0 | 30 | 70 | 100 | 4 |
| 2 | CoreTheory-8 | Organic Chemistry - III | MSCY-232 | 4 | 0 | 0 | 30 | 70 | 100 | 4 |
| 3 | CoreTheory-9 | Physical Chemistry – III | MSCY-233 | 4 | 0 | 0 | 30 | 70 | 100 | 4 |
| 4 | DSE (I) | Bioinorganic & Supramolecular Chemistry | MSCY-2311 | 4 | 0 | 0 | 30 | 70 | 100 | 4 |
| 5 | DSE (O) | Bioorganic Chemistry | MSCY-2321 | 4 | 0 | 0 | 30 | 70 | | 4 |
| 6 | DSE (P) | Biophysical chemistry | MSCY-2331 | 4 | 0 | 0 | 30 | 70 | | 4 |
| 7 | Core Lab-7 | Inorganic Chemistry Lab - III | MSCY-231P | 0 | 0 | 8 | 40 | 60 | 100 | 4 |
| | | Organic Chemistry Lab- III | MSCY-232P | | | | | | | |
| | | Physical Chemistry Lab– III | MSCY-233P | | | | | | | |
| 8 | NC | Industrial Visit/ Seminar Or Presentation Based On The Report Of Visits | NECC-231 | | | | 25 | 0 | NC | 0 |
| 9 | NC | University Social Responsibility | NECC-232 | | | | 25 | 0 | NC | 0 |
| 10 | ECC | Spoken Tutorial Certification | NECC-233 | | | 2 | 25 | 0 | 25 | 1 |
| 11 | ECC | Moocs/ Swayam | NECC-234 | | | 2 | 25 | 0 | 25 | 1 |
| 12 | NC | Sports | SPT-131 | | | | 50 | | NC | 0 |
| | | **Total** | | **24** | **0** | **12** | | | **550** | **22** |

<table>
<tr><th colspan="12">Master of Science (CHEMISTRY)<br>Semester - IV</th></tr>
<tr><th rowspan="2">S. No.</th><th rowspan="2">Course Category</th><th rowspan="2">Course Code</th><th rowspan="2">Subject</th><th colspan="3">Periods</th><th colspan="3">Evaluation Scheme</th><th rowspan="2">Credit</th></tr>
<tr><th>L</th><th>T</th><th>P</th><th>IA</th><th>EA</th><th>Total</th></tr>
<tr><td>1</td><td>MSCY-2422</td><td>Advanced Organic Synthesis/ Supramolecular Chemistry and Carbocyclic Rings</td><td>Core Course-10</td><td>4</td><td>0</td><td>-</td><td>30</td><td>70</td><td>100</td><td>4</td></tr>
<tr><td>2</td><td>MSCY-2423</td><td>Chemistry of Natural Products</td><td>Core Course-11</td><td>4</td><td>0</td><td>-</td><td>30</td><td>70</td><td>100</td><td>4</td></tr>
<tr><td>3</td><td>MSCY-2424</td><td>Newer Synthetic Reactions and Reagents/ Heterocyclic Chemistry</td><td>Core Course-12</td><td>4</td><td>0</td><td>-</td><td>30</td><td>70</td><td>100</td><td>4</td></tr>
<tr><td rowspan="2">4</td><td>MCOE2421</td><td>Biomolecules</td><td rowspan="2">DSE</td><td rowspan="2">4</td><td rowspan="2">0</td><td rowspan="2">0</td><td rowspan="2">30</td><td rowspan="2">70</td><td rowspan="2">100</td><td rowspan="2">4</td></tr>
<tr><td>MCOE-2422</td><td>Pharmaceutical Techniques</td></tr>
<tr><td>5</td><td>MSCY-2422P</td><td>Organic Chemistry Lab - IV</td><td>Core Lab-8</td><td>0</td><td>0</td><td>8</td><td>40</td><td>60</td><td>100</td><td>4</td></tr>
<tr><td>6</td><td>MSCY-2425</td><td>Review Project (Includes Submitting a Dissertation and Making a Presentation)</td><td>Core Course-13</td><td>0</td><td>0</td><td>8</td><td>40</td><td>60</td><td>100</td><td>4</td></tr>
<tr><td>8</td><td>SPT-241</td><td>Sports</td><td>Non Credit</td><td></td><td></td><td></td><td>50</td><td>0</td><td>NC</td><td>0</td></tr>
<tr><td></td><td></td><td>Total</td><td></td><td>16</td><td>0</td><td>16</td><td></td><td></td><td>600</td><td>24</td></tr>
</table>

**_Master of Science (STATISTICS)_**
**_Semester - I_**

| S.No | Course Code | Subject | Periods | | | Evaluation Scheme | | | Credit |
|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | Internal | External | Total | |
| 1 | MSST-111 | Probability Theory | 4 | - | - | 30 | 70 | 100 | 4 |
| 2 | MSST-112 | StatisticalDistributions | 4 | - | - | 30 | 70 | 100 | 4 |
| 3 | MSST-113 | SamplingTechniques | 4 | - | - | 30 | 70 | 100 | 4 |
| 4 | MSST-114 | Data Analysis with R | 4 | - | - | 30 | 70 | 100 | 4 |
| 5 | MSST-111P | Statistical Lab-I | - | - | 4 | 20 | 30 | 50 | 2 |
| 6 | NECC-121 | Industrial Visit/ Seminar Or Presentation Based On The Report Of Visits | | | | 25 | 0 | NC | 0 |
| 7 | NECC-122 | University Social Responsibility | | | | 25 | 0 | NC | 0 |
| 8 | NECC-124 | Moocs/ Swayam | | | 2 | 25 | 0 | 25 | 1 |
| 9 | SPT-121 | Sports | | | | 50 | 0 | NC | 0 |
| | | **Total** | **16** | **-** | **6** | **290** | **310** | **475** | **19** |

**_Master of Science (STATISTICS)_**
**_Semester - II_**

| S.No | Course Code | Subject | Periods | | | Evaluation Scheme | | | Credit |
|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | Internal | External | Total | |
| 1 | MSST-121 | Design of Experiments and LinearEstimation | 4 | - | - | 30 | 70 | 100 | 4 |
| 2 | MSST-122 | Inference I- Theory of Estimation and Testing ofHypothesis | 4 | - | - | 30 | 70 | 100 | 4 |
| 3 | MSST-123 | Matrices and Linear DifferenceEquations | 4 | - | - | 30 | 70 | 100 | 4 |
| 4 | MSST-124 | Real & ComplexAnalysis | 4 | - | - | 30 | 70 | 100 | 4 |
| 5 | MSST-121P | Statistical Lab-II | - | - | 4 | 20 | 30 | 50 | 2 |
| 6 | NECC-121 | Industrial Visit/ Seminar Or Presentation Based On The Report Of Visits | | | | 25 | 0 | NC | 0 |
| 7 | NECC-122 | University Social Responsibility | | | | 25 | 0 | NC | 0 |
| 8 | NECC-124 | Moocs/ Swayam | | | 4 | 50 | 0 | 50 | 2 |
| 9 | SPT-121 | Sports | | | | 50 | 0 | NC | 0 |
| | | **Total** | 16 | - | 8 | 290 | 310 | 500 | 20 |

| Master of Science (STATISTICS)<br>Semester - III | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **S.No** | **Course Code** | **Subject** | **Periods** | | | **Evaluation Scheme** | | | **Credit** |
| | | | **L** | **T** | **P** | **Internal** | **External** | **Total** | |
| 1 | MSST-231 | Inference II- Interval Estimation, Sequential Analysis & Non-ParametricInference | 4 | - | - | 30 | 70 | 100 | 4 |
| 2 | MSST-232 | Engineering Statistics: Quality Control & ReliabilityTheory | 4 | - | - | 30 | 70 | 100 | 4 |
| 3 | MSST-233 | Operations Research- I | 4 | - | - | 30 | 70 | 100 | 4 |
| 4 | MSST-234(a)/ 234(b) | Decision Theory & Bayesian Inference / Stochastic Process & Survival Analysis | 4 | - | - | 30 | 70 | 100 | 4 |
| 5 | MSST-231P | Lab Course-III | - | - | 4 | 20 | 30 | 50 | 2 |
| 6 | NECC-121 | Industrial Visit/ Seminar Or Presentation Based On The Report Of Visits | | | | 25 | 0 | NC | 0 |
| 7 | NECC-122 | University Social Responsibility | | | | 25 | 0 | NC | 0 |
| 8 | NECC-124 | Moocs/ Swayam | | | 2 | 25 | 0 | 25 | 1 |
| 9 | SPT-121 | Sports | | | | 50 | 0 | NC | 0 |
| | | Total | 16 | - | 6 | 265 | 310 | 475 | 19 |

| Master of Science (STATISTICS)<br>Semester - IV | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **S.No** | **Course Code** | **Subject** | **Periods** | | | **Evaluation Scheme** | | | **Credit** |
| | | | **L** | **T** | **P** | **Internal** | **External** | **Total** | |
| 1 | MSST-241 | Multivariate Analysis | 4 | - | - | 30 | 70 | 100 | 4 |
| 2 | MSST-242 | Economic Statistics & Demography | 4 | - | - | 30 | 70 | 100 | 4 |
| 3 | MSST-243 | Operations Research-II | 4 | - | - | 30 | 70 | 100 | 4 |
| 4 | MSST-244(a)/244(b) | Computer Oriented Statistical Methods/Advanced Experimental Designs | 4 | - | - | 30 | 70 | 100 | 4 |
| 5 | MSST-241P | Lab Course-IV | - | - | 4 | 20 | 30 | 50 | 2 |
| 6 | MSST-241RP | Dissertation | | | 8 | 40 | 60 | 100 | 4 |
| 7 | NECC-121 | Industrial Visit/ Seminar Or Presentation Based On The Report Of Visits | | | | 25 | 0 | NC | 0 |
| 8 | NECC-122 | University Social Responsibility | | | | 25 | 0 | NC | 0 |
| 9 | NECC-124 | Moocs/ Swayam | | | 2 | 25 | 0 | 25 | 1 |
| 10 | SPT-121 | Sports | | | | 50 | 0 | NC | 0 |
| | | Total | | - | | | | | 23 |

| Master of Science (MATHEMATICS)<br>Semester - I | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **S.No** | **Course Code** | **Subject** | **Evaluation Scheme** | | | | | | | |
| | | | **Periods per week** | | | **IA** | **EA** | **Total** | **Credit** |
| | | | **L** | **T** | **P** | | | | |
| 1 | MSM-111 | Theory of Ordinary Differential Equations | 4 | - | - | 30 | 70 | 100 | 4 |
| 2 | MSM-112 | Advanced Real Analysis | 4 | - | - | 30 | 70 | 100 | 4 |
| 3 | MSM-113 | Topology | 4 | - | - | 30 | 70 | 100 | 4 |
| 4 | MSM-114 | Advanced Abstract Algebra | 4 | - | - | 30 | 70 | 100 | 4 |
| 5 | NECC-111 | Industrial Visit/ Seminar Or Presentation Based On The Report Of Visits | | | | 25 | 0 | NC | 0 |
| 6 | NECC-112 | University Social Responsibility | | | | 25 | 0 | NC | 0 |
| 7 | NECC-113 | Spoken Tutorial Certification | | | 2 | 25 | 0 | 25 | 1 |
| 8 | NECC-114 | Moocs/ Swayam | | | 2 | 25 | 0 | 25 | 1 |
| 9 | SPT-111 | Sports | | | | 50 | 0 | NC | 0 |
| | | **Total** | **16** | **-** | **4** | **270** | **280** | **450** | **16** |

| Master of Science (MATHEMATICS)<br>Semester - II | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **S.No** | **Course Code** | **Subject** | **Evaluation Scheme** | | | | | | | |
| | | | **Periods per week** | | | **IA** | **EA** | **Total** | **Credit** |
| | | | **L** | **T** | **P** | | | | |
| 1 | MSM-121 | Numerical Analysis | 4 | - | - | 30 | 70 | 100 | 4 |
| 2 | MSM-122 | Complex Analysis | 4 | - | - | 30 | 70 | 100 | 4 |
| 3 | MSM-123 | Probability & Statistics | 4 | - | - | 30 | 70 | 100 | 4 |
| 4 | MSM-124 | Discrete Mathematics | 4 | - | - | 30 | 70 | 100 | 4 |
| 5 | NECC-121 | Industrial Visit/ Seminar Or Presentation Based On The Report Of Visits | | | | 25 | 0 | NC | 0 |
| 6 | NECC-122 | University Social Responsibility | | | | 25 | 0 | NC | 0 |
| 7 | NECC-123 | Spoken Tutorial Certification | | | 2 | 25 | 0 | 25 | 1 |
| 8 | NECC-124 | Moocs/ Swayam | | | 2 | 25 | 0 | 25 | 1 |
| 9 | SPT-121 | | | | | 50 | 0 | NC | 0 |
| | | **Total** | **16** | **-** | **4** | **270** | **280** | **450** | **16** |

| Master of Science (MATHEMATICS)<br>Semester - III | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **S.No** | **Course Code** | **Subject** | **Evaluation Scheme** | | | | | | | |
| | | | **Periods per week** | | | **IA** | **EA** | **Total** | **Credit** |
| | | | **L** | **T** | **P** | | | | |
| 1 | MSM-231 | Functional Analysis | 4 | 2 | - | 30 | 70 | 100 | 6 |
| 2 | MSM-232 | Operations Research | 4 | 2 | - | 30 | 70 | 100 | 6 |
| 3 | MSM-233 | Integral Equations and Calculus of Variations | 4 | 2 | - | 30 | 70 | 100 | 6 |
| 4 | MSM-234 | Graph Theory | 4 | 2 | - | 30 | 70 | 100 | 6 |
| 5 | NECC-231 | Industrial Visit/ Seminar Or Presentation Based On The Report Of Visits | | | | 25 | 0 | NC | 0 |
| 6 | NECC-232 | University Social Responsibility | | | | 25 | 0 | NC | 0 |
| 7 | NECC-233 | Spoken Tutorial Certification | | | 2 | 25 | 0 | 25 | 1 |
| 8 | NECC-234 | Moocs/ Swayam | | | 2 | 25 | 0 | 25 | 1 |
| 9 | SPT-131 | Sports | | | | 50 | | NC | 0 |
| | | **Total** | **16** | **-** | **4** | **270** | **280** | **450** | **24** |

| Master of Science (MATHEMATICS)<br>Semester - IV | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **S.No** | **Course Code** | **Subject** | **Evaluation Scheme** | | | | | | | |
| | | | **Periods per week** | | | **IA** | **EA** | **Total** | **Credit** |
| | | | **L** | **T** | **P** | | | | |
| 1 | MSM-241 | Fluid Dynamics | 4 | 2 | - | 30 | 70 | 100 | 6 |
| 2 | MSM-242 | Number Theory | 4 | 2 | - | 30 | 70 | 100 | 6 |
| 3 | MSM-243 | Elective | 4 | 2 | - | 30 | 70 | 100 | 6 |
| 4 | MSM-244 | Dissertation | - | - | - | 40 | 60 | 100 | 6 |
| 5 | SPT-141 | Sports | | | | 50 | 0 | NC | 0 |
| | | **Total** | **12** | **3** | **-** | **130** | **270** | **400** | **24** |

| M.Sc. PHYSICS (SEM–I) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **S. No.** | **Course Category** | **Course Code** | **Subject** | Periods | | | Credit | Evaluation Scheme | | |
| | | | | L | T | P | | IA | EA | Total |
| 1. | Core Theory-1 | MSPH-111 | Mathematical Physics | 3 | 1 | 0 | 4 | 30 | 70 | 100 |
| 2. | Core Theory-2 | MSPH-112 | Classical Mechanics | 3 | 1 | 0 | 4 | 30 | 70 | 100 |
| 3. | Core Theory-3 | MSPH-113 | Quantum Mechanics –I | 3 | 1 | 0 | 4 | 30 | 70 | 100 |
| 4. | Core Theory-4 | MSPH-114 | Introductions to Electronic Components & Circuits | 3 | 1 | 0 | 4 | 30 | 70 | 100 |
| 5. | Core Lab-1 | MSPH-111P | Lab. Course-I (General Physics Lab) | - | - | 8 | 4 | 30 | 70 | 100 |
| 6. | Non- Credit | SPT-111 | Sports | | | | 0 | 50 | 0 | NC |
| | | | **Total** | **12** | **4** | **8** | **20** | | | **500** |

L-Lecture, T-Tutorials, P-Practical (Labs), IA-Internal Assessment (Class Test, Assignments, Tutorials etc.), EA-External Assessment, NC- Non Credit Course, **SEC- S Enhancement Course, ECC – Ability Enhancement Course, DSE – Discipline Subjective Elective**

<table>
<tr><th colspan="12">M.Sc. PHYSICS (SEM–II)</th></tr>
<tr><th>S. No.</th><th>Course Category</th><th>Course Code</th><th>Subject</th><th colspan="3">Periods</th><th rowspan="2">Credit</th><th colspan="3">Evaluation Scheme</th></tr>
<tr><td></td><td></td><td></td><td></td><td>L</td><td>T</td><td>P</td><td>IA</td><td>EA</td><td>Total</td></tr>
<tr><td>1</td><td>Core Theory-5</td><td>MSPH-121</td><td>E.M. Theory & Electrodynamics</td><td>3</td><td>1</td><td>0</td><td>4</td><td>30</td><td>70</td><td>100</td></tr>
<tr><td>2</td><td>Core Theory-6</td><td>MSPH-122</td><td>Statistical Mechanics</td><td>3</td><td>1</td><td>0</td><td>4</td><td>30</td><td>70</td><td>100</td></tr>
<tr><td>3</td><td>Core Theory-7</td><td>MSPH-123</td><td>Quantum Mechanics –II</td><td>3</td><td>1</td><td>0</td><td>4</td><td>30</td><td>70</td><td>100</td></tr>
<tr><td>4</td><td>Core Theory-8</td><td>MSPH-124</td><td>Solar and Non-Conventional Energy Physics</td><td>3</td><td>1</td><td>0</td><td>4</td><td>30</td><td>70</td><td>100</td></tr>
<tr><td>5</td><td>Core Lab-2</td><td>MSPH-121P</td><td>Lab. Course-II (Basic Electronics lab)</td><td>-</td><td>-</td><td>8</td><td>4</td><td>30</td><td>70</td><td>100</td></tr>
<tr><td>6</td><td>Non-Credit</td><td>SPT-111</td><td>Sports</td><td></td><td></td><td></td><td>0</td><td>50</td><td>0</td><td>NC</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>12</td><td>4</td><td>8</td><td>20</td><td></td><td></td><td>500</td></tr>
<tr><td colspan="11">L-Lecture, T-Tutorials, P-Practical (Labs), IA-Internal Assessment (Class Test, Assignments, Tutorials etc.), EA-External Assessment, NC- Non Credit Course, SEC- Skills Enhancement Course, ECC – Ability Enhancement Course, DSE – Discipline Subjective Elective</td></tr>
</table>

| M.Sc. PHYSICS (SEM–III) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **S. No.** | **Course Category** | **Course Code** | **Subject** | **Periods** | | | **Credit** | **Evaluation Scheme** | | |
| | | | | **L** | **T** | **P** | | **IA** | **EA** | **Total** |
| 1 | Core Theory-9 | MSPH-231 | Solid State Physics | 3 | 1 | 0 | 4 | 30 | 70 | 100 |
| 2 | Core Theory-10 | MSPH-232 | Atomic & Molecular Physics | 3 | 1 | 0 | 4 | 30 | 70 | 100 |
| 3 | Core Theory-11 | MSPH-233 | Nuclear & Particle Physics | 3 | 1 | 0 | 4 | 30 | 70 | 100 |
| 4 | DSE-1 | MSPH-234A/ MSPH-234B | Digital Electronics & Microprocessor/ Condensed Matter Physics | 3 | 1 | 0 | 4 | 30 | 70 | 100 |
| 5 | Core Lab-1 | MSPH-231P | Lab. Course-III (Solid State & Atomic and Molecular Lab) | - | - | 8 | 4 | 30 | 70 | 100 |
| 6 | SEC-1 | MSPH-232S | Seminar | - | - | 4 | 2 | 50 | - | 50 |
| 7 | Non-Credit | SPT-231 | Sports | | | | 0 | 50 | 0 | NC |
| | | | **Total** | **12** | **4** | **12** | **22** | | | **550** |

L-Lecture, T-Tutorials, P-Practical (Labs), IA-Internal Assessment (Class Test, Assignments, Tutorials etc.), EA-External Assessment, NC- Non Credit Course, **SEC- Skills Enhancement Course, ECC – Ability Enhancement Course, DSE – Discipline Subjective Elective**

| M.Sc. PHYSICS (SEM–IV) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **S. No.** | **Course Category** | **Course Code** | **Subject** | **Periods** | | | **Credit** | **Evaluation Scheme** | | |
| | | | | L | T | P | | IA | EA | Total |
| 1 | DSE-2 | MSPH-241A/ MSPH-241B | Communication Electronics-I/ Condensed Matter Physics – I | 3 | 1 | 0 | 4 | 30 | 70 | 100 |
| 2 | DSE-3 | MSPH-242A/ MSPH-242B | Communication Electronics-II Condensed Matter Physics – II | 3 | 1 | 0 | 4 | 30 | 70 | 100 |
| 3 | SEC-2 | MSPH-243 | Computational Methods & Programming | 3 | 1 | 0 | 4 | 30 | 70 | 100 |
| 4 | DSE-4 | MSPH-241AP/ MSPH-242BP | Communication Electronics Lab/ Condensed Matter Physics Lab | 0 | 0 | 4 | 2 | 20 | 30 | 50 |
| 5 | SEC-3 | MSPH-243P | Computational Methods & Programming Lab | 0 | 0 | 4 | 2 | 20 | 30 | 50 |
| 6 | Core SEC-4 | MSPH-241PR | Project | | | 12 | 6 | 50 | 50 | 100 |
| 7 | Non-Credit | SPT-241 | Sports | | | | 0 | 50 | 0 | NC |
| | | | **Total** | 9 | 3 | 20 | 22 | | | 500 |

L-Lecture, T-Tutorials, P-Practical (Labs), IA-Internal Assessment (Class Test, Assignments, Tutorials etc.), EA-External Assessment, NC- Non Credit Course, **SEC- Skills Enhancement Course, ECC – Ability Enhancement Course, DSE – Discipline Subjective Elective**

# FORMAT-3

**IIMTU-NEP IMPLEMENTATION**
**Year: I / Semester: I**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. **Class: M.Sc. (Chemistry)** | Year: I<br>Semester: I |
| **Credits: 04**<br>Theory: 04<br>Practical: | **Subject: Chemistry** |
| **Course Code: MSCY-111** | **Title: Inorganic chemistry-I** |
| **Course Objective:** To provide the advanced knowledge on stereochemistry, bonding and reaction mechanism of the transition metal complexes. | |
| Nature of Paper: **Core** | |
| **Minimum Passing Marks/Credits: 40% Marks** | |
| L: 4<br>T:<br>P: 4(In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits) | |

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | **Stereochemistry and bonding in main group compounds 12 Hrs.**<br>VSEPR, Walsh diagrams (tri atomic molecules), $d\pi - P\pi$ bonds, Bent rule and energetics of hybridization, some simple reactions of covalently bonded molecules. | 12 |
| II | **Metal – Ligand Equilibria in solute**<br>Stepwise and overall formation of constants and their interaction, trends in stepwise constants, factors affecting the stability of metal complexes with reference to the nature of metal ion and ligand, chelate effect and its thermodynamic origin, determination of binary formation constants by pH-metry and spectrophotometry. | 8 |
| III | **Reaction Mechanism of Transition metal complexes 24 Hrs.**<br>Energy profile of a reaction, reactivity of metal complexes, inert and labile complexes, kinetic application of valence bond and crystal field theories.<br>Kinetics of substitution reactions:- Acid hydrolysis, factors affecting acid hydrolysis, base hydrolysis, conjugate base mechanism, direct and indirect evidences in favour of conjugate mechanism, reactions without Metal-ligand bond cleavage. Substitution reaction in square planar complexes, the trans effect, mechanism of the substitution reaction. | 24 |

| | | |
|---|---|---|
| | **Redox reactions (electron transfer reactions):** Mechanism of one electron transfer reactions such as Henry Taube's classical retain of $(NH_3)_5Co^{3+}$-$Cr^{2+}$, Inner sphere type reactions. Outer sphere type reactions (cross reactions) and Marcus hush theory (No mathematical treatment). | |
| IV | **Metal Ligand bonding**<br>Crystal Field Theory (CFT), limitations of crystal field theory.<br>Octahedral, tetrahedral and square planar complexes. | 16 |


1. Structural Inorganic Chemistry, A.F. Wells
2. Concise Inorganic Chemistry, J.D. Lee, Elbs with Chapman and Hall, London.
3. Theoretical Inorganic Chemistry, M.C. Day and J. Selbin, reinhold, EWAP.
4. Elementary Coordination Chemistry, Jones.


If the course is available as Generic Elective then the students of following departments may opt it.
1. B. Tech.
2. Diploma
3. B. Pharm.
4. D. Pharm.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 25 |
| 2) Assignments | 5 |
| 3) ESE | 70 |
| **Total:** | **100** |

Prerequisites for the course: PCM in $12^{th}$

**Course Outcomes:** The student will be able to learn:
Stereochemistry and bonding aspects of many group elements. The students will be able to explain the reaction mechanism of transition metal complexes and factors affecting it and can develop generalized idea of application in the field of medicine, pharmacy, polymer chemistry and Agriculture etc.

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year : I / Semester :I**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. **Class: M.Sc. (Chemistry)** | Year: I<br><br>Semester: I |
| **Credits: 02**<br>Theory: 00<br>Practical: 02 | **Subject: Chemistry** |
| **Course Code: MSCY-111P** | **Title : Inorganic chemistry Lab-I** |

**Course Objective**: It consists of theoretical principles in qualitative analysis of mixture including basic radicals acidic radicals, Separation of cations & anions & preparation of inorganic complexes.

Nature of Paper: **Core**

**Minimum Passing Marks/Credits: 50% Marks**

L:
T:
P: 4 (In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | **Qualitative analysis:**<br>To identify the given cation, anion and interfering radicals (total six including one interfering radical) from the given inorganic mixture. | |
| II | 1. To prepare Hexa-ammine (II) chloride<br>2. To Prepare Potassium dioxolato Cuprate (II) dehydrate<br>3. To prepare Potassium Trioxolato Chromate (III)<br>4. To prepare Tetra ammine Cupric sulphate<br>5. To prepare sodium ferric oxalate<br>6. To prepare crystals of Potasssium Tris Oxalate laminate (III) | |

**Reference / Text Books:**


1. Vogel's Qualitative Inorganic Analysis, revised, svehla, Orient Longman.
2. Vogel's Textbook of Quantitative Inorganic Analysis (revised), J. Bassett, R.C. Denney, G.H. Jeffery and J. Mendham, ELBS.
3. Experimental Inorganic Chemistry, W.G. Palmer, Cambridge.
4. Laboratory Manuel in Organic Chemistry, R.K. Bansal, Wiley Eastern.
5. Experiments in General Chemistry, C.N.R. Rao and U.C. Agarwal, East-West Press.


If the course is available as Generic Elective then the students of following departments may opt it.

| |
|---|
| 1. B. Tech.<br>2. Diploma<br>3. B. Pharm.<br>4. D. Pharma |

| Evaluation/Assessment Methodology | |
|---|---|
| | **Max. Marks** |
| 1) Class tasks/ Sessional Examination<br>2) Assignments<br>3) ESE | 10<br>10<br>30 |
| **Total:** | **50** |
| Prerequisites for the course: PCM in $12^{th}$ | |
| **Course Outcomes:** After performing this lab students will be able to do qualitative analysis of mixtureincluding basic radicals & acidic radicals and preparation of inorganic complexes. | |

**IIMTU-NEP IMPLEMENTATION**
**Year: I/ Semester: I**

| | |
|---|---|
| **Programme:**<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>Class: M.Sc. (Chemistry) | Year: I<br><br>Semester: I |
| **Credits: 04**<br>Theory: 04<br>Practical: 00 | **Subject: Chemistry** |
| **Course Code: MSCY-112** | **Title: Organic chemistry-I** |

**Course Objective:** To impart the advanced knowledge of reactive intermediates, reaction mechanism, stereochemistry of organic compounds.

Nature of Paper: **Core**

**Minimum Passing Marks/Credits: 40%Marks**

L: 4
T:
P: 4(In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits)

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | Delocalized chemical bonding, Conjugation, hyper conjugation, bonding in fullerenes, tautomerism, Aromaticity in benzenoid and nonbenzenoid compounds, alternant and non-alternant hydrocarbons, Huckels's rule, energy levels of n molecular orbitals, annulenes, antiaromaticity, w-aromaticity, homo-aromaticity, PMO approach. Bond weaker than covalent – addition compounds, crown ether complexes and cryptands, inclusion compounds, cyclodextrins, catenanes and rotaxanes. | 10 |
| II | **Stereochemistry**<br>Conformational analysis of cycloalkanes, decalins, effect of conformation on reactivity, conformation of sugars, steric strain due to unavoidable crowding. Elements of symmetry, chirality, molecules with more than one chiral center, thero and erythro isomers, methods of resolution, optical purity. Enantiotopic and diastereotoic atoms, groups and faces. Stereospecific and stereoselective synthesis; Asymmetric synthesis. Optical activity in the absence of chiral carbon (biphenyls, allenes and spiranes), chirality due to helical shape. Stereochemistry of the compounds containing Nitrogen, Sulphur and Phosphorous. | 15 |

| | | |
|---|---|---|
| III | **Reaction mechanism: Structure and Reactivity**<br>Types of mechanisms, types of reactions, thermodynamic and kinetic requirements, kinetic and thermodynamic control, Hammond's postulate, Curtin – Hammet principle. Potential energy diagrams, transition states and intermediates, methods of determining mechanisms, isotope effects. Hard and soft acids and bases. Generation, structure, stability and reactivity of carbonations, carbanions, free radicals, carbenes and nitrenes.<br>Effect of structure on reactivity – resonance and field effects, steric effects, quantitative treatment. The Hammet equation and Linear free energy relationship, substituent and reaction constants, Taft equation. | 15 |
| IV | **Aliphatic Nucleophilic Substitution**<br>Nucleophilic substitution at saturated carbon – $SN_1$, $SN_2$ and related mechanisms; Parameters influencing reaction rates; The Neighboring group mechanism, neighbouring group participation by $\pi$ and $\sigma$ bonds; Anchimeric assistance; Classical and non-classical carbocations, Phenonium ions, common carbocation rearrangements. The SNi mechanism, Nucleophic substitution at an allylic, aliphatic trigonal and a vinyliccarbon. Reactivity effects of substrate structure, attacking nucleophile, leaving group and reaction medium. Phase transfer catalysis, ambident nucleophile, regioselectivity. | 15 |
| V | **Aliphatic Electrophilic Substitution**<br>Bimolecular mechanisms – $SE_2$ and $SE_1$. The $SE_1$ mechanism, electrophilic substitution accompanied by double bond shifts. Effect of substrates, leaving group and the solvent polarity on the reactivity. | 5 |

**Reference / Text Books:**

1. Organic Chemistry, Vol. I & Vol. II, I.L. Finar, Longman.
2. Advanced Organic Chemistry, $2^{nd}$ Edition, R.R. Carey and R.J. Sundberg.
3. Comprehensive Organic Chemistry, Barton and Ollis, Pargamaon.
4. Organic Reactions, Various volumes, R. Adams.
5. Modern synthetic Reactions, H.O. House, Benjamin.
6. Carey, F.A. & Sundberg, R. J. Advanced Organic Chemistry, Parts A & B, Plenum: U.S. (2004).
7. Finar, I. L. & Finar, A. L. Organic Chemistry Vol. 2, Addison-Wesley (1998).
8. Finar, I. L. Organic Chemistry Vol. 1, Longman (1998).
9. Lowry, T. H. & Richardson, K. S. Mechanism and Theory in Organic Chemistry Addison-Wesley Educational Publishers, Inc. (1981).
10. Nasipuri, D. N. Stereochemistry of Organic Compounds: Principles & Applications South Asia Books (1994).
11. March, J. Advanced Organic Chemistry John Wiley & Sons (1992).

If the course is available as Generic Elective then the students of following departments may opt it.

| | |
|---|---|
| 1. B. Tech.<br>2. Diploma<br>3. B. Pharm.<br>4. D. Pharm. | |
| **Evaluation/Assessment Methodology** | |
| | **Max. Marks** |
| 1) Class tasks/ Sessional Examination<br>2) Assignments<br>3) ESE | 25<br>5<br>70 |
| **Total:** | **100** |
| Prerequisites for the course: PCM in 12th | |
| **Course/Learning outcomes:** Students will be expected to gain knowledge on the formation, reactivity and stability of free radicals, and the structure, bonding, generation and reactivity of carbenes and nitrenes, intra- and intermolecular addition reaction of carbenes to double bonds. | |

**Format-3**

**IIMTU-NEP IMPLEMENTATION**

Year: **I/** Semester: **I**

<table>
<tr><td colspan="2">Programme:<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>Class: M.Sc. (Chemistry)</td><td colspan="2">Year: I<br><br>Semester: I</td></tr>
<tr><td colspan="2">Credits: 02<br>Theory: 00<br>Practical: 02</td><td colspan="2">Subject: Chemistry</td></tr>
<tr><td colspan="2">Course Code: MSCY-112P</td><td colspan="2">Title: Organic chemistry Lab-I</td></tr>
<tr><td colspan="4">Course Objective: To practically apply the concepts learnt about separation of organic compound and identification.</td></tr>
<tr><td colspan="4">Nature of Paper: Core</td></tr>
<tr><td colspan="4">Minimum Passing Marks/Credits: 50% Marks</td></tr>
<tr><td colspan="4">L:<br>T:<br>P: 4 (In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)</td></tr>
<tr><td>Unit</td><td colspan="2">Contents</td><td>No. of Lectures Allotted</td></tr>
<tr><td>I</td><td colspan="2">1. To identify the given organic compound and prepare its derivative.<br>2. To analyses the give organic mixture (water separation).</td><td></td></tr>
<tr><td>II</td><td colspan="2">Single step preparations:<br>a. Hydrolysis<br>b. Bromination<br>c. Nitration<br>d. Oxime formation<br>e. Reduction<br>f. Hoffmann Bromide reaction<br>g. Benzoin Condensation reaction</td><td></td></tr>
<tr><td colspan="4">Reference / Text Books:<br>1. Vogel’s Qualitative Inorganic Analysis, revised, svehla, Orient Longman.<br>2. Vogel’s Textbook of Quantitative Inorganic Analysis (revised), J. Bassett, R.C. Denney, G.H. Jeffery and J. Mendham, ELBS.<br>3. Experimental Inorganic Chemistry, W.G. Palmer, Cambridge.<br>4. Laboratory Manuel in Organic Chemistry, R.K. Bansal, Wiley Eastern.<br>5. Experiments in General Chemistry, C.N.R. Rao and U.C. Agarwal, East-West Press.</td></tr>
</table>

If the course is available as Generic Elective then the students of following departments may opt it.
1. B. Tech.
2. Diploma
3. B. Pharm.
4. D. Pharm.

| | |
|---|---|
| **Evaluation/Assessment Methodology** | |
| | **Max. Marks** |
| 1) Class tasks/ Sessional Examination | 10 |
| 2) Assignments | 10 |
| 3) ESE | 30 |
| **Total:** | **50** |

Prerequisites for the course: PCM in $12^{th}$

**Course/Learning Outcome**:
The students will acquire knowledge of:
1. Separation and identification of organic compounds.
2. Purification, Crystallization, and different Distillation processes.
3. Synthesis using substitution and condensation reactions.

**IIMTU-NEP IMPLEMENTATION**
Year: I / Semester: I

| | | |
|---|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. Class: M.Sc. (Chemistry) | | Year: I<br>Semester: I |
| **Credits: 04** Theory: 04 Practical: 0 | **Subject: Chemistry** | |
| **Course Code: MSCY-113** | **Title: Physical chemistry-I** | |
| **Course Objective:** To impart basic and fundamental knowledge of quantum chemistry and Thermodynamics in chemistry. | | |
| Nature of Paper: **Core** | | |
| **Minimum Passing Marks/Credits: 40% Marks** | | |
| L: 4<br>T:<br>P: 4(In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits) | | |

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | **A. Thermodynamics**<br>**1. Classical Thermodynamics**<br>Brief resume of concepts of laws of thermodynamics, free energy, chemical potential and entropies. Partial molar properties, partial molar free energy, partial molar volume and partial molar heat content and their significances. Determinations of these quantities. Concept of fugacity and determination of fugacity. | 30 |
| II | **2. Statistical Thermodynamics**<br>Concept of distribution, thermodynamic probalility and most probable distribution. Ensemble averaging, postulates of ensemble averaging. Canonical, grand canonical and micro canonical ensembles, corresponding distribution laws (using Lgrange's method of undetermined multipliers).<br>Partition functions – translational, rotational, vibrational and electronic partition functions, calculation of thermodynamic properties in terms of partition functions. Applications of partition functions.<br>Heat capacity behavior of solids – chemical equilibria and equilibrium constants in terms of partition functions, Fermi – | |

| | | |
|---|---|---|
| | dirac statistics, distribution law and applications to metal. Bose Einstein statistics distribution law and application to helium. | |
| III | **3. Non Equilibrium Thermodynamics**<br>Thermodynamic criteria for non-equilibrium states, entropy production and entropy flow, entropy balance equations for different irreversible processes (e.g., heat flow, chemical reaction etc.) transformations of the generalized fluxes and force, non-equilibrium stationary states, phenomological equations, microscopic reversibility. | |
| IV | **B. Quantum chemistry**<br>**1. Introduction to Exact Quantum Mechanical Results**<br>The Schrodinger equation and the postulates of quantum mechanics. Discussion of solutions of the Schrodinger equation to some model systems viz., particle in a box, the harmonic oscillator, the rigid rotor, the hydrogen atom. | 30 |
| V | **2. Approximate Methods**<br>The variation theorem, linear variation principle, Perturbation theory (first order and non-degenerate).Applications of variation method and perturbation theory to the Helium atom.<br>**3. Angular Momentum**<br>Ordinary angular momentum, generalized angular momentum, Eigen functions for angular momentum, Eigen values of angular momentum, operator using ladder operators. Addition of angular momenta, spin, Anti-symmetry and Pauli's exclusion principle.<br>**4. Electronic Structure of Atoms**<br>Electronic configuration, Russell –Saunders terms and coupling schemes, Slater – condon parameters, term separation energies of the Pn configuration, term separation energies for the dn configurations, magnetic effects: spin – orbit coupling and Zeeman splitting, introduction to the methods of self-consistent field, the virial theorem.<br>**5. Molecular Orbital theory**<br>Huckel theory of conjugated systems, bond order and charge density calculations. Applications to ethylene, butadiene, cyclopropenyl radical, cyclobutadieneetc. Introduction to extended Huckel theory. | |

**Reference / Text Books:**

1. Advanced physical Chemistry, S. N. Blinder, The Macmilan Company.
2. Thermodynamics of Irreversible Processes, IilaPrigofine.
3. Thermodynamics, R.C. Srivatsava, S. Saha and A.K. Jain, Prentice-Hall, India
4. Physical Chemistry (5th Ed.), I.N. Levine, Tata McGraw Hill Pub. Co. Ltd., New Delhi.
5. Lowe, J. P. & Peterson, K. Quantum Chemistry Academic Press (2005).
6. Mc Quarrie, D. A. Quantum Chemistry Viva Books Pvt Ltd.: New Delhi (2003).

7. Pilar F. L. Elementary Quantum Chemistry 2nd Ed., Dover Publication Inc.: N.Y. (2001).
8. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry 8th Ed., Oxford University Press (2006).
9. Levine, I. L. Quantum Chemistry 5th Ed., Prentice-Hall Inc.: New Jersey (2000).
10. Engel, T. & Reid, P. Physical Chemistry Benjamin-Cummings (2005).
11. Mc Quarrie, D. A. & Simon, J. D. Physical Chemistry: A Molecular Approach 3rd Ed., Univ. Science Books (2001).

If the course is available as Generic Elective then the students of following departments may opt it.

1. B. Tech.
2. Diploma
3. B. Pharm.
4. D. Pharm.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/Sessional Examination<br>2) Assignments<br>3) ESE | 25<br>5<br>70 |
| **Total:** | **100** |

Prerequisites for the course: PCM in 12th

**Course/Learning Outcomes:**

Students will be expected to gain knowledge on the basic skill for understanding of chemical systems and its phenomena at the atomic and molecular level through the principles of quantum chemistry.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: I / Semester: I**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. Class: M.Sc. (Chemistry) | Year: I<br>Semester: I |
| **Credits: 02**<br>Theory: 0<br>Practical: 02 | **Subject: Chemistry** |
| **Course Code: MSCY-113P** | **Title: Physical chemistry Lab-I** |
| **Course Objective**: To practically apply the concepts learn in physical chemistry. | |
| Nature of Paper: **Core** | |
| **Minimum Passing Marks/Credits: 50% Marks** | |
| L: 4<br>T:<br>P: 4 (In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits) | |

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | 1. To find out the strength of the given HCl solution by titrating it against N/10 NaOH using pH meter.<br>2. To find out the strength of the given $CH_3COOH$ solution any titrating it against N/10 NaOH using pH meter.<br>3. To find out the strength of HCl and $CH_3COOH$ in a mixture of both by titrating it against N/10 NaOH using pH meter.<br>4. To determine the solubility of a give salt at room temperature and also draw its solubility curve.<br>5. To find out the heat of solution of oxalic acid by solubility method.<br>6. To standardize the give $KMnO_4$ solution by titrating it against Standard Ferrous Ammonium Sulphate solution. | |

**Reference / Text Books:**


1. Vogel's Qualitative Inorganic Analysis, revised, svehla, Orient Longman.
2. Vogel's Textbook of Quantitative Inorganic Analysis (revised), J. Bassett, R.C. Denney, G.H. Jeffery and J. Mendham, ELBS.
3. Experiments in General Chemistry, C.N.R. Rao and U.C. Agarwal, East-West Press.


If the course is available as Generic Elective then the students of following departments may opt it.
1. B. Tech.
2. Diploma
3. B. Pharm.

| 4. D. Pharm. | |
|---|---|
| **Evaluation/Assessment Methodology** | |
| | **Max. Marks** |
| 1) Class tasks/ Sessional Examination<br>2) Assignments<br>3) ESE | 10<br>10<br>30 |
| **Total:** | **50** |
| Prerequisites for the course: PCM in $12^{th}$ | |
| **Course Outcomes:** After completion of experiments students learn the Quantitative analysis. | |

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: I/ Semester: I**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. Class: M.Sc. (Chemistry) | Year: I<br><br>Semester: I |
| **Credits: 02**<br>Theory: 02 | **Subject: Chemistry** |
| **Course Code: MSCY-114M** | **Title: Mathematics for Chemists** |
| Nature of Paper : **SEC** | |
| **Minimum Passing Marks/Credits: 40% Marks** | |
| L: 4<br>T:<br>P: 4(In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits) | |

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | **Vectors**<br>Vectors, dot, cross and triple products etc. the gradient, divergence and curl vector calculus, Gauss' theorem, divergence theorem etc | 5 |
| II | **Matrix Algebra**<br>Addition and multiplication, inverse, adjoint and transpose of matrices, special matrices (Symmetric, skew-symmetric, hermitian, skew-Hermitian, unit, diagonal, unitary etc.) and their properties. Matrix equations: Homogeneous, non – homogeneous linear equations and conditions for the solutions, linear dependence and independence.<br>Introduction to vector spaces, matrix Eigen values and Eigen vectors, diagonalization determinants (examples from Huckel theory).<br>Introduction to tensors; polarizability and magnetic susceptibility as examples. | 5 |
| III | **Differential Calculus**<br>Functions, continuity and differentiability, rules for differentiation, applications of differential calculus including maxima and minima (examples related to maximally populated rotational energy levels, Bohr's radius and most probable velocity from Maxwell's distribution etc.) exact and inexact differentials with their applications to thermodynamic properties.<br>Integral calculus, basic rules for integration, integration by parts, partial fraction and substitution. Reduction formulae, applications of integral calculus. Functions of several variables, partial differentiation, | 10 |

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|---|---|---|
| | co-ordinate transformations (e.g. Cartesian to spherical polar), curve sketching. | |
| IV | **Elementary Differential Equations**<br>Variable separable and exact first order differential equations, homogeneous, exact and linear equations. Applications to chemical kinetics, secular equilibria, quantum chemistry etc., Solutions of differential equations by the power series method, Fourier series, solutions of harmonic oscillators and Legendre equation etc., spherical harmonics, second order differential equations and their solutions. | 7 |
| V | **Permutation and Probability**<br>Permutations and combinations, probability and probability theorems, probability curves, average, root mean square and most probable errors, examples from the kinetic theory of gases etc., curve fitting (including least squares fit etc.) with a general polynomial fit. | 3 |

**Reference / Text Books:**

1. The Chemistry Mathematics Books, E. Steiner, Oxford University Press.
2. Mathematics for Chemistry, Doggett and Sucliffe, Longman.
3. Mathematical preparation for Physical Chemistry, F. Daniels, McGraw Hill.
4. Chemical Mathematics, D. M. Hirst, Longman.
5. Applied Mathematics for Physical Chemistry, J. P. Barrante, Prentice Hall.
6. Basic Mathematics for Chemists, Tebbutt, Wiley.

If the course is available as Generic Elective then the students of following departments may opt it.
1. B. Tech.
2. Diploma
3. B. Pharm.
4. D. Pharm.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 10 |
| 2) Assignments | 5 |
| 3) ESE | 35 |
| **Total:** | **50** |

Prerequisites for the course: PCM in $12^{th}$

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: I/ Semester: I**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. Class: M.Sc. (Chemistry) | Year: I<br>Semester: I |
| **Credits: 02** Theory: 02 | **Subject: Chemistry** |
| **Course Code: MSCY-114B** | **Title: Biology for Chemists** |
| Nature of Paper: **SEC** | |
| **Minimum Passing Marks/Credits: 40% Marks** | |
| L: 4<br>T:<br>P: 4(In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits) | |

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | **Cell Structure and Functions**<br>Structure of prokaryotic and eukaryotic cells; Intracellular organelles and their functions; Comparison of plant and animal cells; Overview of metabolic process catabolism and anabolism; ATP – the biological energy currency. | 5 |
| II | **Carbohydrates**<br>Conformation of monosaccharide's; Structure and functions of important derivatives of monosaccharides like glycosides; Deoxy sugars, myoinositol, amino sugars; N aceylmuramic acid, sialic acid and disaccharides polysaccharides, Structural polysaccharides- cellulose and chitin; Storage polysaccharides - starch and glycogen; Ascorbic acid, Carbohydrate metabolism:Kreb's cycle; Glycolysis, Glycogenesis and Glycogenolysis, Pentosephosphate pathway.<br>Introduction to vector spaces, matrix Eigen values and Eigen vectors, diagonalization determinants (examples from Huckel theory).<br>Introduction to tensors; polarizability and magnetic susceptibility as examples. | 8 |
| III | **Lipids**<br>Fatty acids, Essential fatty acids; Structures and function of triglycerides; Glycerophspholipids; Sphingolipids, Cholesterol, Bile acids, Prostaglandins; Lipoproteins composition and function; Properties of lipid aggregates– micelles, Bilayers, Liposomes and their possible biological functions; Biological members; Fluid mosaic model | 6 |

| | | |
|---|---|---|
| | of membrane structure. | |
| IV | **Amino acids, Peptides and Proteins**<br>Chemical and enzymatic hydrolysis of proteins to peptides, Secondary structure of proteins, forces responsible for holding secondary structures. α-helix, α -sheets, super secondary structure, triple helix structure of collagen. Tertiary structure of protein folding and domain structure, Quaternary structure.Amino acid metabolism – degradation and biosynthesis of amino acids, sequence determination; chemical / enzymatic.Mass spectral, racemization/ detection. | 6 |
| V | **Nucleic acids**<br>Purine and Pyrimidine of nucleic acids and their synthesis; Base pairing via H–bonding; Structure of ribonucleic acids (RNA) and deoxyribonucleic acid (DNA); Double helix model of DNA and forces responsible for holding it; Chemical and enzymatic hydrolysis of nucleic acids; The chemical basis for heredity, An overview of replication of DNA; Transcription, Translation and genetic code; Chemical synthesis of mono and poly nucleosides. | 5 |

**Reference / Text Books:**


1. Principles of Biochemistry, A.L. Lehninger, Worth Publishers.
2. Biochemistry, L. Stryer, W.H. Freeman.
3. Biochemistry, J. David Rawn, Neil Patterson.
4. Biochemistry, Voet and Voet, john Wiley.


If the course is available as Generic Elective then the students of following departments may opt it.

1. B. Tech.
2. Diploma
3. B. Pharm.
4. D. Pharm.

**Evaluation/Assessment Methodology**

| **Max. Marks** | |
|---|---|
| 1) Class tasks/ Sessional Examination<br>2) Assignments<br>3) ESE | 10<br>5<br>35 |
| **Total:** | **50** |

Prerequisites for the course: PCM in $12^{th}$

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: I/ Semester: II**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D.<br>Class: M.Sc. (Chemistry) | Year: I<br><br>Semester: II |
| **Credits: 04**<br>Theory: 04<br>Practical: 0 | **Subject: Chemistry** |
| **Course Code: MSCY-121** | **Title: Inorganic chemistry-II** |

**Course Objective:** To provide the advanced knowledge on stereochemistry, bonding and reaction mechanism of the transition metal complexes.

Nature of Paper: **Core**

**Minimum Passing Marks/Credits: 40% Marks**

L: 4
T:
P: 4(In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits)

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | **Electronic Spectra and Magnetic Transition Metal Complexes12Hrs.**<br>Spectroscopic ground states, correlation, Orgel and Tanabe-Sugano diagrams for transition metal complexes ($d^1$-$d^9$ states), calculations of Dq, B and □ parameter sparameters, charge transfer spectra, spectroscopic method of assignment of absolute configuration in optically active metal chelates and their stereochemical information, anomalous magnetic moments, magnetic exchange coupling and spin crossover. | 12 |
| II | **Metal π Complexes**<br>nitrosyl, dinitrogen and dioxygen complexes, tertiary phosphine as Ligand. | 12 |
| III | **Metal clusters**<br>Higher bornes, carboranes, metalloboranes and metallocarboranes. Metal carbonyl and halide clusters, compounds with metal-metal multiple bonds. | 18 |
| IV | **Nuclear Chemistry**<br>Radioactive decay &equilibrium. Nuclear Reactions, Q-value cross-sections, types of reactions, Chemical effects of nuclear transformations. Fission& Fusion, Fission products & Fission yields. Radioactive techniques, tracer techniques. | 18 |

**Reference / Text Books:**

1. Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson, John Wiley.
2. Inorganic Chemistry, J.E. Huhey, Harpes and Row.
3. Chemistry of the Elements, N.N. Greenwood and A. Earnshaw, pergamon.
4. Inorganic Electronic Spectroscopy, A.B.P. Lever, Elsevier.

If the course is available as Generic Elective then the students of following departments may opt it.

1. B. Tech.
2. Diploma
3. B. Pharm.
4. D. Pharm.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 25 |
| 2) Assignments | 5 |
| 3) ESE | 70 |
| **Total:** | **100** |

Prerequisites for the course: PCM in $12^{th}$

**Course Outcomes:**

The student will be able to learn:

Stereochemistry and bonding aspects of many group elements. The students will be able to explain the reaction mechanism of transition metal complexes and factors affecting it and can develop generalized idea of application in the field of medicine, pharmacy, polymer chemistry and Agriculture etc.

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: I / Semester: II**

| | |
|---|---|
| **Programme:**<br>Certificate/Diploma/Degree/UG(R)/PG/Ph.D.<br>Class: M.Sc. (Chemistry) | Year: **I**<br><br>Semester: II |
| **Credits: 02**<br>Theory: 0<br>Practical: 02 | **Subject: Chemistry** |
| **Course Code: MSCY-121P** | **Title: Inorganic chemistry Lab-II** |
| **Course Objective:** To practically apply the concepts learnt about Complexometric titrations and to optimize errors arising from various sources in titrimetric estimations. | |
| Nature of Paper: **Core** | |
| **Minimum Passing Marks/Credits: 50% Marks** | |
| L:<br>T:<br>P: 4 (In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits) | |

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | **Volumetric Analysis**<br>1. Acidimetry – alkalimetry titration.<br>2. Oxidation reduction titration.<br>3. Complexometric – EDTA titration.<br>4. pH-metric titration.<br>5. Precipitation titration. | |
| II | **Separation of metal**<br>1. To estimate iron and nickel in a given solution.<br>2. To estimate copper and nickel in the given solution | |

**Reference / Text Books:**


1. Vogel's Qualitative Inorganic Analysis, revised, svehla, Orient Longman.
2. Vogel's Textbook of Quantitative Inorganic Analysis (revised), J. Bassett, R.C. Denney, G.H. Jeffery and J. Mendham, ELBS.
3. Experimental Inorganic Chemistry, W.G. Palmer, Cambridge.
4. Laboratory Manuel in Organic Chemistry, R.K. Bansal, Wiley Eastern.
5. Experiments in General Chemistry, C.N.R. Rao and U.C. Agarwal, East-West Press.


If the course is available as Generic Elective then the students of following departments may opt it.
1. B. Tech.
2. Diploma
3. B. Pharm.

| | |
|---|---|
| 4. D. Pharm. | |
| **Evaluation/Assessment Methodology** | |
| | **Max. Marks** |
| 1) Class tasks/ Sessional Examination<br>2) Assignments<br>3) ESE | 10<br>10<br>30 |
| **Total:** | **50** |
| Prerequisites for the course: PCM in 12th | |
| **Course Outcome:** After performing this lab students will be able to do:<br>1. Qualitative and Quantitative analysis of inorganic compounds<br>2. Quantitative analysis of d-block elements. | |

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: I/ Semester: II**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D.<br>Class: M.Sc. (Chemistry) | Year: I<br><br>Semester: II |
| **Credits: 04**<br>Theory: 04<br>Practical: 0 | **Subject: Chemistry** |
| **Course Code: MSCY-122** | **Title: Organic chemistry-II** |
| Nature of Paper: **Core** | |
| **Minimum Passing Marks/Credits: 40% Marks** | |
| L: 4<br>T:<br>P: 4(In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits) | |

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | **Aromatic Electrophilic Substitution**<br>The areniumion mechanism, orientation and reactivity, energy profile diagrams, Theortho/para ratio, ipso attack, orientation in other ring systems. Quantitative treatment of reactivity in substrates and electrophiles. Diazonium coupling, Vilsmeir reaction, Gattermann-Koch reation. | 6 |
| II | **Aromatic Nucleophilic Substitution**<br>The SNAr, $SN^1$, benzyne and $SRN^1$ mechanisms. Reactivity - effect of substrate structure, leaving group and attacking nucleophile. The von Richter, Sommelet-Hauser and Smiles Rearrangements, | 5 |
| III | **Free Radical Reaction**<br>Types of free radical reactions, free radical substitution mechanism, mechanism at an aromatic substrate, neighbouring group assistance. Reactivity for aliphatic and aromatic substrates at a bridgehead. Reactivity in the attacking radicals.The effect of solvents on reactivity. Allylic halogenations (NBS), oxidation of aldehydes to carboxylic acids, auto-oxidation, coupling of alkynes and arylation of aromatic compounds by diazonium salts. Sandmeyer reaction. Free radical rearrangement. Hunsdiecker reaction. | 8 |
| IV | **Addition to Carbon – Carbon Multiple Bonds**<br>Mechanistic and stereochemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals, regio and | 6 |

| | | |
|---|---|---|
| | chemoselectivity, orientation and reactivity. Addition to cyclopropanering. Hydrogenation of double and triple bonds, hydrogenation of aromatic rings. Hydroboration, Michael reaction, Sharpless asymmetric epoxidation. | |
| V | **Elimination Reactions**<br>The $E^2$, $E^1$ and $E^1$CB mechanisms and their spectrum. Orientation of the double bond. Reactivity - effects of substrate structures, attacking base, the leaving group and the medium. Mechanism and orientation in pyrolytic elimination. | 5 |
| VI | **Pericyclic reactions**<br>Molecular orbital symmetry, Frontier orbitals of ethylene, 1,3-butadiene, 1,3,5-hexatriene and allyl system. Classification of pericyclic reactions. Woodward-Hoffmann correlation diagrams. FMO and PMO approach. Electrocyclic reactions-conrotatory and disrotatory motions, 4n, 4n+2 and allyl systems. Cycloadditions-antarafacial and suprafacial additions, 4n and 4n+2 systems, 2+2 addition of ketenes, 1,3 dipolar cycloadditions and cheleotropic reactions.<br>Sigmatropic rearrangement, - Suprafacial and antarafacial shifts of H, Sigmatropic shifts involving carbon moieties, 3,3- and 5,5-Sigmatropic rearrangements. Claisen, Cope, Sommelet Hauser Rearrangement, Ene reaction. | 18 |

**Reference / Text Books:**

1. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Orient longman.
2. Organic Reaction Mechanism, R. Breslow, Benjamin.
3. Mechanism and Structure in Organic Chemistry, B.S. Gould, (Holt Reinh).

If the course is available as Generic Elective then the students of following departments may opt it.

1. B. Tech.
2. Diploma
3. B. Pharm.
4. D. Pharm.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 25 |
| 2) Assignments | 5 |
| 3) ESE | 70 |
| **Total:** | **100** |

Prerequisites for the course: PCM in $12^{th}$

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: I/ Semester: II**

| | |
|---|---|
| **Programme:**<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>Class: M.Sc. (Chemistry) | Year:**I**<br><br>Semester: **II** |
| **Credits: 02**<br>Theory: 0<br>Practical: 02 | **Subject: Chemistry** |
| **Course Code:**<br>**MSCY-122P** | **Title: Organic chemistry Lab-II** |

**Course Objective:** To practically apply the concepts learnt about separation of organic compounds and their identification.

Nature of Paper: **Core**

**Minimum Passing Marks/Credits: 50% Marks**

L:<br>T:<br>P: 4 (In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | 1. Analysis of binary organic mixtures<br>a) Sepration with $NaHCO_3$<br>b) Separation with NaOH<br>c) Sepration with HCl | |
| II | 2. Two steps preparations:<br>1) To prepare anthranilic acid from phthalic anhydride.<br>2) To prepare o-chlorobenzoic acid from phthalamide.<br>3) To prepare benzyl from Benzaldehyde.<br>4) To prepare benzanilide from Benzophenone. | |

**Reference / Text Books:**

1. Laboratory Manuel in Organic Chemistry, R.K. Bansal, Wiley Eastern.
2. Experiments in General Chemistry, C.N.R. Rao and U.C. Agarwal, East-West Press.

If the course is available as Generic Elective then the students of following departments may opt it.
1. B. Tech.
2. Diploma

| **Evaluation/Assessment Methodology** | |
|---|---|
| | **Max. Marks** |
| 1) Class tasks/ Sessional Examination<br>2) Assignments<br>3) ESE | 10<br>10<br>30 |
| **Total:** | **50** |
| Prerequisites for the course: PCM in $12^{th}$ | |

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: I/ Semester: II**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D.<br>Class: M.Sc. (Chemistry) | Year: I<br><br>Semester: II |
| **Credits: 04**<br>Theory: 04<br>Practical: 0 | **Subject: Chemistry** |
| **Course Code: MSCY-123** | **Title: Physical chemistry-II** |

**Course Objectives:** Chemical kinetics consists of basic concept of order of the reaction, molecularity, and ratelaw. The impact of temperature on the rate of reaction & determination of rate constant. The physical & chemical reactions have been explained through collision theory, Activated complex theory & kinetics of complex reaction. The potential energy surface & reaction mechanism are of great interest. The theories of unimolecular gaseous reactions and their applications of state theory to unimolecular decomposition. The statistical & mechanical derivation of rate constant of a gaseous bimolecular reactions have been used using TST.

Nature of Paper: **Core**

**Minimum Passing Marks/Credits: 40% Marks**

L: 4
T:
P: 4(In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits)

| Unit | Contents | No. of Lectures Allotted | Actual Lecture taken |
|---|---|---|---|
| I | **Chemical Dynamics:**<br>Methods of determining rate laws, collision theory of reaction rates, steric factor, activated complex theory, Arrhenius equation and the activated complex theory; ionic reactions, kinetic salt effects, steady state kinetics, kinetic and thermodynamic control of reactions, treatment of unimolecular reactions.<br>Dynamic chain (hydrogen-bromine reaction, pyrolysis of acetaldehyde, decomposition of ethane), photochemical (hydrogen-bromine and hydrogen-chlorine reactions) and oscillatory reactions (Belousov-Zhabotinsky reaction), homogeneous catalysis, kinetics of enzyme, reactions, general features of fast reactions, study of fast reactions by flow method; relaxation method, flash photolysis and the nuclear magnetic resonance method. Dynamics of | 20 | 16 |

| | | | |
|---|---|---|---|
| | molecular motions, probing the transition state, dynamics of unimolecular reactions (Lindemann Hinshelwood and Rice-Ramsperger - Kassel- Marcuss[RRKM] theories of unimolecular reactions. | | |
| II | **Surface Chemistry Adsorption:** Surface tension, capillary action, pressure difference across curved surface (Laplace equation), vapour pressure of droplets (Kelvin equation), Gibbs adsorption isotherm, estimation of surface area (BET equation), Elementary treatment of BET Equation, catalytic activity at surfaces<br>**Macromolecules:**<br>Polymer-definition, types of polymers, kinetics of radical polymerization, mechanism of polymerization. Molecular mass, number and mass average molecular mass, molecular mass determination (Elementary treatment of Osmometry, Viscometry, Sedimentation and Light scattering methods), chain configuration of macromolecules, calculation of average dimensions of various chain structures. | 20 | 20 |
| III | **Electrochemistry:**<br>Electrochemistry of solutions: Debye-Huckel - Onsager treatment and its extension, ion solvent interactions. Debye-Huckel-Jerummode. Thermodynamics of electrified interface equations. Derivation of electro-capillarity, Lippmann equations (surface excess), methods of determination. Structure of electrified interfaces. Guoy-Chapman, Stern.<br>Over potentials, exchange current density, derivation of Butler Volmer equation, Tafel plot. Quantum aspects of charge transfer at electrodes-solution interfaces, quantization of charge transfer, tunneling, Semiconductor interfaces-theory of double layer at Semiconductor, electrolyte solution interface, structure of double layer interfaces. Electrocatalysis: influence of various parameters. Hydrogen electrode. Bio-electrochemistry, Polarography theory, Ilkovic equation, half wave potential and its significance.<br>Introduction of corrosion, homogenous theory, forms of corrosion, corrosion monitoring and prevention methods. | 20 | 20 |

**Reference / Text Books:**

1. Advanced physical Chemistry, S. N. Blinder, The Macmilan Company.
3. Physical Chemistry, P.W. Atkins, ELBS.
4. Kinetics and Mechanism of Chemical Transformations, J. Rajaraman and J. Kuriacose, McMillan.
5. Modern Electrochemistry Vol. I & II, J.O.M. Bockris and A.K.N. Reddy, Plenum

| | |
|---|---|
| 6. Physical Chemistry (5th Ed.), I.N. Levine, Tata McGraw Hill Pub. Co. Ltd., New Delhi. | |
| If the course is available as Generic Elective then the students of following departments may opt it.<br>1. B. Tech.<br>2. Diploma<br>3. B. Pharm.<br>4. D. Pharm. | |
| **Evaluation/Assessment Methodology** | |
| | **Max. Marks** |
| 1) Class tasks/ Sessional Examination<br>2) Assignments<br>3) ESE | 25<br>5<br>70 |
| **Total:** | **100** |
| Prerequisites for the course: PCM in $12^{th}$ | |
| **Course Outcome**:<br>Chemical kinetics is of great interest to know the rate of reactions. The rate of complex reaction is determined by slow step of the complex reaction. The rate law has given experimental proof to express the order of the reactions. The reaction rates have been studied by different theories. Potential energy surface & reaction mechanism are used to calculate molecular dynamics. The partition function & chemical equilibrium are very important to understand RRK & RRKM theories. The rate constant of gaseous bimolecular reactions has been determined using TST. | |

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: I/ Semester: II**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. Class: M.Sc. (Chemistry) | Year:**I** Semester: **II** |
| **Credits: 06** Theory: 04 Practical: 02 | **Subject: Chemistry** |
| **Course Code: MSCY-123P** | **Title: Physical chemistry Lab-II** |

**Course Objective:** The course content consists of the determination of strength of acids & bases using conductivity meter, potentiometer & to determine the parachors and surface tension.

Nature of Paper: **Core**

**Minimum Passing Marks/Credits: 50% Marks**

L: 4
T:
P: 4 (In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | 1. To determine the relative strengths of two acids i.e., HCl and $H_2SO_4$ by studying the hydrolysis of methyl acetate.<br>2. To find out the rate constant of the hydrolysis of methyl acetate catalysed by (i) HCl and (ii) $H_2SO_4$.<br>3. To find out the strength of HCl solution by titrating it against N/10 NaOH using conductometer.<br>4. To find out the strength of given $NH_4OH$ solution by titrating it against HCl solution using Conductometer.<br>5. To determine the parachor value of given liquid.<br>6. To find out the surface tension of $CH_3COOH$, $C_2H_5OH$, n-Hexane at room temperature and hence calculate the atomic parachors of C, H and O.<br>7. To find out the surface tension of the given liquid by drop weight method at room temperature.<br>8. To titrate a given solution of HCl with 0.1 M molar using Hydrogenelectrode. | |

**Reference / Text Books:**

1. Vogel, A. I. Vogel's Qualitative Inorganic Analysis - 7th ed. (revised by G. Svehla) Longmans (1996) ISBN 058-221866-7

2. Vogel, A. I. Vogel's Textbook of Quantitative Chemical Analysis - 5th Ed. Longman (1989).
3. Daniels, F., Williams, J. W., Bender, P., Alberty, R. A., Cornwell, C. D. & Harriman, J. E. Experimental Physical Chemistry, McGraw-Hill (1962).
4. Das & R. C. & Behera, B., Experimental Physical Chemistry, Tata McGraw-Hill Publishing Co. Pvt. Ltd. (1993).
5. Shoemaker, D. P., Garland, C. W. & Nibler, J. W. Experiments in Physical Chemistry, McGraw-Hill: New York (1996).
6. Day, R. A., Jr. & Underwood, A. L. Quantitative Analysis 3rd Ed. Prentice-Hall India Pvt. Ltd.: New Delhi (1977).
7. Burns, D. T. & Rattenbury, E. M. Introductory Practical Physical Chemistry Pergamon Press (1966)
8. Harris, D. C. Quantitative Chemical Analysis 6th Ed. W. H. Freeman & Co. (2002).

If the course is available as Generic Elective then the students of following departments may opt it.
1. B. Tech.
2. Diploma
3. B. Pharm.
4. D. Pharm.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 10 |
| 2) Assignments | 10 |
| 3) ESE | 30 |
| **Total:** | **50** |

Prerequisites for the course: PCM in $12^{th}$

**Course Outcomes:** After performing this lab student will be able to determine the strength of acids &bases using conductivity meter, potentiometer & surface tension using stalagmometer and parachor value.

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: I/ Semester: II**

| | |
|---|---|
| **Programme:**<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>Class: M.Sc. (Chemistry) | Year: I<br><br>Semester: II |
| **Credits: 02**<br>Theory: 02 | **Subject: Chemistry** |
| **Course Code: MSCY-124** | **Title: Computer for Chemists** |
| Nature of Paper: **SEC** | |
| **Minimum Passing Marks/Credits: 40% Marks** | |
| L: 4<br>T:<br>P: 4(In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits) | |

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | **Introduction to Computers and Computing**<br>Basic structure and functioning of computers with a PC as an illustrative example. Memory, I/O devices. Secondary storage, Computer languages. Operating systems with DOS as an example. Introduction to UNIX and Windows. Data processing, Algorithms and flow-charts. | 10 |
| II | **Computer Programming in C**<br>Elements of the computer language.Constants and variables. Operations and symbols. Expression. Arithmatic assignment statement input and output. Decision control structure such as if, else if, nested if statement while loop, for loop, functions, Switch case, introduction on arrays, programmes based on above.<br>Introduction to vector spaces, matrix Eigen values and Eigen vectors, diagonalization determinants (examples from Huckel theory). | 10 |
| III | **Progamming in Chemistry**<br>Development of small computer course involving simple formula in chemistry such as Vander Waal's equation, pH titration, kinetics, radioactive decay. Evaluation of lattice energy and ionic radii from experimental data. Linear simultaneous equations to solve secular equation within the Huckel Theory. Elementary structural features such as bond lengths, bond angles, dihedral angles etc. of molecule | 10 |

| | | |
|---|---|---|
| | extracted from a data base such as Cambridge database. | |
| IV | **Use of Computer Programmes**<br>Execution of linear regression, X-V Plot, numerical integration and differentiation as well as differential equation solution programmes. Monte-Carlo and molecular dynamics. Introduction to MS Office (MS Word, MS Excel, MS Power Point). Lab sessions based on MS Office package, Introduction to Internet Explorer. | 10 |

**Reference / Text Books:**

1. Computers and Common Sense, R. Hunt and J. Shelly, Prentice Hall.
2. Computational Chemistry, A.C. Norris.
3. Schaum's Outline Series – Theory and Problems of Programming with Fortran Including structured Fortran, S. Lipschutz and A. Poe, McGraw Hill Book Company, Singapore.
4. Computers in Chemistry, K. V. Raman, Tata McGraw Hill (1993).

If the course is available as Generic Elective then the students of following departments may opt it.
1. B. Tech.
2. Diploma
3. B. Pharm.
4. D. Pharm.

| **Evaluation/Assessment Methodology** | |
|---|---|
| | **Max. Marks** |
| 1) Class tasks/ Sessional Examination | 10 |
| 2) Assignments | 5 |
| 3) ESE | 35 |
| **Total:** | **50** |

Prerequisites for the course: PCM in $12^{th}$

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: II/ Semester: III**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D.<br>Class: M.Sc. (Chemistry) | Year: II<br><br>Semester: III |
| **Credits: 04**<br>Theory: 04<br>Practical: 0 | **Subject: Chemistry** |
| **Course Code: MSCY-231** | **Title: Inorganic chemistry-III** |
| **Course Objective:** Structure and bonding issues in organometallic compounds are discussed in view of the18-electron rule. Different reactive ligand types are discussed, including σ-bonded ligands such as alkyl, aryl, hydride, as well as π-bonded ligands such as carbonyl, alkene, diene, alkyne, cyclopentadienyl and arenes. The role of few important organometallic complexes as a catalyst is thoroughly discussed. | |
| Nature of Paper: **Core** | |
| **Minimum Passing Marks/Credits: 40% Marks** | |
| L: 4<br>T:<br>P: 4(In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits) | |

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | The 18-electron rule, counting of electrons and finding metal-metal bonds and related problems. Alkyls Aryls of Transition Metals: Types of synthesis, stability & decomposition Pathways. Carbenes & carbines: Synthesis, nature of bond, structural characteristics. | 8 |
| II | **Transition Metal π-Complexes:** Transition metal π-complexes with unsaturated organic molecules, alkenes, alkynes, allyl, dienyl, arene & trienyl complexes, preparation, properties, nature of bonding & structural features. | 8 |
| III | **Applications of Organometallic Complexes to Catalysis:** Catalysis, Terminology in Hydrogenationcatalysts, classification of hydrogenation catalysts, catalytic cycle of Wilkinson's catalyst, catalytic cycles of iridium and ruthenium based catalysts, hydrogenation by lanthanide organometallic compounds, catalytic asymmetric synthesis, Hydroformylation: Cobalt catalysts and phosphine modified cobalt catalysts, Rhodium-phosphine catalysts, Methanol Carbonylation and Olefin Oxidation: Monsanto, Cativa | 8 |

| | | |
|---|---|---|
| | and Wacker Processes,; Polymerisation and oligomerisation of olefins and dienes, carboxylation of olefins, carbonylation of methanol, Synthetic gas | |
| IV | **Fluxional Organometallic Compound:** Stereo-chemical non-rigidity &fluxionality, stereochemically non-rigid coordination compounds, Trigonalbipyramidal molecules, $\eta^2$-olefins, $\eta^3$ – allyl&dienyl compounds, isomerization & racemization of tris chelate complexes. | 6 |

**Reference / Text Books:**

1. Huheey, J. E. Inorganic Chemistry, Principles of Structure and Reactivity, Harper Inter-Science.
2. Cotton, F. A. and Wilkinson, G. Advanced Inorganic Chemistry,6th edition, Wiley Inter-

If the course is available as Generic Elective then the students of following departments may opt it.

1. B. Tech.
2. Diploma
3. B. Pharm.
4. D. Pharm.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 25 |
| 2) Assignments | 5 |
| 3) ESE | 70 |
| **Total:** | **100** |

Prerequisites for the course: PCM in 12th

The student will have good overview of the fundamental principles of organotransition-metal chemistry and know how chemical properties are affected by metals and ligands. The student will be able to use knowledge about structure and bonding issues to understand the stability and reactivity of simple organometallic complexes.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: II/ Semester: III**

| | | |
|---|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. Class: M.Sc. (Chemistry) | Year: II<br><br>Semester: III | |
| **Credits: 02**<br>Theory: 0<br>Practical: 02 | **Subject: Chemistry** | |
| **Course Code: MSCY-231P** | **Title: Inorganic chemistry Lab-III** | |
| **Course Objective:** It consists of Separation of cations & anions by chromatography & preparation of inorganic complexes. | | |
| Nature of Paper: **Core** | | |
| **Minimum Passing Marks/Credits: 40% Marks** | | |
| L:<br>T:<br>P: 4 (In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits) | | |

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | **I- Chromatography**<br>1. Separation of cations and anions by Paper Chromatography<br>2. Separation of cations and anions by Column Chromatography; Ion exchange | |
| II | **II- Synthesis:**<br>Preparation of selected inorganic compounds and their studies by measurements of decomposition temperature, molar conductance and magnetic susceptibility measurements. (**Any five**)<br><br>1. $[Co(NH_3)_6]$ $[Co(NO_2)6]$<br>2. cis-[Co(trien) (NO2)2]Cl.H2O<br>3. Hg[Co(SCN)4]<br>4. [Co(Py)2Cl2]<br>5. [Ni(NH3)6]Cl2<br>6. [Ni(dmg)2]<br>7. [Cu(NH3)4]SO4· H2O<br>8. Aquabis (acetylacetonato) nitrosylchromium (I), [Cr(NO)(acac)2(H2O)]<br>9. Cis-Bis(glycinato) copper(II) and trans-Bis (glycinato) | |

| | | |
|---|---|---|
| | copper (II)<br>10. Preparation of Zn, Cd and Hg thiocyanates from their respective chlorides<br>11. Bis (benzoylacetonato) copper (II)<br>12. Bis (acetylacetonato) oxovanadium (IV), [VO(acac)2][MoO2(acac)2]<br>13. Hexaammminenickel (II) tetrafluoroborate, [Ni(NH3)6](BF4)2 and determination of nickel content gravimetrically.<br>14. Potassium tris (oxalato) ferrate, K3[Fe(C2O4)3] and determination of oxalate using permanganate. | |

**Reference / Text Books:**


1. Vogel's Qualitative Inorganic Analysis, revised, svehla, Orient Longman.
2. Vogel's Textbook of Quantitative Inorganic Analysis (revised), J. Bassett, R.C. Denney, G.H. Jeffery and J. Mendham, ELBS.
3. Experimental Inorganic Chemistry, W.G. Palmer, Cambridge


If the course is available as Generic Elective then the students of following departments may opt it.

1. B. Tech.
2. Diploma
3. B. Pharm.
4. D. Pharm.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 10 |
| 2) Assignments | 10 |
| 3) ESE | 30 |
| **Total:** | **50** |

Prerequisites for the course: PCM in $12^{th}$

**Course Outcome:** After performing this lab students will be able to do Separation of cations & anions by chromatography & preparation of inorganic complexes.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: I / Semester: III**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. Class: M.Sc. (Chemistry) | Year: II<br><br>Semester: III |
| **Credits: 04** Theory: 04 Practical: 0 | **Subject: Chemistry** |
| **Course Code: MSCY-232** | **Title: Organic chemistry-III** |

**Course Objective**: The course Unit consists of photochemistry & its photochemical reactions like photo reduction & photo-oxidation. Photo physical phenomenon has been applied to study electronic structure of molecules, molecular orbitals & molecules in excited singlet state. The application of chemiluminescence & fluorescence has been applied to study photo-excited donor & acceptor system.

Nature of Paper: **Core**

**Minimum Passing Marks/Credits: 40% Marks**

L: 4
T:
P: 4(In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits)

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | Photochemical Reactions.Interaction of electromagnetic radiation with matter, types of excitations, fate of excited molecule, quantum yield, transfer of excitation energy, actionmetry. | 8 |
| II | Determination of Reaction Mechanism. Classification, rate constants and life times of reactive energy state determination of rate constants of reactions.Effect of light intensity on the rate of photochemical reactions. Types of photochemical reactions-photo dissociation, gas-phase photolysis. | 8 |
| III | Photochemistry of Alkene. Intramolecular reactions of the olefinic bond-geometrical isomerism, cyclisation reactions, rearrangement of 1,4- and 1,5-dienes. Photochemistry of Aromatic Compounds. Isomerization, additions and substitutions. | 8 |
| IV | Photochemistry of Carbonyl Compounds. Intramolecular reactions of carbonyl compounds-saturated, cyclic and acyclic, unsaturated and α, β- | 8 |

| | | |
|---|---|---|
| | unsaturated compounds, cyclohexadiene's. Intermolecularcyclo addition reactions-dimerization and oxetane formation, peterno-butchy. | |
| V | Miscellaneous Photochemical Reactions.Photo-Fries reactions of annelid's, Photo-Fries rearrangement. Bartonreaction. Singlet molecular Oxygen reaction. Photochemical formation of smog.Photodegradation of polymers. Photochemistry of vision. | 8 |

**Reference / Text Books:**

1. Organic Photochemistry by James Morriss Coxon, Brian Halton, [London, New York] Cambridge University Press.
2. Introduction to Organic Photochemistry John D. Coyle, The Open University.
3. Molecular Reactions and Photochemistry by Charles H. De Puy, Orville Lamar Chapman, Pearson Education, Limited.

If the course is available as Generic Elective then the students of following departments may opt it.

1. B. Tech.
2. Diploma
3. B. Pharm.
4. D. Pharm.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 25 |
| 2) Assignments | 5 |
| 3) ESE | 70 |
| **Total:** | **100** |

Prerequisites for the course: PCM in $12^{th}$

**Course Outcomes:** Photochemistry & photochemical laws are of great utility to understand the Beer'lambert's law & its applications. The photochemistry of environment & greenhouse effects is of great applications in plant kingdom. The fluorescence quenching, concentration quenching is of great interest to study photo physical phenomenon.

**Format-3**

# IIMTU-NEP IMPLEMENTATION
## Year: II/ Semester: III

| | |
|---|---|
| **Programme:**<br>Certificate/Diploma/Degree/ UG(R)/PG/Ph.D.<br>Class: M.Sc. (Chemistry) | Year:**II**<br><br>Semester: **III** |
| **Credits: 02**<br>Theory: 0<br>Practical: 02 | **Subject: Chemistry** |
| **Course Code: MSCY-232P** | **Title: Organic chemistry Lab-III** |

**Course Objective:** It consists of quantitative analysis of unknown samples by using spectrophotometer and determination of viscosity at various temperatures.

Nature of Paper: **Core**

**Minimum Passing Marks/Credits: 50% Marks**

L: 4
T:
P: 4 (In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | 1. To verify Lambert's – Beer's Law with the help of UV-Visible spectrophotometer.<br>2. To determine λ max of a given sample.<br>3. To determine the concentration of unknown sample.<br>4. To scan the UV-Vis spectra of unknown sample with the UV-Vis double beam spectrophotometer.<br>5. To determine the dynamic viscosity of polymeric plasticizer at different temperatures with the help of Brukfield viscometer.<br>6. To determine the dynamic viscosity of polymeric plasticizer at different temperatures with the help of Ostwald viscometer.<br>7. To determine formation constant of FeSCN2+ compounds by conductometry.<br>8. To determine rate constants of intermediate complex in the reaction of Cerium (IV) ammonium nitrate and hypophosphoric acid in acid medium. | |

**Reference / Text Books:**


1. Laboratory Manuel in Organic Chemistry, R.K. Bansal, Wiley Eastern.
2. Experiments in General Chemistry, C.N.R. Rao and U.C. Agarwal, East-West Press.


If the course is available as Generic Elective then the students of following departments may opt it

| Evaluation/Assessment Methodology | |
|---|---|
| | **Max. Marks** |
| 1) Class tasks/ Sessional Examination<br>2) Assignments<br>3) ESE | 10<br>10<br>30 |
| **Total:** | **50** |
| Prerequisites for the course: PCM in $12^{th}$ | |
| **Course Outcomes:** After performing this lab student will be able to:<br>1. Quantatively analyse the unknown sample using UV-Visible spectrophotometer.<br>2. Determine the dynamic viscosity at various temperatures. | |

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: II/ Semester: III**

| | | |
|---|---|---|
| **Programme:**<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>Class: M.Sc. (Chemistry) | Year: II/ Semester: III | |
| **Credits: 04**<br>Theory: 04<br>Practical: 0 | **Subject: Chemistry** | |
| **Course Code: MSCY-233** | **Title: Physical chemistry-III** | |
| **Course Objective**: The course Unit consists of photochemistry & its photochemical reactions like photo reduction& photo-oxidation. Photo physical phenomenon has been applied to study electronic structure of molecules, molecular orbitals & molecules in excited singlet state. The application of chemiluminescence & fluorescence has been applied to study photo-excited donor & acceptor system. | | |
| Nature of Paper: **Core** | | |
| **Minimum Passing Marks/Credits: 40% Marks** | | |
| L: 4<br>T:<br>P: 4(In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits) | | |

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | **Mechanism of Absorption and Emission of Radiation of Photochemical Interest**<br>Electronic energy states of atoms; The selection rule, spectroscopic terms for electronic states. notation for excited state of organic molocules, Einstein's treatment of absorption & emission phenomena, Time dependent Schrodinger equation, Intensity of electronic transition, Rules governing the transition between two energy states, d-d transition, charge transfer transition | 20 |
| II | **Photophysical Processes in Electronically Excited Molecules.**<br>Types of photophysical processes, Radiationless transition, Fluorescence emission, Fluorescence & Structure, Triplet State & phosphorescence emission, Emission property and the electronic configuration. Photophysical kinetics of unimolecular processes. | 15 |
| III | **Photophysical Kinetics of Bimolecular Processes.**<br>Kinetic & optical collisions, Biomolecular collision in gases & mechanism of fluorosence quenching, collision in solution, Stern- | 15 |

| | | |
|---|---|---|
| | Volmer equation Concentration dependence of quenching, quenching by foreign substances. | |
| IV | **Photochemical Primary Processes.**<br>Classification of photochemical reaction, rate constants & lifetimes of reactive transition states, light intensity and rate of photochemical reactions, Types of photochemical reaction. | 15 |

**Reference / Text Books:**

1. Principles of Physical Chemistry, P.W. Atkins, Oxford Press.
2. Physical Chemistry, Thomas Engel, Philip Reid, Pearson Education (2006)
3. Fundamental of photochemistry, K. K. Rohatgi – Mukherjee, New Age International, 2008.

If the course is available as Generic Elective then the students of following departments may opt it.

1. B. Tech.
2. Diploma
3. B. Pharm.
4. D. Pharm.

| **Evaluation/Assessment Methodology** | |
|---|---|
| | **Max. Marks** |
| 1) Class tasks/ Sessional Examination | 25 |
| 2) Assignments | 5 |
| 3) ESE | 70 |
| **Total:** | **100** |

Prerequisites for the course: PCM in $12^{th}$

**Course Outcomes:**

Photochemistry & photochemical laws are of great utility to understand the Beer'slambert's law & its applications. The photochemistry of environment & greenhouse effects is of great applications in plant kingdom. The fluorescence quenching, concentration quenching is of great interest to study photo physical phenomenon.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: II/ Semester: III**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. Class: M.Sc. (Chemistry) | Year:**II** Semester: **III** |
| **Credits: 02** Theory: 0 Practical: 02 | **Subject: Chemistry** |
| **Course Code: MSCY-233P** | **Title: Physical chemistry Lab-III** |
| **Course Objective:** The course content consists of the determination of strength of acids & bases using conductivity meter, potentiometer & to determine the parachor value and surface tension. | |
| Nature of Paper: **Core** | |
| **Minimum Passing Marks/Credits: 50% Marks** | |
| L: T: P: 4 (In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits) | |

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | 1. Determine the intensity of light from a UV source using the reaction between $Fe^{3+}$and oxalate ions by photosensitization-Ferrioxalateactinometer.<br>2. (a) Study the photochemical decomposition reaction of cyclohexanone pH-metrically.<br>(b) Study the above reaction conductometrically.<br>3. Prepare the transition metal complex cyano acid of potassium ferrocyanide (or ferricyanide) by the ion-exchange method.<br>(a) Determine the nature of this acid by the conduct metric method.<br>(b) Study the titration curves of the photolyzed acid (UV radiation), and suggest a possible mechanism for its decomposition.<br>4. To determine the molecular weight of a high polymer (polystyrene) from viscosity measurement with the help of ostwald's viscometer.<br>5. To determine freezing point depression constants of camphor using naphthalene as the solute. Hence determine the molecular weight of acetanilide by Rast's method.<br>6. To determine the concentration of a given solution of an optically active compound by polarimetric measurements. | |

| | | |
|---|---|---|
| | 7. To study the inversion of cane sugar in presence of HCl at 30 °C.<br>8. To determine the basicity of an organic acid by conductometric method.<br>9. To titrate a mixture of HCl and $CH_3COOH$ potentiometrically.<br>10. To determine the pH of a number of buffer solutions using hydrogen electrode.<br>11. To study the kinetics of saponification of ethyl acetate by sodium hydroxide at two temperatures by conductance measurements. Hence determine the energy of activation of the reactions. | |

**Reference / Text Books:**

1. Daniels, F., Williams, J. W., Bender, P., Alberty, R. A., Cornwell, C. D. & Harriman, J. E. Experimental Physical Chemistry, McGraw-Hill (1962).
2. Das & R. C. &Behera, B., Experimental Physical Chemistry, Tata McGraw-Hill Publishing Co. Pvt. Ltd. (1993).
3. Shoemaker, D. P., Garland, C. W. &Nibler, J. W. Experiments in Physical Chemistry, McGraw-Hill: New York (1996).
4. Harris, D. C. Quantitative Chemical Analysis 6th Ed. W. H. Freeman & Co. (2002).
5. Willard, H. H., Merritt, L. L., Dean, J. A. & Settle, F. A. (Eds.) Instrumental Methods of Analysis - 7th Ed., Wadsworth Publishing (February 1988) ISBN 0534081428

If the course is available as Generic Elective then the students of following departments may opt it.

1. B. Tech.
2. Diploma
3. B. Pharm.
4. D. Pharm.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 10 |
| 2) Assignments | 10 |
| 3) ESE | 30 |
| **Total:** | **50** |

Prerequisites for the course: PCM in $12^{th}$

**Course Outcomes:**

After performing this lab student will be able to determine the strength of acids &bases using conductivity meter, potentiometer & surface tension using stalagmometer and parachor value.

**IIMTU-NEP IMPLEMENTATION**
**Year: II/ Semester: III**

| | |
|---|---|
| **Programme:**<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>Class: M.Sc. (Chemistry) | Year: II/<br><br>Semester: III |
| **Credits: 04**<br>Theory: 04 | **Subject: Chemistry** |
| **Course Code: MSCY-2311** | **Title: Bio-inorganic & Supra molecular Chemistry** |

**Course Objective**: This course content consists of bio inorganic chemistry of alkali & alkaline earth metal &their importance in biological systems of Plant, animals & human beings. Iron & copper are of great importance in our physiological processes. Iron is the main constituent of haemoglobin & copper catalyse a large number of biological reactions. Nitrogen fixation in nature plays a important role in soil changing ammonia into nitrates which are absorbed by the plants. Trace elements called micronutrients are also important for biodegradation of minerals by bacteria.

Nature of Paper: **Core**

**Minimum Passing Marks/Credits: 40% Marks**

L: 4
T:
P: 4(In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits)

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | **Bioinorganic Chemistry of Alkali and Alkaline Earth Metals:** Essential and trace elements inbiological systems; Structure and functions of biological membranes; mechanism of ion transport across membranes; Sodium pump; Ionophores: valinomycin and crown ether complexes of $Na^+$ and $K^+$; ATP and ADP; Photosynthesis: chlorophyll a PS I and PS II; Role of calcium in muscle contraction; Blood clotting mechanism and biological calcification. | 8 |
| II | **Bioinorganic Chemistry of Iron and Copper:** Iron-sulphur proteins: Rubredoxin and ferredoxins; Metalloporphyrins; Heme proteins: hemoglobin, Structure and Mechanism of hemoglobin, myoglobin and cytochrome c; Non-heme proteins: hemerythrin and hemocyanin. | 8 |
| III | **Nitrogen Fixation, Metal poisoning and their treatment:** Nitrogen in biosphere; Nitrogen cycle; Role of micro-organisms in nitrification; Nitrogen fixation in soils; Metal poisoning and drug | 8 |

| | | |
|---|---|---|
| | action of Inorganic complexes compounds; Metal poisoning, treatment by using chelating agent, mercury, lead & cadmium poisoning & treatment; Platinum complexes in treatment of cancer. Metal deficiency. | |
| IV | **Trace Metals in Plant Life:** Micronutrients present in soil and role in plant life; Biodegradation of minerals by bacteria and its applications in treatment of soil and water pollution. | 8 |
| V | **Supramolecular Chemistry:** Definition and Development of Supramolecular Chemistry, Classification of Supramolecular Host-Guest compounds, Pre- organization and Complementarily, Receptors, Nature of Supramolecular interactions. | 8 |

**Reference / Text Books:**


1. Eichhorn: Inorganic Biochemistry: Vol I, 2 Elsevier.
2. Ochiai: Bioinorganic Chemistry: Allyn & Bacon Burton.
3. Williams: An Introduction to Bioinorganic Chemistry, C.C. Thomos Spring III.
4. Wallace: Decade on synthetic chelating agent in Inorganic plant nutrition, Wallace.
5. Williams: Metals in Life.
6. Zagic: Microbial Biogeochemistry, Academic press.
7. Ahuja: Chemical Analysis of the Environment, Plenum press.


If the course is available as Generic Elective then the students of following departments may opt it.

1. B. Tech.
2. Diploma
3. B. Pharm.
4. D. Pharm.

**Evaluation/Assessment Methodology**

| | |
|---|---|
| | **Max. Marks** |
| 1) Class tasks/ Sessional Examination<br>2) Assignments<br>3) ESE | 25<br>5<br>70 |
| **Total:** | **100** |

Prerequisites for the course: PCM in $12^{th}$

**Course Outcomes:**

this curriculum will help students for develop interest in bioinorganic chemistry of alkali & alkaline earth metal., Photosynthesis, use of ATP & ADP, structure & mechanism of Haemoglobin, myoglobin. Cellular nitrogen fixation in soil will prove very useful.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: II/ Semester: III**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. Class: M.Sc. (Chemistry) | Year: II<br><br>Semester: III |
| **Credits: 04** Theory: 04 | **Subject: Chemistry** |
| **Course Code: MSCY-2321** | **Title: Bio-Organic Chemistry** |
| **Course Objective**: Bioorganic Chemistry is a scientific discipline at the intersection of organic chemistry &biology. The syllabus involves the various type of organic substances viz enzyme, carbohydrate, lipids & nucleic acids for their biological functions. | |
| Nature of Paper: **Core** | |
| **Minimum Passing Marks/Credits: 40% Marks** | |
| L: 4<br>T:<br>P: 4(In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits) | |

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | Introduction: Basic Consideration, Proximity effects and molecular adoption. Enzymes: Introduction, Chemical and Biological catalysis, remarkable properties of enzymes, Nomenclature and classification, concept and identification of active site by use of inhibitors, reversible & irreversible inhibition. | 12 |
| II | Kinds of Reactions Catalyzed by Enzymes: Bond cleavage and consideration, some isomerization and rearrangement reactions. Enzyme catalyzed carboxylation and decarboxylation. Mechanism of Enzyme action: Transition state theory, Orientation and steric effect, acid-base catalysis, covalent catalysis. | 12 |
| III | Enzyme Models: Host guest chemistry, Chiral recognition and catalysis, molecular recognition, molecular asymmetry and prochirality, Biomimetic chemistry, crown ethers, cryptates, cyclodextrins, cyclodextrin based enzyme models, Calixarenes, ionophores, micelles synthetic enzyme or synzymes. | 12 |
| IV | Biotechnological Application of enzymes: Large scale production and purification of enzymes, techniques and methods of immobilization of enzyme activity, application of immobilized enzymes, effect of immobilization on Enzyme activity, application | 12 |

| | | |
|---|---|---|
| | of immobilized enzymes. Clinical uses of enzymes, enzyme therapy, enzymes and recombinant DNA technology. | |
| V | Metalloenzymes, Copper enzymes, superoxide dismutase, cytochrome oxidase and ceruloplasmin; Coenzymes; Molybdenum enzyme: xanthine oxidase; Zinc enzymes: carbonic anhydrase, carboxy peptidase and interchangeability of zinc and cobalt in enzymes; Vitamin $B_{12}$ and $B_{12}$ coenzymes; Iron storage, transport, biomineralization and siderophores, ferritin and transferrins. | 12 |

**Reference / Text Books:**

1. Eichhorn: Inorganic Biochemistry: Vol I, 2 Elsevier.
2. Ochiai: Bioinorganic Chemistry: Allyn & Bacon Burton.
3. Williams: An Introduction to Bioinorganic Chemistry, C.C. Thomos Spring III.

If the course is available as Generic Elective then the students of following departments may opt it.
1. B. Tech.
2. Diploma
3. B. Pharm.
4. D. Pharm.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 25 |
| 2) Assignments | 5 |
| 3) ESE | 70 |
| **Total:** | **100** |

Prerequisites for the course: PCM in $12^{th}$

**Course Outcomes:**
The students will benefit from the learning of this syllabus regarding cell structure & its function etc. Each Unit starts with learning objectives these will be important in the study of bio-Organic chemistry.

**IIMTU-NEP IMPLEMENTATION**
**Year: II/ Semester: III**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. Class: M.Sc. (Chemistry) | Year: II<br><br>Semester: III |
| **Credits: 04**<br>Theory: 04 | **Subject: Chemistry** |
| **Course Code: MSCY-2331** | **Title: Bio-Physical Chemistry** |
| **Course Objective**:<br>Biophysical Chemistry is a scientific discipline at the intersection of Physical chemistry & biology. The syllabus involves the various type of organic substances viz. enzyme, carbohydrate, lipids & nucleic acids for their biological functions. | |
| Nature of Paper: **Core** | |
| **Minimum Passing Marks/Credits: 40% Marks** | |
| L: 4<br>T:<br>P: 4(In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits) | |

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | **Cell membrane and its structure:** The Cell Membrane, lipids in biological membranes, types andarrangements of proteins in membranes, lipo proteins. Danielli and Davson model, Fluid Mosaic Model, permeability of cell membrane. Bio-Energetics: Thermodynamic Considerations: standard free energy change in bio-chemical reactions, exergonic, endergonic reactions, hydrolysis of ATP and its synthesis from ADP. | 8 |
| II | **Thermodynamics of Biopolymers Solutions:** Osmotic pressure, membrane equilibrium, muscular contraction and energy generation in mechanochemical system. Statistical mechanics in biopolymers chain configuration of macromolecules, statistical distribution end – to – end dimensions, calculation of average dimensions for various chain structures. Polypeptide and protein structures and protein folding. | 8 |
| III | **Mechanism of Membrane Transport:** Transport through cell membrane, active and passive transportsystems, Ping - pong mechanism for transport of diffusion, Macromolecules across the Plasma Membrane, Role of Intercellular spaces in transport process, Homocellular, Transcellular Intracellular transport, Irreversible | 8 |

| | | |
|---|---|---|
| | thermodynamic treatment of membrane transport. Nerve conduction, Donnan effect in Osmosis, its dependence on pH difference across the membrane. Semipermeable membrane and Donnan membrane equilibrium. | |
| IV | **Biomolecular Interactions:** Interactions between biomolecules (proteins), Interaction of biomolecules with small ligands, independent ligand binding sites, the Scatchard plot, forces involved in the stability of proteins, hydrophobic interactions, hydrogen bonding, electrostatic interactions, electron delocalization, van der Waal's forces Scope of Genomics, proteomics and bioinformatics, ribosomes: Site and Function of protein synthesis. | 8 |
| V | **Protein molecules:** Protein sequence and structure (primary structure), secondary structure: α-Helix,β- Sheet, classification of proteins, torsion angles, tertiary structure, quaternary structure, Protein folding and refolding, computer simulation: thermodynamic-kinetic approach, statistical mechanics approach, Homolog Modelling, De Novo prediction, Protein misfolding, Biological factors (Chaperones) and chemical factors(Intra and intermolecular interactions) leading folding/refolding/misfolding. Brain diseases associated with it. | 8 |

**Reference / Text Books:**

1. Physical Chemistry of Macromolecules: S.F.Sun
2. The Enzyme Molecules: W. Ferdinand
3. Outlines of Biochemistry: E.E. Conn and P.K. Stumph
4. Biochemistry: Zubay
5. Principles of Biochemistry: A.I. Leninger

If the course is available as Generic Elective then the students of following departments may opt it.

1. B. Tech.
2. Diploma
3. B. Pharm.
4. D. Pharm.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 25 |
| 2) Assignments | 5 |
| 3) ESE | 70 |
| **Total:** | **100** |

Prerequisites for the course: PCM in $12^{th}$

**Course Outcomes:** the students will learn regarding cell structure & its function etc. with reference to physical phenomenon.

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: II/ Semester: IV**

<table>
<tr><td colspan="2">Programme:<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>Class: M.Sc. (Chemistry)</td><td colspan="2">Year: II<br><br>Semester: IV</td></tr>
<tr><td>Credits: 06<br>Theory: 04<br>Practical: 02</td><td colspan="3">Subject: Chemistry</td></tr>
<tr><td>Course Code: MSCY-2422</td><td colspan="3">Title: Advanced Organic Synthesis/ Supramolecular Chemistry & Carbocyclic Rings</td></tr>
<tr><td colspan="4">Course Objective:<br>To teach the concepts and critical bond forming reactions in advanced organic synthesis, asymmetric synthesis, supramolecular chemistry, carbocyclic rings and molecular rearrangements.</td></tr>
<tr><td colspan="4">Nature of Paper: Core</td></tr>
<tr><td colspan="4">Minimum Passing Marks/Credits: 40% Marks</td></tr>
<tr><td colspan="4">L: 4<br>T:<br>P: 4(In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits)</td></tr>
<tr><td>Unit</td><td colspan="2">Contents</td><td>No. of Lectures Allotted</td></tr>
<tr><td>I</td><td colspan="2">Advanced Organic Synthesis<br>Philosophy of organic synthesis: Disconnection approach, one group and two group disconnections, reversal of polarity, chemoselectivity, one group C-C disconnection, two group C-C disconnections, 1,3-difunctional and 1,5-difunctional compounds. Tandem reactions, Domino reactions and multi-component reactions.<br>Asymmetric synthesis: Development of methodologies for asymmetric synthesis, regioselectivity, stereoselectivity, diastereoselectivity and stereospecificity.<br>Total synthesis of the following compounds using disconnection approaches: Gingerol, (z)-jasmone, prostaglandins E2, F2α, menthol, taxol and gandriol.</td><td></td></tr>
<tr><td>II</td><td colspan="2">Supramolecular Chemistry & Carbocyclic Rings<br>Principles of molecular associations and organizations: Non-covalent synthesis, Self assembly and self organization, Supramolecular reactivity and catalysis, Molecular devices, Ion channels, Novel liquid crystals, Gelatorsfibres and adhesives, Dendrimers, organic solids,</td><td></td></tr>
</table>

| | | |
|---|---|---|
| | organic conductors and organic superconductors, catenanes and rotaxanes. Chemistry of small, medium and large ring compounds. Chemistry of non-benzenoid aromatics: Tropones. tropolones, azulenes, metallocenes and annulenes. Bridged rings, caged molecules and adamantane. | |

**Reference / Text Books:**

1. Warren, S. Organic Synthesis: The Disconnection Approach John Wiley & Sons (1984).
2. Lehn, J. M. Supramolecular Chemistry: Concepts & Perspectives, Print ISBN:9783527293124 Wiley-VCH (2006).
3. Vögtle, F. Supramolecular Chemistry: An Introduction John Wiley & Sons (1993).

If the course is available as Generic Elective then the students of following departments may opt it.
1. B. Tech.
2. Diploma
3. B. Pharm.
4. D. Pharm.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 25 |
| 2) Assignments | 5 |
| 3) ESE | 70 |
| **Total:** | **100** |

Prerequisites for the course: PCM in $12^{th}$

**Course Outcomes:** The students will acquire knowledge of
1. Mechanistic pathway of organic reactions.
2. Retrosynthetic approach to planning organic syntheses.
3. Conversion of different functional group via rearrangement reaction.
4. Basic concept and advanced approaches in supramolecular, carbocyclic rings and asymmetric synthesis.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: II/ Semester: IV**

<table>
<tr><td colspan="2">Programme:<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>Class: M.Sc. (Chemistry)</td><td colspan="2">Year:II<br><br>Semester: IV</td></tr>
<tr><td colspan="2">Credits: 02<br>Theory: 0<br>Practical: 02</td><td colspan="2">Subject: Chemistry</td></tr>
<tr><td colspan="2">Course Code: MSCY-2422P</td><td colspan="2">Title: ORGANIC CHEMISTRY LAB-IV</td></tr>
<tr><td colspan="4">Course Objective: To develop experimental skills of various separation and purification techniques.</td></tr>
<tr><td colspan="4">Nature of Paper: Core</td></tr>
<tr><td colspan="4">Minimum Passing Marks/Credits: 50% Marks</td></tr>
<tr><td colspan="4">L:<br>T:<br>P: 4 (In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)</td></tr>
<tr><th>Unit</th><th colspan="2">Contents</th><th>No. of Lectures Allotted</th></tr>
<tr><td>I</td><td colspan="2">Qualitative Analysis:<br>1. Separation and qualitative analysis of mixtures containing two components by chemical methods and physical methods (Separations using acids, bicarbonate bases, water, ether).<br>2. (i) Separation of active single component and mixture of components from pharmaceutical tablets; identification of components by m.p., functional groups.<br>(ii) Qualitative estimation of the components in pharmaceutical tablets<br>3. Application of column chromatography.<br>4. Estimations of mixtures of compounds, geometrical isomers, keto-enoltautomers, etc.</td><td></td></tr>
<tr><td>II</td><td colspan="2">Advanced organic synthesis:<br>Multistage synthesis including photochemical methods; representative examples:<br>a. Hydroquinone→HydroquinoneDiacetate→2,5-Dihydroxyacetophenone → 2, 5 Dibenzoxyacetophenone<br>b. Benzaldehyde → Cinnamic acid → α,β Dibromocinnamic acid→ cis & trans α-Bromocinnamic acid<br>b. Chalcone→ chalcone epoxide→ α-Benzoyl phenyl</td><td></td></tr>
</table>

acetaldehyde

c. Benzaldehyde → Bezoin → Benzil → Benzilic acid
d. Resorcinol → 7-Hydroxy-4-methylcoumarin → 7-Acetoxy-4-methylcoumarin → 4-Methyl-7-hydroxy-8-acetylcoumarin
e. Applications of Grignard Reagent
f. Applications of Wittig reagent
g. Other suitable multi-step synthesis

**2.** Multi-component synthesis:

a. Organic synthesis in water ( Preparation of Hydroxy methyl benzotriazole)
b. Synthesis of Benzimidazole (Condesation of diamines and aldehydes)
c. Other recent examples of multi-component synthesis

**3.** Green chemistry:

a. Direct Oxidative esterification of Aldehyde (using Iodine and Alcohol).
b. Use of microwaves in organic synthesis
   i. Oxidation of toluene
   ii. Esterification
   iii. Lipase-catalyzed Esterification / transesterification reactions and other enzymatic reactions
   iv. Aldol condensation of Benzil And other suitable green synthesis

**Reference / Text Books:**


1. Vogel, A. I. Vogel's Qualitative Inorganic Analysis - 7th ed. (revised by G. Svehla) Longmans (1996) ISBN 058-221866-7.
2. Vogel, A. I. Vogel's Textbook of Quantitative Chemical Analysis - 5th Ed. Longman (1989).
3. Addison Ault Techniques and Experiments for Organic Chemistry 6th Ed. University Science Books (1998).
4. Mann, F. G. & Saunders, B. C. Practical Organic Chemistry 4th Ed. Orient Longmans (1990).
5. Vogel, A. I. Vogel's Textbook of Practical Organic Chemistry 5th Ed. (revised by A.R. Tatchell et al.) Wiley (1989) ISBN 0582-46236-3.
6. Daniels, F., Williams, J. W., Bender, P., Alberty, R. A., Cornwell, C. D. & Harriman, J. E. Experimental Physical Chemistry, McGraw-Hill (1962).
7. Day, R. A., Jr. & Underwood, A. L. Quantitative Analysis 3rd Ed. Prentice-Hall India Pvt. Ltd.: New Delhi (1977).
8. Harris, D. C. Quantitative Chemical Analysis 6th Ed. W. H. Freeman & Co. (2002).
9. Willard, H. H., Merritt, L. L., Dean, J. A. & Settle, F. A. (Eds.) Instrumental Methods of Analysis - 7th Ed., Wadsworth Publishing (February 1988) ISBN 0534081428


If the course is available as Generic Elective then the students of following departments may opt it.

1. B. Tech.

| | |
|---|---|
| 2. Diploma<br>3. B. Pharm.<br>4. D. Pharm. | |
| **Evaluation/Assessment Methodology** | |
| | **Max. Marks** |
| 1) Class tasks/ Sessional Examination<br>2) Assignments<br>3) ESE | 25<br>5<br>70 |
| **Total:** | **100** |
| Prerequisites for the course: PCM in $12^{th}$ | |
| **Course Outcomes:** The students will acquire knowledge of:<br>1. Advanced methods of organic synthesis.<br>2. Synthetic procedures: aqueous workup, distillation, reflux, separation, isolation, and crystallization.<br>3. Characterization of compounds. | |

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: II/ Semester: IV**

<table>
<tr><td colspan="2">Programme:<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>Class: M.Sc. (Chemistry)</td><td colspan="2">Year: II<br><br>Semester: IV</td></tr>
<tr><td colspan="2">Credits: 04<br>Theory: 04</td><td colspan="2">Subject: Chemistry</td></tr>
<tr><td colspan="2">Course Code: MSCY-2423</td><td colspan="2">Title: Chemistry of Natural Products</td></tr>
<tr><td colspan="4">Course Objective:<br>The course content consists of classification, isolation & biosynthesis of common plantproducts. A natural product has also been prepared by coenzyme. The compounds & their derivatives have been studied for their applications. Synthesis, application & structural studies of Antibiotics, Terpenoids, and alkaloids have been done. The steroids are the chemical compounds which are widely used to control acute diseases & they are given in specific condition. The biogenesis of pyridine, morphine carbohydrates & protein has been studied.</td></tr>
<tr><td colspan="4">Nature of Paper: Core</td></tr>
<tr><td colspan="4">Minimum Passing Marks/Credits: 40% Marks</td></tr>
<tr><td colspan="4">L: 4<br>T:<br>P: 4(In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits)</td></tr>
<tr><th>Unit</th><th colspan="2">Contents</th><th>No. of Lectures Allotted</th></tr>
<tr><td>I</td><td colspan="2">Terpenoids. General methods of structure elucidation.Isoprene rule. Structure determination, stereochemistry, and synthesis of the following representative molecules: citral, geraniol,-terpineol, menthol,-pinene, camphor, and abietic acid. Biosynthesis of terpenoids.</td><td>8</td></tr>
<tr><td>II</td><td colspan="2">Alkaloids.General methods of structure elucidation. Structure determination, stereochemistry, and synthesis of the following representative molecules: ephedrine, nicotine, atropine, quinine and morphine. Biosynthesis of alkaloids.</td><td>8</td></tr>
<tr><td>III</td><td colspan="2">Steroids.Structure elucidation, stereochemistry and chemical synthesis of cholesterol, bile acids, and roster one, testosterone, estrone, progestrone and aldosterone. Biosynthesis of steroids.</td><td>8</td></tr>
<tr><td>IV</td><td colspan="2">Plant Pigments. Carotenoids. Structure and synthesis of-carotene. Flavonoids. Nature, general methods for structure elucidation and synthesis of anthocyanins and flavones Structure and synthesis of cyanidin chloride, cyanin, flavone, flavonol and quercetin.</td><td>8</td></tr>
</table>

| | | |
|---|---|---|
| | Biosynthesis of flavonoids. Chlorophyll. Chemistry of chlorophyll. | |
| V | Vitamins and Antibiotics. Vitamins. Structure and synthesis of vitamin B1 (thiamine), B2 (riboflavin) and B6 (pyridoxine). Chemistry of Vitamin B12. Antibiotics. Structure and synthesis of penicillins and chloramphenicol. | 8 |

**Reference / Text Books:**


1. Finar, I.L. Organic Chemistry, ELBS.
2. Nogradi, M. Stereoselective Synthesis: A Practical Approach, VCH.
3. Hostettmann, Kurt, Gupta, M.P. and Marston, A. Chemistry, Biological and Pharmacological Properties of Medicinal Plants, Americas, Harwood Academic Publishers.
4. Aggarwal, O.P. Chemistry of Organic Natural Products, Goel Publishing House.
5. Rahman, A. and Choudhary, M.I. New Trends in Natural Product Chemistry, Harwood Academic


If the course is available as Generic Elective then the students of following departments may opt it.

1. B. Tech.
2. Diploma
3. B. Pharm.
4. D. Pharm.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination<br>2) Assignments<br>3) ESE | 25<br>5<br>70 |
| **Total:** | **100** |

Prerequisites for the course: PCM in $12^{th}$

**Course Outcomes:**

The natural products have been synthesized and their derivatives have been studied in detail as they are industrially important. The antibiotics & their actions have been studied to know more about antibiotics their derivatives. The steroids are the targeted chemical compounds and they are used in severe diseases otherwise their use is not recommended by doctors. The alkaloids, cholesterol & vitamins have been synthesized & their impact has been studied on human physiology.

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: II/ Semester: IV**

| | |
|---|---|
| **Programme:**<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>Class: M.Sc. (Chemistry) | Year: II<br><br>Semester: IV |
| **Credits: 04**<br>Theory: 04 | **Subject: Chemistry** |
| **Course Code: MSCY-2424** | **Title: Newer Synthetic Reactions &Reagents/ Heterocyclic Chemistry** |
| **Course Objective**: To acquire the knowledge of enolates, Umpolung and Hetrocyclic Chemistry. | |
| Nature of Paper: **Core** | |
| **Minimum Passing Marks/Credits: 40% Marks** | |
| L: 4<br>T:<br>P: 4(In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits) | |

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | **Newer Synthetic Reactions and Reagents**<br>Enolates, Thermodynamic versus Kinetic enolates, enonate equivalents and enamines: Applications in carbon-carbon bond formation and related reactions. Applications in chiral synthesis. Phosphorus, Sulphur and nitrogen ylides: Preparation, applications in organic synthesis and mechanism. Umpolung reactions (sulphur compounds, nitro compounds, lithiated ethers and related compounds).Principles and applications of phase transfer catalysis, crown ethers and polymer- supported reagents in organic synthesis.<br>Principles of Green Chemistry and its applications: Biotrans formations: Classification of enzymes, advantages and disadvantages, Artificial enzymes, applications in organic synthesis; Principles of ultrasound and microwave assisted organic synthesis. Reactions in ionic liquids. | |
| II | **Heterocyclic Chemistry**<br>Introduction to heterocycles: Nomenclature, spectral characteristics, reactivity and aromaticity<br>Synthesis and reactions of three and four membered heterocycles, e.g., aziridine, azirine, azetidine, oxiranes, thiarines, oxetenes and thietanes. | |

| | | |
|---|---|---|
| | Five membered rings with two heteroatoms: pyrazole, imidazole, oxazole, thiazole, isothiazole and benzofusedanalogs.<br>Benzofused five membered heterocycles with one heteroatom, e.g. indole, benzofuran, benzothiophene.<br>Chemistry of bicyclic compounds containing one or more heteroatoms.<br>Benzofused six membered rings with one, two and three heteroatoms: benzopyrans, quinolines, isoquinolines, quinoxazalines, acridines, phenoxazines, phenothiazines, benzotriazines, pteridines. Seven and large membered heterocycles: azepines, oxepines, thiepines. Chemistry of porphyrins and spiroheterocycles., quinine and morphine. Biosynthesis of alkaloids. | |

**Reference / Text Books:**


1. Carey, F.A. &Sundberg, R. J. Advanced Organic Chemistry, Parts A & B, Plenum: U.S. (2004).
2. Carruthers, W. Modern Methods of Organic Synthesis Cambridge University Press (1971).
3. Acheson, R. M. Introduction to the Chemistry of Heterocyclic Compounds John Wiley & Sons (1976).
4. Anastas , Paul and Warner , John C., Green Chemistry- Theory and Practical, (2005).
5. Alhuwalia, VK and Kidwai, M. New trends in Green Chemistry. Anamaya Publishers, New Delhi (2003).


If the course is available as Generic Elective then the students of following departments may opt it.

1. B. Tech.
2. Diploma
3. B. Pharm.
4. D. Pharm.

| **Evaluation/Assessment Methodology** | |
|---|---|
| | **Max. Marks** |
| 1) Class tasks/ Sessional Examination | 25 |
| 2) Assignments | 5 |
| 3) ESE | 70 |
| **Total:** | **100** |

Prerequisites for the course: PCM in $12^{th}$

**Course Outcomes:** The students will acquire knowledge of

1. Application of modern synthetic reactions and reagents in organic synthesis (including Ylides and Umpolung reaction).
2. Nomenclature and reactivity and synthesis of different heterocyclic compounds.
3. Organic reactions involving green Chemistry. The students also get an idea about greener approaches such as the usage of microwave and ionic liquids based synthesis of compounds.

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: II/ Semester: IV**

| | |
|---|---|
| **Programme:**<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>Class: M.Sc. (Chemistry) | Year: II/<br><br>Semester: IV |
| **Credits: 04**<br>Theory: 04 | **Subject: Chemistry** |
| **Course Code: MCOE -2421** | **Title: Biomolecules** |
| **Course Objective**: To acquire the knowledge of structure, function, and physicochemical properties of bio molecules. | |
| Nature of Paper: **Core** | |
| **Minimum Passing Marks/Credits: 40% Marks** | |
| L: 4<br>T:<br>P: 4(In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits) | |

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | **Proteins and Lipids**<br>Peptides and proteins: Classification of naturally occurring peptides, depsipeptide and peptide alkaloids with examples, Sequence determination, chemical, enzymatic and mass spectral methods, Modern methods of peptide synthesis with protection and deprotection, Solid phase synthesis, combinatorial synthesis of peptides, Chemistry of oxytocin, valinomycin, enkephalins, self assembly and aggregation of peptides,<br>Lipids : Classification and biological importance of fatty acids and lipids, stereochemical notation in lipids, chemical synthesis of phospholipids and glycolipids, properties of lipid aggregates, micelles, bilayers, lyposomes and biological membranes. | |
| II | **Nucleic Acids and Carbohydrates**<br>Nucleic acids: Secondary structure of DNA and RNA, stabilizing forces, polymorphic nature of DNA, multistranded DNA structures, sequence determination by chemical and enzymatic methods, genome sequencing, chemical synthesis of DNA, solution phase and solid phase synthesis, phosphodiester-triester and phosphite methods, phosphoramide approach; PNA, LNA, UNA, automated DNA synthesizers, purification of oligonucleotides, HPLC and gel electrophoresis. | |

| | | |
|---|---|---|
| | Carbohydrates: Types of naturally occurring sugars, deoxy sugars, amino sugars, branched chain sugars, sugar methyl ethers and acid derivatives of sugars, polysaccharides of industrial and biological importance, dextran, chemistry of sialic acids, cell-cell recognition and blood group substances. | |

**Reference / Text Books:**

1. Bodansky, M. Peptide Chemistry: A Practical Textbook Springer-Verlag (1988).
2. Dugas, H. & Penney, C. Bioorganic Chemistry: A Chemical Approach to Enzyme Action Springer-Verlag (1989).

If the course is available as Generic Elective then the students of following departments may opt it.

1. B. Tech.
2. Diploma
3. B. Pharm.
4. D. Pharm.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 25 |
| 2) Assignments | 5 |
| 3) ESE | 70 |
| **Total:** | **100** |

Prerequisites for the course: PCM in $12^{th}$

**Course Outcomes:** The students will acquire knowledge of:

1. Physico-chemical properties, and molecular architecture of biomolecules
2. Folding, stability, and dynamics of protein.
3. Transfer of genetic information from one generation to another generation.
4. Synthesis of DNA, its purification and characterization.
5. This course also discusses about biological roles of lipids and fatty acids, its synthesis and biological membranes.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: II/ Semester: IV**

<table>
<tr><td>Programme:<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>Class: M.Sc. (Chemistry)</td><td>Year: II<br><br>Semester: IV</td></tr>
<tr><td>Credits: 04<br>Theory: 04</td><td>Subject: Chemistry</td></tr>
<tr><td>Course Code: MCOE -2422</td><td>Title: Pharmaceutical Techniques</td></tr>
<tr><td colspan="2">Course Objective: To acquire knowledge of drug design, and development, pharmacokinetics, and pharmacodynamics.</td></tr>
<tr><td colspan="2">Nature of Paper: Core</td></tr>
<tr><td colspan="2">Minimum Passing Marks/Credits: 40% Marks</td></tr>
<tr><td colspan="2">L: 4<br>T:<br>P: 4(In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits)</td></tr>
</table>

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | **Drug Delivery Technologies**<br>Pharmaceutical Techniques Technologies Development Importance of Targeted Drug Delivery, Efficacy, Safety and Toxicity Issues. Molecular basis of targeted drug delivery. Drug Release and Uptake Phenomenon. Drug Encapsulation Technologies. Different Carriers for Drug Encapsulation:<br>Nanomaterials (metal-based, metal oxide based and polymeric) in drug encapsulation and drug delivery: their characterization, generation, efficacy, toxicity and release profile. Factors affecting drug loading and drug release. Techniques to measure degree of loading and release efficiency.Metabolism and excretion of drug delivery carriers.<br>General considerations; Methods of preparations, characterization and applications of liposomes, ionosomers, resealed erythrocytes, nanoparticulate systems, solid-liquidnanoparticles, dendrimers, organogels, multiple emulsions and nanoemulsions.<br>Overview and application of aquasomes, pharmacosomes, liquid crystalline systems, protein and peptide-based drug delivery systems.<br>Polymers in drug encapsulation and drug delivery: Classification, synthesis and applications of biodegradable and natural polymers in formulation of controlled drug delivery systems. | |

| | | |
|---|---|---|
| II | **Pharmaceutical Technologies Development**<br>Drug discovery, lead identification and lead optimization, Chemical, pharmaceutical and clinical technology development.<br>Investigational New Drug (IND) and its Applications: criteria, contents, categories, submission, regulation, noteworthy examples.<br>Clinical trials: Phase I, II and III clinical trials.<br>Pilot Plant Scale-Up Techniques: Primary function of the pharmaceutical pilot plant, factors to be considered during development, reporting responsibilities, personnel requirements, space requirements, review of the formula, raw materials, relevant processing equipments, production rates, process evaluation, master manufacturing procedures, GMP consideration, pilot plant design for tablet development. | |

**Reference / Text Books:**

1. Mathiowitz, E., Ed. Encyclopaedia of controlled delivery (1999).
2. Joseph R. Robinson and Vincent H. L. Lee Controlled Drug Delivery – Fundamentals and Applications.
3. Saltzman, W. Mark Drug Delivery: Engineering Principles and Drug Therapy (Oxford Press)
4. Loyd V. Allen, Jr., Nicolas G. Popovich and Howard C. Arsel Ansel's Pharmaceutical Dosage Forms and Drug Delivery Systems.
5. The Art, Science and Technology of Pharmaceutical Compounding – Loyd V. Alen Jr.

If the course is available as Generic Elective then the students of following departments may opt it.
1. B. Tech.
2. Diploma
3. B. Pharm.
4. D. Pharm.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 25 |
| 2) Assignments | 5 |
| 3) ESE | 70 |
| **Total:** | **100** |

Prerequisites for the course: PCM in $12^{th}$

**Course Outcomes:** The students will acquire knowledge of:
1. Drug designing and development, their SAR and QSAR.
2. Mode of action of different drugs.
3. Role of drugs to inhibit the particular enzymes and treatment of disease.
4. Drug delivery and pharmaceutical technologies development

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: II/ Semester: IV**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. Class: M.Sc. (Chemistry) | Year: II<br><br>Semester: IV |
| **Credits: 04** Theory: 04 | **Subject: Chemistry** |
| **Course Code: MSCY -2426** | **Title: Review Project (Includes Submitting a Dissertation and Making a Presentation)** |
| **Course Objective**: To acquire knowledge of drug design, and development, pharmacokinetics, and pharmacodynamics. | |
| Nature of Paper: **Core** | |
| **Minimum Passing Marks/Credits: 40% Marks** | |
| L: 4<br>T:<br>P: 4(In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits) | |

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| | For students to enter into preliminary research field both in theory and experiment the concept of Project has been introduced in the final Semester. In the Project, the student will explore new developments from the books and journals, collecting literature / data and write a Dissertation based on his / her work and studies. The Project Work can also be based on experimental work in industries/ research laboratories. Selection of Topic:<br>1. Students will make project which should be preferably a working of third thoughts based on their subject.<br>2. The student will be assigned a faculty guide who will be the supervisor of the students. The faculty would be identified at the end of the III semester.<br>3. The assessment of performance of the students should be made at least twice in the semester. Internal assessment shall be for 50 marks. The students shall present the final project live using overhead projector PowerPoint presentation on LCD to the internal committee and the external examiner.<br>The evaluation committee shall consist of faculty members constituted by the college which would be comprised of at least three members comprising of the department Coordinator's Class | **40** |

| | | |
|---|---|---|
| | Coordinator and a nominee of the Director/Principal. The students guide would be special in invitee to the presentation. The seminar session shall be an open house session. The internal marks would be the average of the marks given by each members of the committee. | |
| **Evaluation/Assessment Methodology** | | |
| | | **Max. Marks** |
| 1) Class tasks/ Sessional Examination<br>2) Assignments<br>3) ESE | | 25<br>5<br>70 |
| | **Total:** | **100** |
| Prerequisites for the course: PCM in $12^{th}$ | | |
| **Course Outcomes:**<br>The course would help to enrich the subject knowledge of the students and increase their confidence level in the field of both academia and industry. | | |

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: I / Semester: I**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. **Class:**M.Sc.(Statistics) | Year: I<br><br>Semester: I |
| **Credits 4**<br>Theory: 4 | **Subject: Statistics** |
| **Course Code:MSST-111** | **Title:ProbabilityTheory** |
| **Course Objectives:**<br>The purpose of the course is to develop knowledge of the fundamental probability tools for quantitatively determining the risk. The application of these tools lies with the problems encountered in decision making | |
| **Nature of Paper:** Core | |
| **Minimum Passing Marks/Credits:40% Marks** | |
| L: 4<br>T:<br>P:(In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits) | |

| **Unit** | **Contents** | **No. of Lectures Allotted** |
|---|---|---|
| I | Classes of Sets, Fields, Sigma-Fields, Minimal Sigma Field, Borel Sigma Field, Sequence of Sets, Lim_sup & Lim_inf of Sequence of Sets, Measure, Proabability Measure, Conditional Probability, Bayes Theorem and Independent Events. | **10** |
| II | Measurable Functions, Random Variables, Distribution Function of Random Variables, Joint distribution of two Random Variables, Marginal & Conditional Distributions, Expectation, Moment Generating Function, Probability Generating function, Characteristic Functions & their properties, Uniqueness, Inversion & Continuity Theorems of Characteristic Function. | **10** |
| III | Chebychev's, Markov's, Basic, Kolmogorov's, Jenson's Inequalities. Three Series Criterion, Borel Zero-One Law. | **10** |
| IV | Chebychev's, Markov's, Basic, Kolmogorov's, Jenson's Inequalities. Three Series Criterion, Borel Zero-One Law. | **10** |
| V | Weak Law & Strong Law of Large Numbers for iid sequences, Bernoulli's, Khintchine's Theorems of Large Numbers, CLT for Sequence of Independent Random Variables under Lindeberg's & Liaounoff's Conditions, and CLT for iid Random Variables. | **10** |

**Reference / Text Books:**

1. Rohatgi V.K., "An Introduction to Probability Theory & Mathematical Statistics", Wiley Eastern Ltd. , New Delhi.
2. Mukhopadhyay Parimal., "Theory of Probability"-New Central Book Agency, Calcutta.
3. Hogg R.V.& Craig A.T., "Introduction to Mathematical Statistics"- Macmillion Publications, New York.
4. Mukhopadhyay P., "Mathematical Statistics"-New Central Book Agency Calcutta.
5. Srinivasan& Mehta., "Probability & Random Process"- Tata Mc-GrawHill , New Delhi.
6. Cramer H., "Mathematical Methods of Statistics"- Princeton University Press.
7. Baner H., "Probability Theory"- Narosa Publication House, New Delhi.
8. Parzen E., "Modern Probability Theory & Applications"- Willey Eastern Ltd. New Delhi.
9. Bhatt B.R., "Modern Probability Theory"- Wiley Eastern Ltd. New Delhi.
10. Pitman J., "Probability" –Narosa Publishing House, New Delhi

If the course is available as Generic Elective then the students of following departments may opt it.

1. MSc (Mathematics)

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 25 |
| 2) Assignments | 5 |
| 3) ESE | 70 |
| **Total:** | 100 |

Prerequisites for the course:Statistics is one of the subjects in under graduation (UG) level.

**Course Learning Outcomes:**

The students will be able to distinguish between probability models appropriate to differentchance events and calculate probability according to these methods.

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: I / Semester: I**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D.<br>**Class:**M.Sc.(Statistics) | Year: I<br><br>Semester: I |
| **Credits 4**<br>Theory: 4 | **Subject: Statistics** |
| **Course Code:MSST-112** | **Title: Statistical Distributions** |
| **Course Objectives:**<br>The main objective of the course is to provide the detailed knowledge of the characterization of all the useful discrete and continuous distributions. | |
| **Nature of Paper:** Core | |
| **Minimum Passing Marks/Credits: 40%Marks** | |
| L: 4<br>T:<br>P: (In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits) | |

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | Study with examples and applications of uniform, Binomial, Poisson, Geometric distributions. Their means, variances, measures of skewness, characteristics functions, moment and probability generating functions, $r^{th}$ descending factorial moments and mode. The various important properties with their proofs related to these distributions including truncated and compound. | **10** |
| II | Generations and applications of Negative Binomial, Multinomial and hyper geometric distributions. Their characteristics functions, moment and probability generating functions and descending factorial moment. Mean vectors, variance covariance matrix, marginal and conditional distributions of multinomial. Limiting compound and mode of negative binomial and hyper-geometric distributions. Theory of exceedency of hyper-geometric distribution. | **10** |
| III | Distributions of rectangular, exponential, Gamma, Beta, Cauchy and Log normal with their properties including proofs. Their mean variance, and characteristic functions. The characterizations related to above distributions along with their truncated and compound. | **10** |
| IV | Sampling distributions of mean and variance, student's $t^2$, F and sample correlation coefficient (r) when population correlation is zero. Their means, variances, measures of skewness, characteristics and | **10** |

| | | |
|---|---|---|
| | moment generating functions, limiting distributions and important properties with their proofs. | |
| V | Bivariate normal distribution with its applications and important properties. Standard bivariate normal distribution. Development of the formula of recurrence relation for moments and other important related problems to this distribution. Distributions of order statistics, sample range, sample median, joint distributions of $r^{th}$ & $s^{th}$ order statistics. Distributions of minimum and maximum observations. Curve fitting by Orthogonal Polynomials | **10** |

**Reference / Text Books:**

1. Rohatgi V.K., "An Introduction to Probability Theory & Mathematical Statistics", Wiley Eastern Ltd. , NewDelhi.
2. Mukhopadhyay Parimal., "Theory of Probability"-New Central Book Agency, Calcutta.
3. Hogg R.V. & Craig A.T., "Introduction to Mathematical Statistics"- Macmillion Publications, New York.
4. Mukhopadhyay P., "Mathematical Statistics"-New Central Book Agency Calcutta.
5. Srinivasan& Mehta., "Probability & Random Process"- Tata Mc-GrawHill, New Delhi.
6. Cramer H., "Mathematical Methods of Statistics"- Princeton University Press.
7. Baner H., "Probability Theory"- Narosa Publication House, New Delhi.
8. Parzen E., "Modern Probability Theory & Applications"- Willey Eastern Ltd. New Delhi.
9. Bhatt B.R., "Modern Probability Theory"- Wiley Eastern Ltd. New Delhi.
10. Pitman J., "Probability" –Narosa Publishing House, NewDelhi

If the course is available as Generic Elective then the students of following departments may opt it.
1. M.Sc. (Mathematics)
2. M.Com.

**Evaluation/Assessment Methodology**

| | Max. Marks |
|---|---|
| 1) Class tasks/ Sessional Examination | 25 |
| 2) Assignments | 5 |
| 3) ESE | 70 |
| **Total:** | 100 |

Prerequisites for the course: Statistics is one of the subjects in under graduation(UG) level.

**Course Learning Outcomes:**
The students will be able to formulate the mathematical/statistical models for real data set arising in various fields in order to analyse in respect of various useful characteristics of the populations.

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: I / Semester: I**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D.<br>**Class:**M.Sc.(Statistics) | Year: I<br><br>Semester: I |
| **Credits 4**<br>Theory: 4 | **Subject: Statistics** |
| **Course Code:MSST-113** | **Title: SamplingTechniques** |
| **Course Objectives:**<br>The course aims to defining the population under study, its sampling frame, studying various sampling methods, determining the sample size and collecting data. | |
| **Nature of Paper:** Core | |
| **Minimum Passing Marks/Credits: 40%Marks** | |
| L: 4<br>T:<br>P: (In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits) | |

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | **Basic Concepts:** Census and sample surveys, advantages and disadvantages of sample surveys, Limitations of sampling, Basic principles of sample survey, Principle steps in sample survey, Sampling and non-sampling errors, Inter-penetrating, Sub-samples, Pilot survey.<br>**Simple Random Sampling:** Simple random sampling, Sampling from finite populations with and without replacement, Unbiased estimation and confidence intervals for population mean and total, Simple random sampling of attributes. | **10** |
| II | **Stratified Sampling:** Reasons for stratification , choice of strata , choice of sampling unit, stratified random sampling, estimation of population mean and its variance, choice of sample sizes in different strata, variances of estimates with different allocation, effects of deviation from optimum allocations, estimation of the gain in precision due to stratification, cost function, construction of strata. | **10** |
| III | **Systematic Sampling:** Estimation of sample mean and its variance, comparison of systematic sampling with simple random and stratified sampling.<br>**Ratio and Regression Estimation:** Ratio and regression methods of | **10** |

| | | |
|---|---|---|
| | estimation, variances of the estimates, optimum property of ratio estimates, comparison among ratio and regression and simple and biased estimates. | |
| IV | **Cluster Sampling:** Estimates of mean and its variance for equal and unequal clusters, efficiency in terms of intra- class correlation, optimum unit of sampling, sampling with replacement, estimation of mean and itsvariance.<br>**PPS Sampling scheme:** Sampling techniques with varying probabilities for simple random sampling with and without replacement. Herwits Thompson Estimator, Mid ZunoSen Sampling Scheme. | **10** |
| V | **Multistage and Multiphase Sampling:** Introduction of Multistage sampling, Two stage sampling with equal stage units, Estimation of its mean and variance, Introduction of Multiphase sampling, double sampling for stratification. | **10** |

**Reference / Text Books:**

1. Chocran W.G., " Sampling Techniques" –Wiley Eastern Ltd.,NewDelhi.
2. Sukhatma P.V., "Sampling Theory of Survey with Applications"-Piyush Publications, NewDelhi.
3. Raj D. Sampling Survey Theory-Narasa Publication House, New Delhi.
4. Murthy M.N. Sampling Theory and Methods- Statistical Publishing Society,Calcutta.
5. Daroga Singh and F.S. Chaudhary. Sampling Survey Design-Wiley Eastern Ltd.NewDelhi.
6. Mukhopadhayay Parimal. Theory and Methods of Survey Sampling-Prentice Hall of IndiaLtd. NewDelhi.
7. Foreman E.K. Survey Sampling Principles-Dekker Vol.120.
8. Kish L. Survey Sampling.
9. Ravindra S. and Naruang S. Elements of Survey Sampling-Kluwar Academic Press.
10. 10.Goon Gupta and Das Gupta. Fundamentals of Statstics. Vol. I. The world Press Pvt. Ltd. Calcutta.
11. Thomson M.E. Theory of Sample Survey. Chapman and Hall London.

If the course is available as Generic Elective then the students of following departments may opt it.

1. M.Sc. (Mathematics)

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 25 |
| 2) Assignments | 5 |
| 3) ESE | 70 |
| **Total:** | 100 |

Prerequisites for the course: Statistics is one of the subjects in under graduation (UG) level.

**Course Learning Outcomes:**

The students will be able to formulates and calculates the estimators of population mean, population total, population ratio of two variables, the percentage and the total number of units in the population that possess some characteristic.

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: I / Semester: I**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D.<br>**Class:**M.Sc.(Statistics) | Year: I<br><br>Semester: I |
| **Credits 4**<br>Theory: 4 | **Subject: Statistics** |
| **Course Code:MSST-114** | **Title: Data Analysis with R** |
| **Course Objectives:**<br>The objective of the course is to enhance the programming skills and working knowledge of available numerical and statistical software's. | |
| **Nature of Paper:** Core | |
| **Minimum Passing Marks/Credits: 40%Marks** | |
| L: 4<br>T:<br>P: (In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits) | |

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | R language and environment:<br>Basics of R, naming a data object, R is a functional language, creation of data objects including vectors, factors, matrices, list and data frames. Extraction from a data object. Input and output facilities. | **10** |
| II | Graphics in R: the plot command, histogram, bar-plot, box-plot, points, lines, segments, arrows, inserting mathematical symbols in a plot, pie diagram, customization of plot setting, graphical parameters, adding text, saving to a file, adding a legend. | **10** |
| III | Vector matrix operations: matrix operations such as addition, subtraction, multiplication, rank, eigenvalues, matrix inverse, generalized inverse, solution of linear equations. | **10** |
| IV | Basic statistics using R: measures of central tendency and dispersion. Covariance, correlation, regression, some discrete and continuous probability distributions, one and two sample z and t tests, Bartlett's test, F test for equality of variances, Chi-square tests, confidence intervals, one-way and two-way ANOVA, random number generation | **10** |
| V | Regression modeling:<br>Analysis of simple and multiple regression models, analysis of | **10** |

| | | |
|---|---|---|
| | variance and analysis of deviance. Fitting with optim (). | |

**Reference / Text Books:**


1. Dalgaard P. (2008). Introductory Statistics with R, Springer.
2. Kleiber C and Zeileis A (2008) Applied Econometrics with R. Springer New York.
3. Maindonald, J.H. & Braun, J. (2010). Data Analysis and Graphics Using R, 3rd Edition. Cambridge UniversityPress.
4. Zuur, A.F., Leno, E.N. & Meesters, E.H.W.G. (2010). A Beginner's Guide to R.Springer.
5. Crawley, M.J. (2012). The R Book, 2nd Edition.Wiley.
6. Lander J. P. (2014). R for Everyone: Advanced Analytics and Graphics, Pearson.
7. Crawley, M.J. (2015). Statistics: An Introduction Using R, 2nd Edition.Wiley.
8. Xie, Y. (2015). Dynamic Documents with R and knitr (2nd edition), CRC Press


If the course is available as Generic Elective then the students of following departments may opt it.
1. BSc(CS)
2. BCA
3. MBA

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 25 |
| 2) Assignments | 5 |
| 3) ESE | 70 |
| **Total:** | 100 |

Prerequisites for the course:Basic knowledge of R software under graduation (UG) level.

**Course Learning Outcomes:**

The students will be able to use advanced statistical software's such as R for the analysis of complex statistical data coming from the various fields like industry, marketing, finance, agriculture and business.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: I / Semester: I**

<table>
<tr><td>Programme:<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>Class:M.Sc.(Statistics)</td><td colspan="2">Year: I<br><br>Semester: I</td></tr>
<tr><td>Credits: 2<br>Practical: 2</td><td colspan="2">Subject: Statistics</td></tr>
<tr><td>Course Code:MSST-111P</td><td colspan="2">Title: Statistical Lab-I</td></tr>
<tr><td colspan="3">Course Objectives:<br>These concepts will be verified by experimental means:<br>1. The purpose of the course is to develop knowledge of the fundamental probability tools for quantitatively determining the risk. The application of these tools lies with the problems encountered in decision making<br>2. Characterization of all the useful discrete and continuous distributions.<br>3. To enhance the programming skills and working knowledge of available numerical and statistical software's.</td></tr>
<tr><td colspan="3">Nature of Paper: Core</td></tr>
<tr><td colspan="3">Minimum Passing Marks/Credits: 50%Marks</td></tr>
<tr><td colspan="3">L:<br>T:<br>P: 4 (In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)</td></tr>
<tr><td>List of Practicals</td><td>No. of Practicals</td><td>No. of Lectures Allotted</td></tr>
<tr><td>Fitting of Statistical Distributions<br>Statistical Distributions<br>Sampling Techniques<br>R</td><td>05<br>10<br>05<br>10</td><td>60</td></tr>
<tr><td colspan="3">Reference / Text Books:<br>Suggested Readings:<br>As suggested for papers code MSST 111, MSST 112, MSST 113 and MSST-114</td></tr>
<tr><td colspan="3">If the course is available as Generic Elective then the students of following departments may opt it.<br>1. M.Sc (Mathematics)<br>2. M.Com.<br>3. B.Sc. (CS)<br>4. MBA<br>5. B.Sc. (BioStatistics)</td></tr>
</table>

| **Evaluation/Assessment Methodology** | |
|---|---|
| Continuous Internal Evaluation shall be based on Practical File/Record, Class Activities and Overall performance. The marks shall be as follows: | |
| | **Max. Marks** |
| 1) Practical File/Record | **10** |
| 2) Class Interaction | **5** |
| 3) Report Preparation | **5** |
| 4) Practical Exam | **30** |
| **Total:** | **50** |
| Prerequisites for the course:Knowledge of Basic practical Statistics taught in the undergraduation(UG) level. | |
| **Course Learning Outcomes:**<br>After completing this course a student will have these skills:<br>1. The students will be able to distinguish between probability models appropriate to different<br>2. The students will be able to formulate the mathematical/statistical models for real data set arising in various fields in order to analyse in respect of various useful characteristics of the populations<br>3. The students will be able to use advanced statistical software's such as R for the analysis of complex statistical data coming from the various fields like industry, marketing, finance, agriculture and business**.** | |

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: I / Semester: II**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. **Class:** M.Sc.(Statistics) | Year: I<br><br>Semester: II |
| **Credits 4**<br>Theory: 4 | **Subject: Statistics** |
| **Course Code:MSST-121** | **Title: Design of Experiments and Linear Estimation** |

**Course Objectives:**
To provide background of the fundamental theories and practices of statistical modeling and the analysis of observational, experimental and survey data, including continuous, binary and categorical data.

**Nature of Paper:** Core

**Minimum Passing Marks/Credits: 40% Marks**

L: 4
T:
P: (In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | **Design of Experiments**<br>Analysis of Variance, One-way ANOVA, Two-way ANOVA and Three-way ANOVA with their layout and statistical analysis, Analysis of Covariance for a one- way layout with concomitant variable, Analysis of Covariance for a RBD layout with concomitant variable.. | **10** |
| II | Principles of design of experiments, Uniformity trials, completely randomized, Randomized block and Latin square designs including missing plot techniques and their efficiency comparison, Split plot and strip plot designs | **10** |
| III | Factorial experiments ($2^n$, $3^2$, $3^3$ systems only), Complete and Partial confounding, balanced incomplete block designs with parametric relations and analysis under a fixed effect model | **10** |
| IV | Linear Estimation, Gauss-Markov set-up, Random & Mixed Models, Error & Estimation Space, Gauss-Markov Theorem, Least Square Estimates, Normal Equations, Residual Sum of Squares | **10** |
| V | Normal Equations, Residual Sum of Squares, BLUE, Conditions for Quadratic forms to be Chi-Square distributed, and Cochran's Theorems. | **10** |

| | |
|---|---|
| **Reference / Text Books:**<br>1. Biswas Suddendu, A Linear Model Approach To Regression Analysis & Its Application- New Age International Publication.<br>2. Bapot R.B., Linear Algebra and Linear Model- Cambridge University Press.<br>3. Goon Gupta and Das Gupta, Fundamentals Of Statistics- S. Chand & Company, New Delhi<br>4. Das and Giri, Design Of Experiments- Wiley Eastern Ltd. New Delhi.<br>5. Chochran W.G. and G.M., Experimental Design- John Wiley and Sons New York.<br>6. Waynee Lee, Experimental Design and Analysis- W.H. Freema and Company San Francisco<br>7. Kempthorne, O, The Design and Analysis Of Experiment- Wiley Eastern Ltd, New Delhi.<br>8. Winer B.J., Statistical Principles In Experimental Design- Tata Mc-Graw Hill Publishing Co.<br>9. Federer W.T, Experimental Design- Oxford & IBM Publishing Company. | |
| If the course is available as Generic Elective then the students of following departments may opt it.<br>1. BSc(Ag) | |
| **Evaluation/Assessment Methodology** | |
| | **Max. Marks** |
| 1) Class tasks/ Sessional Examination | 25 |
| 2) Assignments | 5 |
| 3) ESE | 70 |
| **Total:** | 100 |
| Prerequisites for the course: Knowledge of Statistics taught in the preceding semester. | |
| **Course Learning Outcomes:**<br>Students should be able to understand the random behavior of experimental processes, particularly, scientific, engineering and industrial. | |

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: I / Semester: II**

<table>
<tr><td colspan="2">Programme:<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>Class: M.Sc.(Statistics)</td><td>Year: I<br><br>Semester: II</td></tr>
<tr><td colspan="2">Credits 4<br>Theory: 4</td><td>Subject: Statistics</td></tr>
<tr><td colspan="2">Course Code:MSST-122</td><td>Title: Inference-I: Point Estimation and Testing of Hypothesis</td></tr>
<tr><td colspan="3">Course Objectives:<br>The purpose of estimation theory is to arrive at an estimator that exhibits optimality. The estimator takes observed data as a an input and produces an estimate of the parameters.</td></tr>
<tr><td colspan="3">Nature of Paper: Core</td></tr>
<tr><td colspan="3">Minimum Passing Marks/Credits: 40% Marks</td></tr>
<tr><td colspan="3">L: 4<br>T:<br>P: (In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)</td></tr>
<tr><td>Unit</td><td>Contents</td><td>No. of Lectures Allotted</td></tr>
<tr><td>I & II</td><td>Properties of good estimators: consistency, unbiasedness, efficiency, sufficiency, and completeness, Crammer Rao-Inequality its applications and examples, Characterization of distribution admitting sufficient statistics, Rao-Blackwell theorem and Lehman-Scheffe' theorem, Uniformly minimum variance unbiased estimation</td><td>20</td></tr>
<tr><td>III</td><td>Methods Of Estimation: Method of maximum likelihood, Moments, Minimum Chi- Square, properties of M.L.E, existence of a best asymptotically normal estimate under regulatory conditions, Hazor Bazar theorem.</td><td>10</td></tr>
<tr><td>IV & V</td><td>Classical Hypothesis testing: Simple & Composite Hypothesis, Concept of Critical Regions, Test Functions, Two Types of Error, Power of the Test, Level of Significance, Neyman-Pearson Lemma & its Generalization, Uniformly Most Powerful Tests, UMP Test of One-sided Hypothesis for Distributions with Monotone Likelihood Ratio Test, Randomized Tests, UMPU, Types A, A1 Critical Regions, Likelihood Ratio Test, Similar Test.</td><td>20</td></tr>
</table>

**Reference / Text Books:**

1. Goon A.M., Gupta M.K., & Das Gupta B. An Outline of Statistical Theory V-II- The World Press Private Ltd., Calcutta.
2. Rohtagi V.K. An Introduction to Probability Theory and Mathematical Statistics- Wiley Eastern Ltd., New Delhi.
3. Hogg R.V. & Craig A.T. Introduction to Mathematical Statistics- Mac-Millan Publications Ltd. New York.
4. Lehmann E.L. Theory of Point Estimation – John Wiley & Sons New York.
5. Mood Grabill& Bose Introduction to the Theory Of Statistics- Mc-Graw Hill
6. Rohtagi V.K. Statistical Inference- Wiley Eastern Ltd. New Delhi.
7. Kalbfleiseh J.G. Probability and Statistical Inference Vol-I & II- Springer- Verlag New York
8. Saxena & Surendran Statistical Inference – S.Chand& Co Ltd., New Delhi.
9. Jacks S. The Theory Of Statistical Inference- Chapman & Hall London.
10. Kale B.K. Parametric Inference – Narosa Publishing House, New Delhi.
11. Mukhopadhyay P. Mathematical Statistics- New Central Book Agency, Calcutta

If the course is available as Generic Elective then the students of following departments may opt it.

1. NA

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 25 |
| 2) Assignments | 5 |
| 3) ESE | 70 |
| **Total:** | 100 |

Prerequisites for the course: Knowledge of Statistics taught in the preceding semester.

**Course Learning Outcomes:**

This course will make a student to learn the various properties of a good estimator as well as techniques to develop such estimators from both classical and Bayesian point of view.

**IIMTU-NEP IMPLEMENTATION**
**Year: I / Semester: II**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D.<br>**Class:** M.Sc.(Statistics) | Year: I<br><br>Semester: II |
| **Credits 4**<br>Theory: 4 | **Subject: Statistics** |
| **Course Code:MSST-123** | **Title: Matrices and Linear Difference Equations** |

**Course Objectives:**
To enable the readers to have a proper appreciation of the subject matter and to fortify their confidence in the understanding and application of methods.

**Nature of Paper:** Core

**Minimum Passing Marks/Credits: 40% Marks**

L: 4
T:
P: (In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | **Matrices:** Algebra of matrices, matrices associated with a given matrix. Symmetric, Skew-symmetric, Hermitian and Skew–Hermitian matrices with their properties, Inverse of a matrix and the related theorems, Trace of a matrix, Idempotent, Involutory and Nilpotentmatrices. | **10** |
| II | Definition of rank, Elementary transformations and their impact on rank, Elementary matrices and their inverse, Normal form of a matrix and related important theorems, rank of a product of two matrices.<br>Vector and Vector–space, linearly dependent and independent set of vectors and the related theorems, Sub-Space of an n-vector space, Basis of a sub space. | **10** |
| III | System of linear homogeneous and non homogeneous equations, Necessary and sufficient conditions for the consistency of a system of non-homogeneous equations.<br>Characteristic matrix, equation and roots of a matrix, Caley Hamilton theorem, Unitary and Orthogonal matrices, Inner product of vectors and length of a vector , orthogonalvectors. | **10** |
| IV | Quadratic forms, Congruence of quadratic forms, Canonical form, Definite, semi- definite and indefinite quadratic forms, Orthogonal reduction of a real symmetric matrix, Simultaneous | **10** |

| | | |
|---|---|---|
| | reduction of a pair of quadratic forms. | |
| V | **Linear Difference Equations:** Difference equation with its applications and properties in various fields. Solutions of the first order linear homogeneous/non- homogeneous difference equations with constant coefficient by operator and trial methods. Solutions of the linear homogeneous difference equations with variable coefficients. | **10** |

**Reference / Text Books:**

1. Vashishtha A.R, ”Matrices:”, Krishna Prakashan Media Pvt. Ltd.
2. Narayan, S., “A Text Book Of Matrices”, S Chand & Co Ltd., New Delhi.
3. Bishwas S., “A Text Book Of Matrix Algebra”, Khanna Publications, New Delhi.
4. Goel & Mittal, ” Numerical Mathematics”
5. Saran, N., ”Introduction tomatrices”
6. Sharma, M.M., “Linear Difference Equations.” Krishna Prakashan
7. Goel and Mittal, “Numerical Methods.”
8. Gupta and Aggarwal, “Linear Difference Equations.”

If the course is available as Generic Elective then the students of following departments may opt it.
1.B.Sc. (Mathematics)
2.MSc. (Mathematics)

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 25 |
| 2) Assignments | 5 |
| 3) ESE | 70 |
| **Total:** | 100 |

Prerequisites for the course: Knowledge of Statistics taught in the preceding semester.

**Course Learning Outcomes:**
Students should be able to understand the concept and principles of differential calculus to solve different geometric and physical problems that may arise in business, economics and life sciences.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: I / Semester: II**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. **Class:** M.Sc.(Statistics) | Year: I<br><br>Semester: II |
| **Credits 4**<br>Theory: 4 | **Subject: Statistics** |
| **Course Code:MSST-124** | **Title: Real and ComplexAnalysis** |
| **Course Objectives:**<br>The main object of studying the course is to follow up various properties and important formulae related to real and complex numbers with their proofs. | |
| **Nature of Paper:** Core | |
| **Minimum Passing Marks/Credits: 40% Marks** | |
| L: 4<br>T:<br>P: (In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits) | |

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | **Real Analysis:** Concepts of continuity and differentiability , Roll's theorem with its geometric interpretation, Lagrange's and Cauchy's mean value theorems, Taylor's development of a function in a finite form with Lagranges's, Cauchy's and Roche's forms of remainders. | **10** |
| II | Double and Multiple integrals, Change of order of integration, Beta and Gamma functions, Dirichlet's multiple integrals and its Liouville's extension. Convergence of Improper integrals.. | **10** |
| III | Laplace and Laplace-Stieltjes transforms with their important properties. Inverse Laplace-transform and various methods to obtain it. Mean and Variance in terms of L.T. Solution of simple differential and differential-difference equations by using L.T. | **10** |
| IV | **Complex Analysis:** Fundamental operations of complex numbers, Properties of the moduli and arguments, Geometric representation of algebric operations. Limites, continuity and differentiability of a complex valued function. Analytic function, Cauchy-Riemann equations. Harmonic function, Methods for construction of analytic function. | **10** |
| V | Complex integration, Cauchy's fundamental theorem, Cauchy's integral formula and its extension, Cauchy's integral formula for the first and nth derivative of analytic function, Liouville's, Taylor's | **10** |

| | | |
|---|---|---|
| | and Laurent's theorems. Zeros and various types of singularities of an analytic function. Contour integration. | |

**Reference / Text Books:**

1. Shanti Narayan: A course of mathematicalanalysis.
2. Rudin, W.: Principles of mathematicalanalysis.
3. Richardson, C.H.: An Introduction to calculus of finite differences.
4. Goel & Mittal: Numerical mathematics.
5. Sharma, J.N.: Infiniteseries.
6. Phillips, E.G.: Functions of a complexvariable.
7. Sharma, J.N.: Functions of a complexVariable.
8. Sharma,J.N. &Vasishtha,A.R.: Realanalysis.
9. Gupta,R.K.: Theory of functions of a complexvariables.
10. Spiegel, M.R.: Complexvariables

If the course is available as Generic Elective then the students of following departments may opt it.

1. B. Sc. (Mathematics)

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 25 |
| 2) Assignments | 5 |
| 3) ESE | 70 |
| **Total:** | 100 |

Prerequisites for the course: Knowledge of Statistics and Mathematics taught in the preceding semester.

**Course Learning Outcomes:**

The students will be able to apply the tools studied in the course in his further studies of statistical courses and research investigation.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: I / Semester: I**

<table>
<tr><td colspan="2">Programme:<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>Class: M.Sc.(Statistics)</td><td colspan="2">Year: I<br><br>Semester: II</td></tr>
<tr><td>Credits: 2<br>Practical: 2</td><td colspan="3">Subject: Statistics</td></tr>
<tr><td>Course Code:MSST-121P</td><td colspan="3">Title: Statistical Lab-II</td></tr>
<tr><td colspan="4">Course Objectives:<br>These concepts will be verified by experimental means:<br>1) To provide background of the fundamental theories and practices of statistical modeling and the analysis of observational, experimental and survey data, including continuous, binary and categorical data.<br>2) The purpose of estimation theory is to arrive at an estimator that exhibits optimality. The estimator takes observed data as an input and produces an estimate of the parameters.<br>3) The main object of studying the course is to follow up various properties and important formulae related to real and complex numbers with their proofs.</td></tr>
<tr><td colspan="4">Nature of Paper: Core</td></tr>
<tr><td colspan="4">Minimum Passing Marks/Credits: 50% Marks</td></tr>
<tr><td colspan="4">L:<br>T:<br>P: 4 (In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)</td></tr>
<tr><td colspan="2">Topics</td><td>No. of Practical</td><td>No. of Lectures Allotted</td></tr>
<tr><td colspan="2">Matrices<br>Real and Complex Analysis<br>Design of Experiments<br>Theory of Estimation & Testing ofHypothesis</td><td>05<br>05<br>10<br>10</td><td>60</td></tr>
<tr><td colspan="4">Reference / Text Books:<br>Suggested Readings:</td></tr>
<tr><td colspan="4">As suggested for papers code MSST 121, MSST 122, MSST 123 and MSST 124.</td></tr>
<tr><td colspan="4">If the course is available as Generic Elective then the students of following departments may opt it.<br>1. B.Sc. (Ag)<br>2. B.Sc. (Mathematics)</td></tr>
</table>

| Evaluation/Assessment Methodology | |
|---|---|
| Continuous Internal Evaluation shall be based on Practical File/Record, Class Activities and Overall performance. The marks shall be as follows: | **Max. Marks** |
| 1) Practical File/Record | **10** |
| 2) Class Interaction | **5** |
| 3) Report Preparation | **5** |
| 4) Practical Exam | **30** |
| **Total:** | **50** |

Prerequisites for the course: Knowledge of practical Statistics taught in the preceding semester and theories taught in the present semester.

**Course Learning Outcomes:**

After completing this course a student will have these skills:

1. Students should be able to understand the random behavior of experimental processes, particularly, scientific, engineering and industrial.
2. This course will make a student learn the various properties of a good estimator as well as techniques to develop such estimators from both classical and Bayesian point of view.
3. The students will be able to apply the tools studied in the course in his further studies of statistical courses and research investigation

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: II / Semester: III**

<table>
<tr><td colspan="2">Programme:<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>Class: M.Sc.(Statistics)</td><td colspan="2">Year: II<br><br>Semester: III</td></tr>
<tr><td colspan="2">Credits 4<br>Theory: 4</td><td colspan="2">Subject: Statistics</td></tr>
<tr><td colspan="2">Course Code:<br>MSST-231</td><td colspan="2">Title: Inference-II: Interval Estimation, Sequential Analysis & Non-Parametric Inference</td></tr>
<tr><td colspan="4">Course Objectives:<br>The aim of the course is to provide deeper knowledge of the inferential statistics such as sequential estimation, OC and ASN functions, loss and risk functions, one, two and k-samples non-parametric tests.</td></tr>
<tr><td colspan="4">Nature of Paper: Core</td></tr>
<tr><td colspan="4">Minimum Passing Marks/Credits: 40% Marks</td></tr>
<tr><td colspan="4">L: 4<br>T:<br>P: (In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)</td></tr>
<tr><td>Unit</td><td colspan="2">Contents</td><td>No. of Lectures Allotted</td></tr>
<tr><td>I</td><td colspan="2">Interval Estimation: Confidence Regions, Best Confidence Intervals, Shortest Confidence Intervals, General Method of finding Confidence Interval, and Relationship with the Testing of Hypothesis.</td><td>10</td></tr>
<tr><td>II & III</td><td colspan="2">Sequential Analysis: Sequential probability ratio test and their applications to binomial, normal and other simple cases, O.C. and A.S.N. functions and their applications, termination theorem of SPRT with probability one. Wald’s fundamental identity and its uses</td><td>20</td></tr>
<tr><td>IV & V</td><td colspan="2">Non-Parametric Inference :Probability Integral Transformation, Estimation Of Quantiles, Construction of Confidence Interval for Population Quantiles, Estimation & Testing, Test for Randomness, Test based on Runs & Sign for one & two samples problems, Median test, Wilcoxon and Mann-Whitney tests. Kolmogorov-Smrinov test for one and twosamples.</td><td>20</td></tr>
<tr><td colspan="4">Reference / Text Books:<br>1. Wald A, “Sequential Analysis”- John Wiley and Sons NewYork<br>2. Gibbons J.D., “Non- parametric Statistical Inference”. McGraw Hill International Edition.<br>3. Siegel S, “Non Parametric Statistics for Behavioral Sciences”- McGraw Hill Edition.<br>4. Mood Grabill and Boss, “Introduction to the Theory of Statistics”.-Mc-Graw Hill.</td></tr>
</table>

5. Goon A.M.,Gupta M.K. and Das Gupta B. “An Outline of Statistical Theory V-II”.-The World Press Private Ltd. Calcutta.
6. Rohatgi V.K., “An Introduction to Probability Theory and Mathematical Statistics- Wiley Eastern Ltd. New Delhi.
7. Wald A. Statistical Decision Functions”- John Wiley and Sons, NewYork.
8. Ferguson T.S., “Mathematical Statistics-A Decision Theoretic Approach”- AcademicPress.


If the course is available as Generic Elective then the students of following departments may opt it.

1. NA

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 25 |
| 2) Assignments | 5 |
| 3) ESE | 70 |
| **Total:** | 100 |

Prerequisites for the course: Knowledge of Statistics taught in the preceding semester.

**Course Learning Outcomes:**

The students will be able to demonstrate knowledge and understanding of the principles and theory of statistical inference and the ability to formulate statistical hypothesis and to use theory to estimate model parameters.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: II / Semester: III**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D.<br>**Class:** M.Sc.(Statistics) | Year: II<br><br>Semester: III |
| **Credits 4**<br>Theory: 4 | **Subject: Statistics** |
| **Course Code:MSST-232** | **Title: Engineering Statistics, Quality Control and Reliability Theory** |

**Course Objectives:**
The objective of the course is to have the knowledge of various methods to control the quality of a product and to increase the reliability of a device/system.

**Nature of Paper:** Core

**Minimum Passing Marks/Credits: 40% Marks**

L: 4
T:
P: (In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | **Quality Control:** Concept of quality and meaning of control, Product and Process controls. Concept of 3-sigma limits. Modified and Specifications limits. Different types of control charts like □X, R, np, p and c with their applications in industry. | **10** |
| II | 100% inspection sampling, sampling inspection v/s 100% inspection. Single, Double, Multiple and sequential sampling plans for attributes. OC, AOQL, ASN and ATI curves. Concept of producer's and consumer's risk, AQL and LTPD. Variable sampling plans. | **10** |
| III | **Reliability Theory:** Concepts of reliability, point wiseand steady state availabilities, hazard rate, failure and bath-tub failure rate curve. Constant, linearly increasing and non-linear increasing hazard models. | **10** |
| IV | Gamma, normal, log-normal and truncated normal failure laws. Mean time to system failure (MTSF) and mean time between failures. Series, parallel, k-out of n, series-parallel, parallel-series, and non-series parallel configurations. Concept of redundancy, comparison of component, unit and stand by redundancies. | **10** |
| V | Analysis of reliability and MTSF of n-unit standby redundancy. Concepts of repair and preventive-maintenance (P.M.). Analysis of-n | **10** |

| | | |
|---|---|---|
| | non-identical unit series system with constant failure and repair rates, two identical unit active and passive redundant systems with constant failure and repair rates. Concepts of imperfect switching device, priority and non-priority repairs. | |

**Reference / Text Books:**


1. Barlow R.F. and Proschan F. Mathematical Theory of Reliability- John Wiley and Sons.
2. Sri Nath L.S., Mathematical Theory Of Reliability- Affiliated East West Press Pvt. Ltd.
3. Balagurusamy , E., Reliability Engineering- Tata Mc-Graw Hill Publications, New Delhi.
4. Govil A.K., Reliability Engineering.
5. Duncan A.J., Quality Control and industrial Statistics
6. Ekambaram, Acceptance Sampling
7. Bowkder A.K. and Goode H.P., Sampling Inspection by Variables- Mc-Graw Hill Edition.
8. Montogomary, Introduction to Statistical Quality Control- John Wiley and Sons, New York
9. Goon Gupta and Das Gupta, Fundamentals Of Statistics Vol-II. The World Press Pvt. Ltd.
10. Dimitri Kececioglu, Reliability and Life Testing Hand Book- Prentice Hall PTR, New Jersey
11. Suddendu Biswas, Statistics Of Quality Control- Prentice Hall Of India, Pvt. Ltd.
12. Ernest, G. Frankel : System reliability and riskanalysis.


If the course is available as Generic Elective then the students of following departments may opt it.

1. B.Tech

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 25 |
| 2) Assignments | 5 |
| 3) ESE | 70 |
| **Total:** | 100 |

Prerequisites for the course: Knowledge of Statistics taught in the preceding semester.

**Course Learning Outcomes:**

The students will be able to apply the fundamental tools/methods in various industrial plants.

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: II / Semester: III**

| | | |
|---|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D.<br>**Class:** M.Sc.(Statistics) | | Year: II<br><br>Semester: III |
| **Credits 4**<br>Theory: 4 | **Subject: Statistics** | |
| **Course Code:MSST-233** | **Title: Operations Research- I** | |
| **Course Objectives:**<br>To provide the ideas of formulating mathematical modeling and their optimum solution in the context of practical problems belonging to Govt./Pvt.Sectors. | | |
| **Nature of Paper:** Core | | |
| **Minimum Passing Marks/Credits: 40% Marks** | | |
| L: 4<br>T:<br>P: (In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits) | | |

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | **Introduction:** Definition and scope of operations research, Different types of models used in OR. Various phases of OR.<br>**Allocation Problems:** Mathematical formulation of L.P.P, Graphical method to solve a L.P.P, Convex set, Convex combination and extreme points. Simplex method to solve a L.P.P with slack, Surplus and Artificial variables. Construction of dual of a L.P.P. | **10** |
| II | **Inventory Control:** Problems of inventory and the various costs associated with inventory control. EOQ models with uniform/non-uniform rate of demands when shortages are allowed and not allowed while the replenishment of inventory is instantaneous. EOQ models with uniform rate of demands when shortages are allowed/not allowed and replenishment of the inventory is non-instantaneous. Single period inventory models with no set up cost and demand rate is discrete/continuous r.v. Newspaper Boy problem. | **10** |
| III | **Transportation Problem:** Mathematical formulation of a transportation problem, Northwest corner rule, unit cost penalty method and method of matrix minima. Optimality test, Unbalanced transportation problem, Degenerecy in transportation problems.<br>Assignment Problems: Assignment problems, formulation of these problems and their solutions, Unbalanced Assignment problems. | **10** |

| | | |
|---|---|---|
| IV | **Game Theory:** Criteria of pure and mixed strategies, pay-off matrix and saddle point. Solution of zero sum two person games- 2□2, 2□n, m□2 and m□n by minimax and maximin technique, arithmetic method, algebraic method, dominance principle, graphical method matrix method, sub-game method and linear programming techniques. | **10** |
| V | **Queueing Theory:** Introduction of the queuing system, Various components of a queueing system. Pure Birth Process; Pure Death Process, Birth and Death Process, M/M/1, M/M/1 (Generalised), M/M/1 FCFS/K/□, M/M/C, Ample Server models, Erlang's loss model, Machine repair problem. | **10** |

**Reference / Text Books:**


1. Gass, S.I , A Linear Programming Methods and Applications- Mc-Graw Hill Publishing Co.
2. Taha , Operations Research and Introduction- Mac-Millan Publishing Co., New York.
3. Churchman C.W., Ackoff R.L. and Arnoff E.L., Introduction To Operations Research-John Wiley and Sons, New York.
4. Saaty T.L., Mathematical Methods Of operations Research, Mc-Graw Hill Book Co., New York.
5. Satty, T.L., Elements Of Queueing Theory – Mc-Graw Hill Book Co., New York.
6. Yaspan A., Sasieni M., & Fiedman L., Linear Programming methods and Applications-John Wiley and Sons NewYork.
7. Churchill R.V., Operation Mathematics-Mc- Graw Hill Kogakusha Ltd., Calcutta.
8. Kanti Swaroop and Manmohan, Operations Research- S. Chand and Co., New Delhi.
9. Sharma S.D., Operations Research- Pragati Prakashan, Meerut.
10. Gupta R.K., Linear Programming- Krishna Prakashan Media Pvt. Ltd., Meerut.
11. Jones A.J., Games Theory- John Wiley and Sons- New York.
12. Straffin E.D., Games Theory and Strategy- The Mathematical Association Of America.
13. Thomas L.C., Games Theory and Applications- John Wiley and Sons, New York.


If the course is available as Generic Elective then the students of following departments may opt it.

1. M.B.A

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 25 |
| 2) Assignments | 5 |
| 3) ESE | 70 |
| **Total:** | 100 |

Prerequisites for the course: Knowledge of Statistics taught in the preceding semester.

**Course Learning Outcomes:**

The students will be able to apply the fundamental tools/methods in various industrial plants.

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: II / Semester: III**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D.<br>**Class:** M.Sc.(Statistics) | Year: II<br><br>Semester: III |
| **Credits 4**<br>Theory: 4 | **Subject: Statistics** |
| **Course Code:MSST-234(a)** | **Title: Decision Theory &Bayesian Inference** |

**Course Objectives:**
The course aims to include the methods of testing of hypothesis and its counterpart interval estimation both in classical as well as Bayesian frame work.

**Nature of Paper:** Core

**Minimum Passing Marks/Credits: 40% Marks**

L: 4
T:
P: (In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | **Decision Theory**: Loss function, Risk function, Randomised and Non-Randomised Decision Rules, Admissible Decision Rule, Complete, Essential complete and minimal complete classes of decision rules and their relationship, Minimax and Bayes decision rules, Estimation testing viewed as decision rule problem, Bayes and minimax estimators. Minimax and Bayes tests in simple cases. | **10** |
| II & 1II | **Bayes Estimation:** An outline of Bayesian framework, Bayes Theorem, Types of priors, Conjugate prior, proper and improper prior, subjective prior etc., Methods of obtaining priors, Types of loss functions, Squared error loss function, Absolute error loss, O-1 loss, Asymmetric loss functions such as LINEX and Entropy loss functions, Mixture of loss functions, Computation of posterior distribution, Bayesian calculations, Monte Carlo Technique, Approximation methods, Emperical method, Gibbs sampler. | **20** |
| IV | **Bayesian Interval Estimation:** Credible Intervals, Highest Posterior Density Regions, Interpretation of the Confidence Coefficient of an Interval & its Comparison with the Coefficient of Classical Confidence Intervals. | **10** |
| V | **Bayesian Hypothesis testing:** Specification of the Appropriate Form of the Prior Distribution for a Bayesian Testing of Hypothesis | **10** |

| | | |
|---|---|---|
| | Problem, Prior Odds, Posterior Odds, Bayes Factor, Bayesian Information Criterion(BIC). | |

**Reference / Text Books:**


1. Mood Grabill and Boss, "Introduction to the Theory of Statistics"-Mc-Graw Hill.
2. Goon A.M., Gupta M.K. and Das Gupta B., "An Outline of Statistical Theory V-II"-The World Press Private Ltd. Calcutta.
3. Rohatgi V.K., "An Introduction to Probability Theory and Mathematical Statistics" Wiley Eastern Ltd. NewDelhi.
4. Hogg R.V. and Craig A.T., "Introduction to Mathematical Statistics"-Macmillion Publications.
5. Wald A., "Statistical Decision Functions"- John Wiley and Sons. New York.
6. Ferguson T.S., "Mathematical Statistics"-A Decision Theoretic Approach- Academic Press.
7. Robert, C.P., Casella, "Monte Carlo Statistical methods" G. Springer, New York.
8. Berger, J.O., "Statistical Decision Theory and Bayesian Analysis", Springer Series.


If the course is available as Generic Elective then the students of following departments may opt it.

1. NA

| Evaluation/Assessment Methodology | |
|---|---|
| | **Max. Marks** |
| 1) Class tasks/ Sessional Examination | 25 |
| 2) Assignments | 5 |
| 3) ESE | 70 |
| **Total:** | 100 |

Prerequisites for the course: Knowledge of Statistics taught in the preceding semester.

**Course Learning Outcomes:**

After learning this course a student must be able to develop tests and confidence intervals for population parameters.

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: II / Semester: III**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D.<br>**Class:** M.Sc.(Statistics) | Year: II<br><br>Semester: III |
| **Credits 4**<br>Theory: 4 | **Subject: Statistics** |
| **Course Code:MSST-234(b)** | **Title: Stochastic Process& Survival Analysis** |
| **Course Objectives:**<br>Keeping in view the need of the course, the aim is to study the different types of stochastic process, random walk, renewal theory with their wide applicability in social science, economics and management sciences. | |
| **Nature of Paper:** Core | |
| **Minimum Passing Marks/Credits: 40% Marks** | |
| L: 4<br>T:<br>P: (In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits) | |

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | **Stochastic Process:** Markov Chain, Champman Kolmogorov equation, classification of states, criteria for ergodic, persistent null and transient states, stationary distributions, limit theorems on transient and persistent null states | **10** |
| II | Pure birth process, pure death process, birth and death processes, Yule-Furry process, Stationary process, Kolmogorov forward and backward equations, Counting Process, Poisson process, Generalized, filtered and compound Poisson process, | **10** |
| III | Random walk, Wiener processes, Gaussion processes, mean function and covariance, Kernal strictly stationary and covariance stationary processes, Processes with independent increments, Renewal equations. | **10** |
| IV & V | **Survival Analysis:** Definition of survival function, Failure-rate and hazard function, Mean residual life and their relationship, Problems of life testing, Estimation of average life and survival function with type-I and type-II censored experiments, Discussion of different procedures followed in life testing experiments, Estimation of survival parameters with Exponential, Weibull, Normal, Log-normal and Gamma models for failure data. | **20** |

**Reference / Text Books:**


1. Cox, D.R. and Miller,H.D.: The Theory Of Stochastic Processes.
2. Deeb, J.L. : Stochastic Processes.
3. Srinivasan, S.K. and Processes. Menata, K.K. : Stochastic
4. Bartlett, M.S. : Introduction to Stochastic Processes.
5. Prabhu,N.U. : Stochastic Processes.
6. Sinha,S. K. : Reliability and Life Testing.
7. Lawless, J.F. : Statistical Models and Methods for Life Time Data.
8. Mann Scheffer and Life Data. And Singupurwalla : Methods for Statistical Analysis of Reliability


If the course is available as Generic Elective then the students of following departments may opt it.

1. NA

**Evaluation/Assessment Methodology**

| | Max. Marks |
|---|---|
| 1) Class tasks/ Sessional Examination | 25 |
| 2) Assignments | 5 |
| 3) ESE | 70 |
| **Total:** | 100 |

Prerequisites for the course: Knowledge of Statistics taught in the preceding semester and taught in under graduation level.

**Course Learning Outcomes:**

The knowledge of the course can be applied in various diverse fields such as operations research, finance and insurance sectors, banking, planning & forecasting.

**IIMTU-NEP IMPLEMENTATION**
**Year: II / Semester: III**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. **Class:** M.Sc.(Statistics) | Year: II<br><br>Semester: III |
| **Credits: 2** Practical: 2 | **Subject:** Statistics |
| **Course Code:MSST-231P** | **Title: Statistical Lab-III** |

**Course Objectives:**
These concepts will be verified by experimental means:
1. The aim of the course is to provide deeper knowledge of the inferential statistics such as sequential estimation, OC and ASN functions, loss and risk functions, one, two and k-samples non-parametric tests.
2. The objective of the course is to have the knowledge of various methods to control the quality of a product and to increase the reliability of a device/system.
3. Keeping in view the need of the course, the aim is to study the different types of stochastic process, random walk, renewal theory with their wide applicability in social science, economics and management sciences.

**Nature of Paper:** Core

**Minimum Passing Marks/Credits: 50% Marks**

L:
T:
P: 4 (In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| Topics | No. of Practicals | No. of Lectures Allotted |
|---|---|---|
| Quality Control | 10 | 40 |
| Interval Estimation, Sequential Analysis & Non-Parametric Inference | 15 | |
| Operation Research I | 05 | |
| Bayesian/Survival Analysis | 05 | |

**Reference / Text Books:**
**Suggested Readings:**
**As suggested for papers code MSST 231, MSST 232, MSST-233 and MSST 234(a)/(b).**

If the course is available as Generic Elective then the students of following departments may opt it.
1. B.Tech.

| **Evaluation/Assessment Methodology** | |
|---|---|
| Continuous Internal Evaluation shall be based on Practical File/Record, Class Activities and Overall performance. The marks shall be as follows: | |
| | **Max. Marks** |
| 1) Practical File/Record | **10** |
| 2) Class Interaction | **5** |
| 3) Report Preparation | **5** |
| 4) Practical Exam | **30** |
| **Total:** | **50** |
| Prerequisites for the course: Knowledge of practical Statistics taught in the preceding semesters and theories taught in the present semester. | |

**Course Learning Outcomes:**

After completing this course a student will have these skills:

1. The students will be able to demonstrate knowledge and understanding of the principles and theory of statistical inference and the ability to formulate statistical hypothesis and to use theory to estimate model parameters.
2. The students will be able to apply the fundamental tools/methods in various industrial plants.
3. The knowledge of the course can be applied in various diverse fields such as operations research, finance and insurance sectors, banking, planning & forecasting.

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: II / Semester: IV**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. **Class:** M.Sc.(Statistics) | Year: II Semester: IV |
| **Credits 4** Theory: 4 | **Subject: Statistics** |
| **Course Code:MSST-241** | **Title: Multivariate Analysis** |

**Course Objectives:**
To provide practical training and experience in the application of the theory to the statistical modeling of data from real applications, including model identification, estimation and interpretation.

**Nature of Paper:** Core

**Minimum Passing Marks/Credits: 40% Marks**

L: 4
T:
P: (In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | Multivariate Normal Distribution, Distribution of Random Vector Y = CX when C is a Non-Singular Matrix, Distribution of p-variate Random Vector Z = DX when D is a qxp matrix of rank q(<p), Marginal & Conditional Distributions of a Sub-Vector of a Normally Distributed Vector, Moment Generating Function & Characteristic Function of a Normally Distributed Random Vector, Additive property of a p-variate NormalDistribution. | **10** |
| II | Maximum Likelihood Estimators of Mean Vector and Co-Variance Matrix, Distribution of the Sample Mean Vector, Distribution of the Quadratic Form, $Y' T^{-1} Y$ when Y~ Np (0,T), and T is Non-Singular, Tests & Confidence Regions for μ when Λ is known, Sufficient statistics for μ and Λ. | **10** |
| III | Hotelling's $T^2$ Statistic as a function of Likelihood Ratio Criterion, its Distribution, Applications and Invariant property, Mahalanobis $D^2$ Statistic, Wishart Distribution with derivation & its properties. | **10** |
| IV | Problem of Classification into one of two categories, Procedures of Classification into one of two populations with known density functions, Priori probabilities & costs of misclassification, Best Regions of Classification into one of two known Multivariate | **10** |

| | | |
|---|---|---|
| | Normal Populations, Fisher's Discriminant Functions. | |
| V | Multiple regression Analysis, Multiple & Partial Correlations and their Estimation, Distributions of Partial & Multiple Correlation Coefficients in Samples from Multivariate Normal Populations in the Null cases only. | **10** |

**Reference / Text Books:**

1. Anderson T.W., "Multivariate Analysis"- Wiley Eastern Ltd., NewDelhi.
2. Giri N.C., "Multivariate Statistical Inference" – Charles Griffin and Co. Ltd. London
3. Rao, C.R, "Advanced Statistical Methods In Biometric Research"- John Wiley and Sons.
4. Morrison, D.F. "Multivariate Statistical Methods" Mcgraw Hill .International Edition.
5. Roy, S.N. "Some aspects of Multivariate analysis".
6. Singh,B.M. "Multivariate statistical analysis".

If the course is available as Generic Elective then the students of following departments may opt it.

1. NA

| Evaluation/Assessment Methodology | |
|---|---|
| | **Max. Marks** |
| 1) Class tasks/ Sessional Examination | 25 |
| 2) Assignments | 5 |
| 3) ESE | 70 |
| **Total:** | 100 |

Prerequisites for the course: Knowledge of Statistics taught in the preceding semesters.

**Course Learning Outcomes:**

The students should be able to demonstrate knowledge and understanding of parametric and nonparametric tests, discriminant analysis, factor analysis, and principal component analysis in medical, industrial, engineering, business and many other scientific areas.

**IIMTU-NEP IMPLEMENTATION**
**Year: II / Semester: IV**

<table>
<tr><td>Programme:<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>Class: M.Sc.(Statistics)</td><td colspan="2">Year: II<br><br>Semester: IV</td></tr>
<tr><td>Credits 4<br>Theory: 4</td><td colspan="2">Subject: Statistics</td></tr>
<tr><td>Course Code:MSST-242</td><td colspan="2">Title: Economic Statistics and Demography</td></tr>
<tr><td colspan="3">Course Objectives:<br>The course aims to study various models and components of time series analysis for forecasting purposes. It also gives the study of distribution of population with respect to birth, migration, aging and death.</td></tr>
<tr><td colspan="3">Nature of Paper: Core</td></tr>
<tr><td colspan="3">Minimum Passing Marks/Credits: 40% Marks</td></tr>
<tr><td colspan="3">L: 4<br>T:<br>P: (In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)</td></tr>
</table>

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I & II | **Time Series Analysis:** Objects, Decomposition, Tests of Randomness, Trend component, polynomial, logistic, Gompertz, Log-normal trend functions, smoothing of moving average , spencer's formulae and effects, Slutsky-yule effect, variate difference method, Measurement of seasonal and cyclical functions, peridogram and Harmonic Analysis. **Stationary Time Series:** Concepts, Autocorrelation and Correlogram analysis | **20** |
| III | **Demand Analysis:** Distribution of Income, Income and Demand elasticities. Method for estimating elasticities using family budget data and time series data, Engel's Curve and Engel's law. | **10** |
| IV & V | **Demography:** Sources of Demographic data, Limitations and uses of demographic data, vital rates and ratios, Definition, construction and uses, life tables, complete and abridged construction of life table from vital statistics and census returns, uses of life tables. Logistic and other population growth curves, Measure of fertility gross and net reproduction rates, stationary and stable population theory. Uses of Lotka's stable population theory in estimation of demographic parameters, methods of inter-censal and post-censal estimation. | **20** |

**Reference / Text Books:**

1. Goon Gupta and Das Gupta, Fundamentals Of Statistics V-II, The World Press, Pvt. Ltd.,
2. Kendall M .G.., The Advanced Theory Of Statistics Vol-I & II- Charles Griffin & Co. Ltd.,
3. Wald H, Demand Analysis- The Academic Press
4. Johnsonton J, Economic Models –John Wiley and Sons, New York.
5. Cox P.R., Demography- Cambridge University Press.
6. Biswas, S : Stochastic processes in demography and applications.

If the course is available as Generic Elective then the students of following departments may opt it.

1. BA(Economics)
2. MA(Economics)
3. MCom
4. MBA

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 25 |
| 2) Assignments | 5 |
| 3) ESE | 70 |
| **Total:** | 100 |

Prerequisites for the course: Knowledge of Statistics taught in the preceding semesters.

**Course Learning Outcomes:**

After studying this course one learns the most important technique of forecasting used in economic analysis. It will also equip a student with tools used in population studies.

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: II/ Semester: IV**

| | | |
|---|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D.<br>**Class:** M.Sc.(Statistics) | Year: II<br><br>Semester: IV | |
| **Credits 4**<br>Theory: 4 | **Subject: Statistics** | |
| **Course Code:MSST-243** | **Title: Operations Research-II** | |
| **Course Objectives:**<br>To provide the ideas of formulating mathematical modeling and their optimum solution in the context of practical problems belonging to Govt./Pvt. Sectors. | | |
| **Nature of Paper:** Core | | |
| **Minimum Passing Marks/Credits: 40% Marks** | | |
| L: 4<br>T:<br>P: (In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits) | | |

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | **Introduction:** Definition and scope of operations research, Different types of models used in OR. Various phases of OR.<br>**Allocation Problems:** Mathematical formulation of L.P.P, Graphical method to solve a L.P.P, Convex set, Convex combination and extreme points. Simplex method to solve a L.P.P with slack, Surplus and Artificial variables. Construction of dual of a L.P.P. | **10** |
| II | **Inventory Control:** Problems of inventory and the various costs associated with inventory control. EOQ models with uniform/non-uniform rate of demands when shortages are allowed and not allowed while the replenishment of inventory is instantaneous. EOQ models with uniform rate of demands when shortages are allowed/not allowed and replenishment of the inventory is non-instantaneous. Single period inventory models with no set up cost and demand rate is discrete/continuous r.v. Newspaper Boy problem. | **10** |
| III | **Transportation Problem:** Mathematical formulation of a transportation problem, Northwest corner rule, unit cost penalty method and method of matrix minima. Optimality test, Unbalanced transportation problem, Degenerecy in transportation problems.<br>Assignment Problems: Assignment problems, formulation of these problems and their solutions, Unbalanced Assignment problems. | **10** |

| | | |
|---|---|---|
| IV | **Game Theory:** Criteria of pure and mixed strategies, pay-off matrix and saddle point. Solution of zero sum two person games- 2□2, 2□n, m□2 and m□n by minimax and maximin technique, arithmetic method, algebraic method, dominance principle, graphical method matrix method, sub-game method and linear programming techniques. | **10** |
| V | **Queueing Theory:** Introduction of the queuing system, Various components of a queueing system. Pure Birth Process; Pure Death Process, Birth and Death Process, M/M/1, M/M/1 (Generalised), M/M/1 FCFS/K/□, M/M/C, Ample Server models, Erlang's loss model, Machine repair problem. | **10** |

**Reference / Text Books:**

1. Gass, S.I , A Linear Programming Methods and Applications- Mc-Graw Hill Publishing Co.
2. Taha, Operations Research and Introduction- Mac-Millan Publishing Co., New York.
3. Churchman C.W., Ackoff R.L. and Arnoff E.L., Introduction To Operations Research-John Wiley and Sons, New York.
4. Saaty T.L., Mathematical Methods Of operations Research, Mc-Graw Hill Book Co., New York.
5. Satty, T.L., Elements Of Queueing Theory – Mc-Graw Hill Book Co., New York.
6. Yaspan A., Sasieni M., & Fiedman L., Linear Programming methods and Applications- John Wiley and Sons NewYork.
7. Churchill R.V., Operation Mathematics-Mc- Graw Hill Kogakusha Ltd., Calcutta.
8. Kanti Swaroop and Manmohan, Operations Research-S.Chand and Co., New Delhi.
9. Sharma S.D., Operations Research- Pragati Prakashan, Meerut.
10. Gupta R.K., Linear Programming- Krishna Prakashan Media Pvt. Ltd., Meerut.
11. Jones A.J., Games Theory- John Wiley and Sons-New York.
12. Straffin E.D., Games Theory and Strategy- The Mathematical Association Of America.
13. Thomas L.C., Games Theory and Applications- John Wiley and Sons, NewYork.

If the course is available as Generic Elective then the students of following departments may opt it.

1. B.A. (Economics)
2. M.Com
3. MBA

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 25 |
| 2) Assignments | 5 |
| 3) ESE | 70 |
| **Total:** | 100 |

Prerequisites for the course: Knowledge of Statistics taught in the preceding semester and in under graduation level.

**Course Learning Outcomes:**

The knowledge of the contents of this course will help businessman/industrial managers to take optimum decisions/solutions to the executive type of problem.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: II / Semester: IV**

| | | |
|---|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D.<br>**Class:** M.Sc.(Statistics) | Year: II<br><br>Semester: IV | |
| **Credits 4**<br>Theory: 4 | **Subject: Statistics** | |
| **Course Code:MSST-244(a)** | **Title: Computer Oriented Statistical Methods** | |
| **Course Objectives:**<br>The objective of the course is to enhance the programming skills and working knowledge of available numerical and statistical softwares. | | |
| **Nature of Paper:** Core | | |
| **Minimum Passing Marks/Credits: 40% Marks** | | |
| L: 4<br>T:<br>P: (In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits) | | |

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I & II | Introduction to the statistical software R, Data objects in R, Creating vectors, Creating matrices, Manipulating data, Accessing elements of a vector or matrix, Lists, Addition, Multiplication, Subtraction, Transpose, Inverse of matrices. Read afile. Booleanoperators. | **20** |
| III | **R-Graphics:** Histogram, Boxplot, Steam and leaf plot, Scatter plot, matplot, Plot options; Multiple plots in a single graphic window, Adjusting graphicalparameters.<br>**Looping:** For loop, repeat loop, while loop, if command, if else command. | **10** |
| IV & V | **Statistical Methods:** Univariate and Multivariate statistics; Mean, Median, Variance, Covariance, Correlation, Linear regression. One and two sample t-tests, Analysis of Variance (ANOVA): Factor variables, ANOVA table, Multiple comparisions; Chi-square tests: goodness of fit, Contingency tables, Non-parametric tests, Distribution functions in R, A simulation application: Monte Carlo Integration, Random sampling, Bootstrapping. | **20** |

**Reference / Text Books:**


1. Alain F. Zuur, Elena N. Ieno, and Erik Meesters, “A Beginner’s Guide to R”, Springer, 2009, ISBN:978-0-387-93836-3.
2. Michael J. Crawley, “Statistics: An Introduction using R”, Wiley, 2005, ISBN0-470-02297-3.

3. Phil Spector, "Data Manipulation with R", Springer, New York, 2008, ISBN978-0-387-74730-9.
4. Maria L. Rizzo, "Statistical computing with R", Chapman & Hall/CRC, Boca Raton, FL, 2008, ISBN 1-584-88545-9.
5. W. John Braun and Duncan J. Murdoch, "A first course in Statistical programming withR", Cambridge University Press, Cambridge, 2007, ISBN978-0521872652.

If the course is available as Generic Elective then the students of following departments may opt it.

1. BCA (Data Science)
2. B.Sc. (Data Science)

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 25 |
| 2) Assignments | 5 |
| 3) ESE | 70 |
| **Total:** | 100 |

Prerequisites for the course: Statistics courses of first semester of study.

**Course Learning Outcomes:**

The students will improve their ability to think critically, to analyze a real problem and solve it using a wide array of mathematical tools. They will also be able to apply these ideas to a wide range of problems that include the Engineering applications.

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: II / Semester: IV**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D.<br>**Class:** M.Sc.(Statistics) | Year: II<br><br>Semester: IV |
| **Credits 4**<br>Theory: 4 | **Subject: Statistics** |
| **Course Code:MSST-244(b)** | **Title: Advanced Experimental Designs** |

**Course Objectives:**
The objective of the course is to provide the knowledge of the construction and analysis of various applied designs such as BIBD, Factorial, Different types of L.S.D. etc.

**Nature of Paper:** Core

**Minimum Passing Marks/Credits: 40% Marks**

L: 4
T:
P: (In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I & II | **Constructions:** Elementary Theory of groups, Elements of projective and Euclidean Geometries, Galois, Construction of -<br>1. Mutually orthogonal Latin squares<br>2. Hyper Graeco Latin Squares<br>3. Incomplete Block Designs (Balanced and Partially Balanced)<br>4. Totally and partially Confounded symmetric factorial designs. | **20** |
| III & IV | **Statistical Analysis:** Analysis of factorial design (2×4, 3×3, $3^2$) Square and rectangular lattice designs, partially balanced incomplete block designs with recovery of inter-block information. | **20** |
| V | **Response Surfaces:** Fractional replication in case of $2^n$ and $3^n$ types, Analysis of group experiments. | **10** |

**Reference / Text Books:**


1. Levi,F.W : AlgebraVol.-I
2. Mann,H.B. : Analysis and Design of Experiments (DoverPublication Inc., New York).
3. Cockran, W.G. and : Experimental Designs (Asia Publishing House, Bombay) Cox, G.M
4. Kelmpthrone, O. : The Design and Analysis of Experiments (John Wiley &Sons)

If the course is available as Generic Elective then the students of following departments may opt it.

1. B.Sc. (Agriculture)
2. M.Sc. (Agriculture)

| | |
|---|---|
| **Evaluation/Assessment Methodology** | |
| | **Max. Marks** |
| 1) Class tasks/ Sessional Examination | 25 |
| 2) Assignments | 5 |
| 3) ESE | 70 |
| **Total:** | 100 |

Prerequisites for the course: Statistics courses of Second semester of study.

**Course Learning Outcomes:**

Keeping the knowledge of the course, one can apply the techniques of advanced design in Biological and Agriculture research in order to see the significant effect of different new drugs/treatments.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: II / Semester: IV**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. **Class:** M.Sc.(Statistics) | Year: II<br>Semester: IV |
| **Credits: 2** Practical: 2 | **Subject:** Statistics |
| **Course Code:MSST-241P** | **Title: Statistical Lab-IV** |

**Course Objectives:**

These concepts will be verified by experimental means:

1. To provide practical training and experience in the application of the theory to the statistical modeling of data from real applications, including model identification, estimation and interpretation.
2. The course aims to study various models and components of time series analysis for forecasting purposes. It also gives the study of distribution of population with respect to birth, migration, aging and death.
3. To provide the ideas of formulating mathematical modeling and their optimum solution in the context of practical problems belonging to Govt./Pvt. Sectors.

**Nature of Paper: Core**

**Minimum Passing Marks/Credits: 50%Marks**

L:
T:
P: 4 (In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| Topics | No. of Practicals | No. of Lectures Allotted |
|---|---|---|
| Time Series | 05 | 40 |
| Multivariate Analysis | 10 | |
| Operation Research II | 05 | |
| Practicals based on Software/Advanced Design | 10 | |

**Reference / Text Books:**
**Suggested Readings:**
**As suggested for papers code MSST 241, MSST 242, MSST 243 and MSST 244(a)/244(b).**

If the course is available as Generic Elective then the students of following departments may opt it.

1. BA(Economics)
2. MA(Economics)
3. B.Sc.(Agriculture)
4. M.Sc.(Agriculture)
5. MCom

| | |
|---|---|
| 6. MBA | |
| **Evaluation/Assessment Methodology** | |
| Continuous Internal Evaluation shall be based on Practical File/Record, Class Activities and Overall performance. The marks shall be as follows: | **Max. Marks** |
| 1) Practical File/Record<br>2) Class Interaction<br>3) Report Preparation<br>4) Practical Exam | **10**<br>**5**<br>**5**<br>**30** |
| **Total:** | **50** |
| Prerequisites for the course: Knowledge of practical Statistics taught in the preceding semester and theories taught in the present semester. | |

**Course Learning Outcomes:**

After completing this course a student will have these skills:

1. The students should be able to demonstrate knowledge and understanding of parametric and nonparametric tests, discriminant analysis, factor analysis, and principal component analysis in medical, industrial, engineering, business and many other scientific areas.
2. After studying this course one learns the most important technique of forecasting used in economic analysis. It will also equip a student with tools used in population studies.
3. The knowledge of the contents of this course will help businessman/industrial managers to take optimum decisions/solutions to the executive type of problem.

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: II / Semester: IV**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D.<br>**Class:** M.Sc.(Statistics) | Year: II<br><br>Semester: IV |
| **Credits: 4**<br>Practical: 4 | **Subject:** Statistics |
| **Course Code:MSST-241RP** | **Title: DISSERTATION** |

**Course Objectives:**
For students to enter into preliminary research field both in theory and experiment the concept of Project has been introduced in the final Semester. In the Project, the student will explore new developments from the books and journals, collecting literature / data and write a Dissertation based on his / her work and studies. The Project Work can also be based on experimental work in industries /research laboratories. Selection of Topic:

**Nature of Paper: Core**

**Minimum Passing Marks/Credits: 40%Marks**

L:
T:
P: 8 (In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | Students will make project which should be preferably a working of third thoughts based on their subject. | **10** |
| II | The student will be assigned a faculty guide who will be the supervisor of the students. The faculty would be identified at the end of the III semester. | **10** |
| III | The assessment of performance of the students should be made at least twice in the semester. Internal assessment shall be for 40 marks. The students shall present the final project live using overhead projector PowerPoint presentation on LCD to the internal committee and the external examiner | **10** |
| IV | The evaluation committee shall consist of faculty members constituted by the college which would be comprised of at least three members comprising of the department Coordinator's Class Coordinator and a nominee of the Director/Principal. The students guide would be special in invitee to the presentation. The seminar session shall be an open house session. The internal marks would be the average of the marks given by each members of the committee. | **10** |

| Evaluation/Assessment Methodology | |
|---|---|
| | **Max. Marks** |
| 1) Class tasks<br>2) ESE | 40<br>60 |
| **Total:** | 100 |

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: I / Semester: I**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D.<br>**Class:** M.Sc.(Mathematics) | Year: I<br><br>Semester: I |
| **Credits: 4**<br>Theory: 4<br>Practical: 0 | **Subject: Mathematics** |
| **Course Code:MSM-111** | **Title: Theory of Ordinary Differential Equations** |

**Course Objectives:**

1. Understand the concept of Existence and Uniqueness of solution of a differential equation.
2. Understand the concept of Linear System Homogenous and Non-Homogenous system and also the Behavior of solution of nth order Linear Homogenous equations.
3. Remember The Power Series solution of 2nd order Homogenous Equation and understand the Some Special functions.
4. Understand the Boundary value problem for 2nd order differential Equation and Application of Strum-Liouville Problem.
5. Understand the Critical Points and Stability for Linear and Non-Linear systems.

**Nature of Paper: Core**

**Minimum Passing Marks/Credits: 40% Marks**

L: 4
T: 0
P: 0 (4Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| **Unit** | **Contents** | **No. of Lectures Allotted** |
|---|---|---|
| 1 | Existence, uniqueness and continuation of solutions of a differential equation and system of differential equations. Differential and integral inequalities. Fixed point methods. | **9** |
| 2 | Linear systems, properties of homogeneous and non-homogeneous systems, behaviour of solutions of nth order linear homogeneous equations. | **9** |
| 3 | Review of power series, Power series solution of second order homogeneous equations, ordinary points, regular singular points, solution of Gauss hypergeometric equations, Hermite and Chebyshev polynomials. | **9** |
| 4 | Boundary value problems for second order differential equations, Green's function and its applications. Eigen value problems, self adjoint form, Sturm –Liouvile problem and its applications. | **9** |

| | | |
|---|---|---|
| 5 | Autonomous systems, phase plane and its phenomenon, critical points and stability for linear and non linear systems, Liapunov's direct method, periodic solutions, limit cycle, the Poincare-Bendixson theorem. | **9** |

**Reference / Text Books:**


1. Braun, M. "Differential Equations and Their Applications", 4th Ed., Springer 2011
2. Brauer, F. and Nohel, J.A., "The Qualitative Theory of Ordinary Differential Equations", Dover Publications 1989
3. Coddington E.A., "Ordinary Differential Equations", Tata McGraw Hill 2002
4. Deo, S.G., Lakshmikantham, V., and Raghvendra, V.,"Text Book of Ordinary Differential Equations", 2nd Ed., Tata McGraw Hill 2010
5. Simmons G.F., "Ordinary Differential Equations with Applications", Tata McGraw Hill 2003


If the course is available as Generic Elective then the students of following departments may opt it.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | **20** |
| 2) Assignments | **10** |
| 3) ESE | **70** |
| **Total:** | 100 |

Prerequisites for the course:

**Course Learning Outcomes:**

1. Recall the definitions of existence and uniqueness of solutions for a single differential equation.
2. Memorize the properties of linear and non-linear systems of differential equations.
3. Explain the significance of fixed point methods in solving differential equations.
4. Describe the behavior of solutions of nth order linear homogeneous equations.
5. Apply fixed point methods to prove the existence and continuation of solutions for a given differential equation.
6. Solve a system of linear differential equations using matrix methods.
7. Analyze the conditions under which a solution is guaranteed to exist and be unique for a system of differential equations.
8. Examine the behavior of solutions of higher-order linear homogeneous equations near ordinary and regular singular points.
9. Evaluate the effectiveness of Green's function method in solving boundary value problems for second order differential equations.
10. Critique the applications and limitations of Sturm-Liouville problems in solving eigenvalue problems.
11. Design a scenario involving an autonomous system and its phase plane to demonstrate critical points and stability.
12. Develop a novel approach for finding periodic solutions and verify using Liapunov's direct method.

**Formate-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: I / Semester: I**

| | |
|---|---|
| **Programme:**<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>**Class:**M.Sc. (Mathematics) | Year: I<br><br>Semester: I |
| **Credits 4**<br>Theory: 4<br>Practical: 0 | **Subject: Mathematics** |
| **Course Code:MSM-112** | **Title: Advanced Real Analysis** |

**Course Objectives:**

1. Understanding Fundamentals of Real Numbers and Completeness
2. Mastering Convergence and Limits in Sequences and Series
3. Analyzing Properties of Functions and Their Continuity
4. Mastery of Convergence and Continuity of Functions
5. Developing Proficiency in Integral Calculus

**Nature of Paper: Core**

**Minimum Passing Marks/Credits: 40% Marks**

L: 4
T: 0
P: 0 (4 Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | Real number system, ordering, bounded sets, order completeness axiom, mathematical induction, well ordering principle; Archimedian property, Dedekind's theorem, complete ordered field, limit point of a set, Bolzano-Weierstrass theorem, open and closed sets, compact sets and Heine-Borel theorem. | 9 |
| II | Sequences, Cauchy's first and second limit theorems, Cauchy sequences, Cauchy criterion for convergent sequences, bounded and monotonic sequences, Euler's constant, subsequences, limit superior and limit inferior. Series of real valued functions and their Tests for convergence | 9 |
| III | Limit and continuity, uniform continuity, monotonic functions, functions of bounded variation, absolutely continuous functions, Taylor's theorem (finite form), Lagrange's form of remainder. | 9 |
| IV | Sequences and series of real valued functions, their point-wise, absolute and uniform convergence, Cauchy's general principle of uniform convergence, continuity of the limit (sum) function, | 9 |

| | | |
|---|---|---|
| | differentiation and integration of the sequences and series of functions, Weierstrass approximation theorem. | |
| V | Riemann integration, Darboux's theorem, necessary and sufficient conditions for integrability, functions defined by integrals, fundamental theorem of calculus, first and second mean value theorems of integral calculus | 9 |

**Reference / Text Books:**

1. Walter Rudin, Principles of Mathematical Analysis, (3rd edition) McGraw-Hill, Kogakusha, 1976, International student edition.
2. T. M. Apostol, Mathematical Analysis, Narosa Publishing, New Delhi, 1985.
3. J. White, Real Analysis, An Introduction, Addison-Wesley Publishing, Co. Inc., 1968.
4. H. L. Royden, Real Analysis, (4th Edition), Macmillan Publishing Co. Inc. New York

If the course is available as Generic Elective then the students of following departments may opt it.
NA

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 20 |
| 2) Assignments | 10 |
| 3) ESE | 70 |
| **Total:** | **100** |

Prerequisites for the course:

**Course Learning Outcomes:**
1. Demonstrate a solid understanding of the real number system, its properties, and the order completeness axiom.
2. Apply Cauchy's limit theorems to analyze the convergence behavior of sequences.
3. Evaluate the behavior of monotonic, bounded variation, and absolutely continuous functions.
4. Apply Cauchy's general principle of uniform convergence to prove function continuity results.
5. Understand Darboux's theorem and use it to determine the integrability of functions.
6. Synthesize the fundamental theorem of calculus to establish connections between differentiation and integration.

**IIMTU-NEP IMPLEMENTATION**
**Year: I / Semester : I**

<table>
<tr><td colspan="2">Programme:<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>Class: M.Sc.(Mathematics)</td><td>Year: I<br><br>Semester: II</td></tr>
<tr><td colspan="2">Credits 4<br>Theory: 4<br>Practical: 0</td><td>Subject: Mathematics</td></tr>
<tr><td colspan="2">Course Code: MSM-113</td><td>Title: Topology</td></tr>
<tr><td colspan="3">Course Objectives:<br>1. Understand the concept of topological space and its different types.<br>2. Understand the concept of Continuous functions, homeomorphisms and Connected and disconnected sets, connectedness on the real line.<br>3. Understand the concept of Countability axioms, Separable spaces, second countability and separability.<br>4. Understand the concept of Separation axioms – T0, T1, T2, T3, T3 (1/2), T4, their characterizations and basic properties. Remember some important Theorems.<br>5. Understand the concept of Compactness – Continuous functions and compact sets, basic properties of compactness.</td></tr>
<tr><td colspan="3">Nature of Paper: Core</td></tr>
<tr><td colspan="3">Minimum Passing Marks/Credits: 40% Marks</td></tr>
<tr><td colspan="3">L: 4<br>T: 0<br>P: 0 (4 Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)</td></tr>
<tr><td>Unit</td><td>Contents</td><td>No. of Lectures Allotted</td></tr>
<tr><td>I</td><td>Definition and examples of topological space, Closed sets, Closure, Dense subset, Neighborhoods, interior, exterior, boundary and accumulation points, Derived sets, Bases and sub-bases. Subspaces, product spaces and relative topology.</td><td>9</td></tr>
<tr><td>II</td><td>Continuous functions, homeomorphisms, the pasting lemma, Connected and disconnected sets, connectedness on the real line, components, locally connected spaces.</td><td>9</td></tr>
<tr><td>III</td><td>Countability axioms – First and second countable spaces, Lindelof's theorems, Separable spaces, second countability and separability.</td><td>9</td></tr>
<tr><td>IV</td><td>Separation axioms – T0, T1, T2, T3, T3 (1/2), T4, their characterizations and basic properties. Urysohn's lemma and Teitze extension theorem, Statement of Urysohn'smetrization theorem.</td><td>9</td></tr>
</table>

| | | |
|---|---|---|
| V | Compactness – Continuous functions and compact sets, basic properties of compactness, compactness and finite intersection property, sequentially and countably compact sets, local compactness and one point compactification. Statements of Tychonoff's Product theorem and Stone-cechcompactification theorem. | 9 |

**Reference / Text Books:**


1. J. R. Munkres, Topology, A First Course, PHI Pvt. Ltd., N. Delhi, 2000.
2. G. F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill Book Company, 1963.
3. J. Dugundji, Topology, Allyn and Bacon, 1966 (Reprinted in India by PHI).
4. S. Willard, General Topology, Addison-Wesley, Reading, 1970.
5. K D Joshi, Introduction to General Topology, Wiley Eastern Ltd., 1983


If the course is available as Generic Elective then the students of following departments may opt it.
NA

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 20 |
| 2) Assignments | 10 |
| 3) ESE | 70 |
| **Total:** | 100 |

Prerequisites for the course:

**Course Learning Outcomes:**

1. Demonstrate a comprehensive understanding of fundamental concepts in topology, including open and closed sets, neighborhoods, and the topology induced by a basis.
2. Apply topological definitions and concepts to analyze the continuity and convergence of functions.
3. Analyze the properties of topological spaces, including Hausdorff, regular, and normal spaces.
4. Combine various techniques to prove theorems related to compactness, connectedness, and separation properties.
5. Develop counterexamples or provide constructions to illustrate specific topological concepts or properties.
6. Evaluate the applicability of different topological properties in solving specific problems, such as the existence of continuous functions or the non-existence of certain mappings.

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: 1 / Semester: I**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D.<br>**Class:** M.Sc.(Mathematics) | Year: I<br><br>Semester: I |
| **Credits 4**<br>Theory: 4<br>Practical: 0 | **Subject: Mathematics** |
| **Course Code:MSM-114** | **Title: Advanced Abstract Algebra** |

**Course Objectives:**

1. Understand the concept of Group with some examples, Subgroup and Normal Groups
2. Understand the concept of Homomorphisms, automorphisms and permutation groups and Remember Cayley's theorem, Sylow's theorems.
3. Understand the concept of ,Rings, some special classes of Rings, homomorphisms, Ideal, Integral domain, Principal Ideal domain, unique factorization domain.
4. Understand the concept of field and some examples, the field of Quotients of an Integral domain, Euclidean rings, polynomial rings.
5. Understand the concept of Field Extensions, Algebraic extensions, Splitting fields and algebraic closures, Normal and separable extensions.

**Nature of Paper: Core**

**Minimum Passing Marks/Credits: 40% Marks**

L: 4
T: 0
P: 0 (4 Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | Group theory: Definition and some examples of groups, some preliminary lemmas, subgroups, a counting principle, normal subgroups and Quotient groups.. | 9 |
| II | Homomorphisms, automorphisms, Cayley's theorem, permutation groups, Sylow's theorems. | 9 |
| III | Ring theory: Definition and examples of Rings, some special classes of Rings, homomorphisms, Ideal and Quotient rings, Maximal Ideal, Integral domain, Principal Ideal domain, unique factorization domain. | 9 |
| IV | Definition of field and some examples, the field of Quotients of an Integral domain, Euclidean rings, polynomial rings. | 9 |
| V | Field Extensions, Algebraic extensions, Splitting fields and algebraic closures, Normal and separable extensions. | 9 |

**Reference / Text Books:**

1. Gallian, Joseph. Contemporary abstract algebra. Chapman and Hall/CRC, 2021.
2. N. Herstein, Topics in Algebra, New Age International (P) Limited, New Delhi
3. S. Lang, Algebra, 3rd Edition, Pearson Education Asia, New Delhi
4. I. S. Luther and IBS Passi, Algebra, Vol. I-Groups, Vol.-II Rings Narosa Publishing House (Vol. I-1996 Vol. II-1996)
5. J. B. Fraleigh, A First Course in Abstract Algebra, Narosa Publishing House, New Delhi.

If the course is available as Generic Elective then the students of following departments may opt it.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 20 |
| 2) Assignments | 10 |
| 3) ESE | 70 |
| **Total:** | **100** |

Prerequisites for the course:

**Course Learning Outcomes:**

1. Define key abstract algebra terms, such as groups, rings, fields.
2. Explain the concept of a subgroup and provide examples.
3. Solve equations in polynomial rings.
4. Prove theorems related to group isomorphisms.
5. Compare different types of rings and their properties.
6. Develop a novel example of a non-commutative ring and demonstrate its properties.

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: I / Semester: II**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D.<br>**Class:** M.Sc.(Mathematics) | Year: I<br><br>Semester: II |
| **Credits 4**<br>Theory: 4<br>Practical: 0 | **Subject: Mathematics** |
| **Course Code: MSM-121** | **Title:Numerical Analysis** |

**Course Objectives:**

1. The focuses on understanding the concept of Errors in computation and some direct and iterative methods for solving System of linear equations.
2. Students learn about the concept of some iterative methods for solving non-linear equations.
3. The focuses on understand the concept of Interpolation-Some operators and their properties, Finite difference table, Error in approximating a function by polynomial
4. Students learn about the concept of Numerical differentiation and integration.
5. Students learn about the concept of Ordinary differential equations- Initial and boundary value problems, Solutions of Initial Value Problems.

**Nature of Paper: Core**

**Minimum Passing Marks/Credits: 40% Marks**

L:4
T:0
P: 0 (4 Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits)

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | Errors in computation- Floating point representation of numbers, Significant digits, Rounding and chopping a number and error due to these absolute and relative errors, Computation of errors using differentials, Errors in evaluation of some standard functions, Truncation error. Linear equations-Gauss elimination method, LU Decomposition method, Gauss–Jordan method, Tridiagonal system, Inversion of matrix, Gauss-Jacobi method, Gauss- Seidal method. | 9 |
| II | Nonlinear equations-Iterative method, Bisection method, Method of false position, its convergence, Secant method, Newton-Raphson method, Convergence of Newton-Raphson method for simple and multiple roots. | 9 |
| III | Interpolation-Some operators and their properties, Finite difference table, Error in approximating a function by polynomial, Newton forward and backward Difference formulae, Gauss forward and backward formulae, | 9 |

| | | |
|---|---|---|
| | Stirling's and Bessel formulae, Lagrange's method, Divided differences and Newton's divided difference formula. | |
| IV | Numerical differentiation and integration-Differentiation methods based on Newton's forward and backward formulae, Differentiation by central difference formula, Integration- Methodology of numerical integration, Rectangular rule, Trapezoidal rule,Simpson's1/3rd and 3/8th rules, Gauss-Legendre quadrature formula. | 9 |
| V | Ordinary differential equations- Initial and boundary value problems, Solutions of Initial Value Problems, Picard's method, Taylor's method, Single and multistep methods, Euler's and Modified Euler's method, Runge-Kutta second order method and statement of fourth order, Milne's method, Adams-Bashforth method | 9 |

**Reference / Text Books:**

1. B.S. Grewal, Numerical Methods in Engineering and Science. Khanna Publishers, Delhi (2010)
2. AK Jaiswal, Anju Khandewal, Computer Based Numerical and Statistical Techniques, New Age International (P) Ltd. New Delhi (2015).
3. M.K. Jain, S.R.K. Iyengar, R.K. Jain, Numerical Methods for Scientific and Engineering Computations, New Age International (P) Ltd. New Delhi (2003).

If the course is available as Generic Elective then the students of following departments may opt it.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 10+10 |
| 2) Assignments | 10 |
| 3) ESE | 70 |
| **Total:** | **100** |

Prerequisites for the course:

**Course Learning Outcomes:**

1. Write the concept of errors in computation, including floating-point representation of numbers, significant digits, rounding, and chopping numbers.Knowledge of numerical analysis principles, including error analysis, convergence, stability, and efficiency of numerical methods
2. Explain numerical methods to solve mathematical problems that involve approximation, interpolation, integration, differentiation, and solving equations.
3. Evaluate the impact of approximation errors and truncation errors on the accuracy of numerical solutions. Apply various methods for solving linear equations, including Gauss elimination method, LU Decomposition method, Gauss–Jordan method, and Tridiagonal system.
4. Analyze the accuracy and stability of numerical solutions obtained through different methods. Apply numerical integration techniques, including rectangular rule, trapezoidal rule, Simpson's 1/3rd rule, Simpson's 3/8th rule, and Gauss-Legendre quadrature formula
5. Solve initial value problems using methods such as Picard's method, Taylor's method, single and multistep methods, Euler's method, Modified Euler's method, Runge-Kutta second order

method, fourth order method, Milne's method, and Adams-Bashforth method.

6. Apply numerical analysis techniques to solve real-world problems from various domains, such as physics, engineering, finance, and scientific research. Solve initial value problems using methods such as Picard's method, Taylor's method, single and multistep methods, Euler's method, Modified Euler's method, Runge-Kutta second order method, fourth order method, Milne's method, and Adams-Bashforth method.

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: I / Semester: II**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D.<br>**Class:** M.Sc.(Mathematics) | Year: I<br><br>Semester: II |
| **Credits 4**<br>Theory: 4<br>Practical: 0 | **Subject: Mathematics** |
| **Course Code:MSM-122** | **Title: Complex Analysis** |

**Course Objectives:**

1. Understand the concept of Functions of a complex variable. Complex integration. Limits, continuity, uniform continuity, differentiability and analyticity of functions and Remember some important Theorems.
2. Understand the concept of Bilinear transformations, their properties and classifications, conformal mappings Meromorphic functions.
3. Understand the concept of singularities. Residues, Evaluation of integrals. Branches of many valued functions.
4. Understand the concept of Gamma function and its properties and Remember some important theorems.
5. Understand the concept of Canonical products. Jensen's formula. Poisson-Jensen formula and Order of an entire function.

**Nature of Paper: Core**

**Minimum Passing Marks/Credits: 40% Marks**

L: 4
T: 0
P: 0 (4 Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| **Unit** | **Contents** | **No. of Lectures Allotted** |
|---|---|---|
| I | Functions of a complex variable. Complex integration. Limits, continuity, uniform continuity, differentiability and analyticity of functions. Cauchy-Goursat Theorem. Cauchy's integral formula. Higher order derivatives. Morera's Theorem. Cauchy's inequality and Liouville's theorem. The fundamental theorem of algebra. Taylor's theorem. Maximum modulus principle. Schwarz lemma. | 9 |
| II | Bilinear transformations, their properties and classifications. Definitions and examples of conformal mappings Meromorphic functions. The argument principle. Rouche's theorem. Inverse function theorem. (Statement only). | 9 |

| | | |
|---|---|---|
| III | Laurent's series. Isolated singularities. Residues. Cauchy's residue theorem. Evaluation of integrals. Branches of many valued functions with special reference to arg z, log z and za. | 9 |
| IV | Weierstrass' factorization theorem. Gamma function and its properties. Riemann zeta function. Riemann's functional equation. Runge's theorem. Mittag-Leffler's theorem. Analytic continuation. Uniqueness of direct analytic continuation. Uniqueness of analytic continuation along a curve. Power series method of analytic continuation. | 9 |
| V | Canonical products. Jensen's formula. Poisson-Jensen formula. Hadamard's three circles theorem. Order of an entire function. Exponent of Convergence. Borel's theorem. Hadamard's factorization theorem. | 9 |

**Reference / Text Books:**

1. J. B. Conway, Functions of One Complex Variable, Springer-Verlag, International student Edition, Narosa Publishing House, 1980.
2. L.V. Ahlfors, Complex Analysis, McGraw-Hill,1979
3. H. A. Priestly, Introduction to Complex Analysis, Clarendon Press, 1990
4. R.V. Churchill, Complex Variable and Applications, McGraw Hill

If the course is available as Generic Elective then the students of following departments may opt it.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 20 |
| 2) Assignments | 10 |
| 3) ESE | 70 |
| **Total:** | **100** |

Prerequisites for the course:

**Course Learning Outcomes:**

1. Define Analytic Function, Entire function, Meromorphic Function, Bilinear Transformation, State Cauchy theorem, Cauchy Integral formula, Morera's theorem, Liouville's theorem, Taylor's and Laurent's theorem, Roache's theorem, Hadamard three-circle theorem, MittagLefeller theorem, Weiertrass Factorization theorem, Fundamental theorem of arithmetic.
2. Explain the concept of singularity and residue, Differentiate between various kinds of singularities.
3. Categorize the singularities, Apply the Cauchy theorem, Cauchy integral formula, Cauchy residue theorem, Schwarz lemma.
4. Decide a complex valued function is analytic, entire or meromorphic, Decide a transformation is bilinear, conformal.
5. Evaluate the residue, Integral with the help of residue.
6. Construction of analytic function.

Format-3

## IIMTU-NEP IMPLEMENTATION
## Year: I / Semester: II

<table>
<tr><td colspan="2">Programme:<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>Class: M.Sc.(Mathematics)</td><td colspan="2">Year: I<br><br>Semester: II</td></tr>
<tr><td>Credits 4<br>Theory: 4<br>Practical: 0</td><td colspan="3">Subject: Mathematics</td></tr>
<tr><td>Course Code:MSM-123</td><td colspan="3">Title: Probability & Statistics</td></tr>
<tr><td colspan="4">Course Objectives:<br>1. Understand the concept of the basics of Probability.<br>2. Understand the concept of Moment generating function, Cumulant generating function and cumulants and their Applications and Discrete distributions, Continuous distributions.<br>3. Understand the concept of Central limit theorem and applications and Statistical inference and sampling distribution.<br>4. Understand the concept of Correlation and regression and their Properties.<br>5. Understand the concept of Test of significance and, Small sample test based on t, F and Chi-square statistics.</td></tr>
<tr><td colspan="4">Nature of Paper: Core</td></tr>
<tr><td colspan="4">Minimum Passing Marks/Credits: 40% Marks</td></tr>
<tr><td colspan="4">L: 4<br>T: 0<br>P: 0 (4 Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)</td></tr>
<tr><td>Unit</td><td colspan="2">Contents</td><td>No. of Lectures Allotted</td></tr>
<tr><td>I</td><td colspan="2">Probability: Set theoretic approach, Baye’s theorem, Geometric probability, Random experiments, Sample spaces, Random variables, Distribution functions, Joint probability distribution function, Conditional distribution function, Transformation of one and two dimensional Random variables, Mathematical expectation: Covariance, Variance of variables, Chebysheff’s inequality.</td><td>9</td></tr>
<tr><td>II</td><td colspan="2">Moment generating function, Cumulant generating function and cumulants, Applications and why they are used, Discrete distributions: Geometric, Binomial, Poisson and uniform distributions, Continuous distributions : Normal, Exponential, Gamma, Chi-square, t, F, Beta, and uniform on an interval.</td><td>9</td></tr>
</table>

| | | |
|---|---|---|
| III | Central limit theorem and applications (1) for a sequence of independent, identically distributed random variables (2) to establish normal approximations to other distributions, and to calculate probabilities, Statistical inference and sampling distribution. | 9 |
| IV | Correlation and regression: Partial and multiple correlations, Correlation coefficients, rank correlation, Regression lines and its properties. | 9 |
| V | Test of significance: (1) Null and alternative hypotheses, Simple and composite hypotheses, Errors, Test statistic. (2) Large sample tests for proportion and mean, Small sample test based on t, F and Chi-square statistics.. | 9 |

**Reference / Text Books:**

1. V.K. Rohatgi, A. K. Md. Ehsanes Saleh: An Introduction to Probability and Statistics, Wiley-Interscience
2. Kennedy and Gentle: Statistics Computing, Published by CRC Press, 1980
3. P.L. Mayer: Introductory Probability and Statistical Applications, IBH.
4. A.M. Mood and F. Graybill: Introduction to the Theory of Statistics, TMH, New Delhi.
5. Robert V. Hogg, Allen Craig, Joseph W. McKean: Introduction to Mathematical Statistics, Pearson Education, New Delhi

If the course is available as Generic Elective then the students of following departments may opt it.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 20 |
| 2) Assignments | 10 |
| 3) ESE | 70 |
| **Total:** | **100** |

Prerequisites for the course:

**Course Learning Outcomes:**

1. Demonstrate a solid understanding of fundamental probability concepts, including sample spaces, events, and probability axioms.
2. Utilize the concept of conditional probability and Bayes' theorem to solve problems involving dependent events.
3. Analyze discrete and continuous probability distributions, including their probability mass functions and probability density functions.
4. Investigate properties of common distributions like the binomial, Poisson, and normal distributions.
5. Evaluate measures of central tendency and dispersion to summarize and interpret data distributions.
6. Design real-world scenarios where probability and statistics concepts can be applied, such as in quality control, decision making, or risk assessment.

**Format-3**

## IIMTU-NEP IMPLEMENTATION
## Year: I/ Semester: II

<table>
<tr><td>Programme:<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>Class: M.Sc.(Mathematics)</td><td>Year: I<br><br>Semester: II</td></tr>
<tr><td>Credits 4<br>Theory: 4<br>Practical: 0</td><td>Subject: Mathematics</td></tr>
<tr><td>Course Code:MSM-124</td><td>Title: Discrete Mathematics</td></tr>
<tr><td colspan="2">Course Objectives:<br>1. Understand the concept of Formal Logic-Statements, Symbolic Representation of statements, duality, Tautologies and contradictions. Quantifiers, Predicates and Validity of arguments. Propositional Logic etc.<br>2. Understand the concept of Lattices and their types, Cover of an element, atoms, join and meet irreducible elements.<br>3. Understand the concept of Boolean Algebras and Remember Various Boolean Identities.<br>4. Understand the concept of Walk, Path, Circuit, Cycles, Degree of a vertex, Connected graphs, Complete and Bipartite graphs, Planar graphs, Euler’s formula for connected Planar graphs, Kuratowski’s Theorem (Statement only) and its uses.<br>5. Understand the concept of Trees, Cut-sets, Spanning Trees and, Matrix Representation of graphs, Directed Graphs, Indegree and outdegree of a vertex.</td></tr>
<tr><td colspan="2">Nature of Paper: Core</td></tr>
<tr><td colspan="2">Minimum Passing Marks/Credits: 40% Marks</td></tr>
<tr><td colspan="2">L: 4<br>T: 0<br>P: 0 (4 Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)</td></tr>
</table>

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | Formal Logic- Statements, Symbolic Representation of statements, duality, Tautologies and contradictions. Quantifiers, Predicates and Validity of arguments. Propositional Logic. Languages and Grammars, Finite State Machines and their transition table diagrams. | 9 |
| II | Lattices: Lattices as partially ordered sets, their properties, duality, Lattices as algebraic systems, Sub lattices, Direct products, Bounded Lattices, Complete Lattices, Complemented Lattices and Distributive lattices. Cover of an element, atoms, join and meet irreducible elements. | 9 |
| III | Boolean Algebras: Boolean Algebras as lattices. Various Boolean Identities. The Switching Algebra example. Sub algebras, Direct | 9 |

| | | |
|---|---|---|
| | products and Homeomorphisms. Boolean forms and their Equivalence. Min-term Boolean forms, Sum of product Canonical forms. Minimization of Boolean functions, Applications of Boolean Algebra to Switching Theory (using AND, OR & NOT gates). The Karnaugh Map method. | |
| IV | Definition of (undirected) graph, Walk, Path, Circuit, Cycles, Degree of a vertex, Connected graphs, Complete and Bipartite graphs, Planar graphs, Euler's formula for connected Planar graphs, Kuratowski's Theorem (Statement only) and its uses. Colouring of graphs, Five colour theorem and statement of Four colour theorem. | 9 |
| V | Trees , Cut-sets, Spanning Trees, Fundamentals Cut-sets and minimum Spanning Trees, Prim's and Kruskal's algorithms, Connectivity, Matrix Representation of graphs, Directed Graphs, In degree and out degree of a vertex. | 9 |

**Reference / Text Books:**


1. J. P. Trembley & R. Manohar, Discrete Mathematical Structures with Applications to Computer Science, McGraw-Hill Book Co., 1997.
2. N. Deo, Graph Theory with Applications to Engineering and Computer Sciences, PHI, New Delhi
3. Seymour Lepschutz, Finite Mathematics, McGraw-Hill Book Co. New –York.
4. J. E. Hopcroft and J.D. Ullman, Introduction to Automata Theory Languages & Computation, Narosa Publishing House, Delhi.
5. C. L. Liu, elements of Discrete Mathematics, McGraw-Hill Book Co.


If the course is available as Generic Elective then the students of following departments may opt it.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 20 |
| 2) Assignments | 10 |
| 3) ESE | 70 |
| **Total:** | 100 |

Prerequisites for the course:

**Course Learning Outcomes:**

1. Demonstrate a comprehensive understanding of key concepts in discrete mathematics, including sets, relations, and functions.
2. Apply counting principles, such as permutations and combinations, to solve problems related to arrangements and selections.
3. Analyze properties of graphs, including vertex degrees, connectivity, and planarity.
4. Synthesize techniques of propositional and predicate logic to construct and analyze mathematical statements.
5. Assess the applicability of Boolean algebra in solving problems related to digital circuits and logic design.
6. Develop examples of applications involving recurrence relations and generating functions to model and analyze sequences.

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: II / Semester : III**

| | |
|---|---|
| **Programme:**<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>**Class:** M.Sc.(Mathematics) | Year: II<br><br>Semester: III |
| **Credits 4**<br>Theory: 4<br>Practical: 0 | **Subject: Mathematics** |
| **Course Code:MSM-231** | **Title: Functional Analysis** |

**Course Objectives:**

1. Understand the concept of Normed linear spaces, Banach spaces and Remember the Examples and counter examples.
2. Understand the concept of Basic properties of finite dimensional normed linear spaces, Bounded linear transformations and normed linear spaces of bounded linear transformations, Uniform boundedness theorem and some of its applications.
3. Understand the concept of Dual spaces and Remember the weak convergence, open mapping and closed graph theorems, Hahn Banch theorem for real and complex linear spaces.
4. Understand the concept of Inner product spaces, Hilbert spaces.
5. Understand the concept of Structure of Hilbert spaces and Remember the Projection theorem, Riesz representation theorem.

**Nature of Paper: Core**

**Minimum Passing Marks/Credits: 40% Marks**

L: 4
T: 0
P: 0 (4Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | Normed linear spaces, Banach spaces, Examples and counter examples, Quotient space of normed linear spaces and its completeness. Equivalent norms | 9 |
| II | Reisz Lemma, Basic properties of finite dimensional normed linear spaces, Bounded linear transformations and normed linear spaces of bounded linear transformations, Uniform boundedness theorem and some of its applications. | 9 |
| III | Dual spaces, weak convergence, open mapping and closed graph theorems, Hahn Banch theorem for real and complex linear spaces. | 9 |
| IV | Inner product spaces, Hilbert spaces – Orthonormal sects, Bessel's inequality, complete orthonormal sets and Perseval's identity. | 9 |

| | | |
|---|---|---|
| V | Structure of Hilbert spaces, Projection theorem, Riesz representation theorem, Adjoint of an operator on Hilbert space, Self adjoint operators, Normal and Unitary operators. Projections | 9 |

**Reference / Text Books:**

1. P.K. Jain, O.P. Ahuja& Khalil Ahmad: Functional Analysis, New Age (International P. Ltd.) New Delhi.
2. E. Kreyszig: Introductory Functional Analysis with Applications, John Wiley and Sons, New York.
3. G.F. Simmons: Introduction to Topology and Modern Analysis, McGraw Hill Book Co., New York.

If the course is available as Generic Elective then the students of following departments may opt it.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 20 |
| 2) Assignments | 10 |
| 3) ESE | 70 |
| **Total:** | **100** |

Prerequisites for the course:

**Course Learning Outcomes:**

1. Demonstrate a thorough understanding of fundamental concepts such as normed vector spaces, inner product spaces, and Banach spaces.
2. Apply the open mapping theorem and the closed graph theorem to analyze properties of linear operators between normed spaces.
3. Analyze the convergence properties of sequences and series in normed and Banach spaces.
4. Investigate compactness, boundedness, and completeness in functional spaces.
5. Synthesize techniques like spectral theory to study the properties of bounded linear operators on Hilbert spaces.
6. Assess the applicability of different norms and metrics in specific functional spaces.
7. Develop examples of linear operators that satisfy certain properties or counterexamples that illustrate specific concepts.

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: II/ Semester: III**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D.<br>**Class:** M.Sc.(Mathematics) | Year: II<br><br>Semester: III |
| **Credits 4**<br>Theory: 4<br>Practical: 0 | **Subject: Mathematics** |
| **Course Code: MSM-232** | **Title: Operations Research** |

**Course Objectives:**

1. To Understand the concept of. Linear programming problems and, Theory of simplex method. Duality theory and sensitivity analysis. Dual simplex method.
2. To Understand the concept of Transportation and Assignment problems of linear programming. Sequencing theory and Travelling salesperson's problem.
3. To Understand the concept of Replacement, Problems in mortality and staffing. Inventory problems, Simple deterministic and stochastic models of inventory control.
4. To Understand the concept of Network analysis and Project planning and Understand the concept of control with PERT/CPM.
5. To Understand the concept of Queuing theory and Game theory

**Nature of Paper: Core**

**Minimum Passing Marks/Credits: 40% Marks**

L: 4
T: 0
P: 0 (4Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| **Unit** | **Contents** | **No. of Lectures Allotted** |
|---|---|---|
| I | Operations research and its scope, Necessity of operations research in industry. Linear programming problems. Convex sets, Simplex method, Theory of simplex method. Duality theory and sensitivity analysis. Dual simplex method. | 9 |
| II | Transportation and Assignment problems of linear programming. Sequencing theory and Travelling salesperson's problem. | 9 |
| III | Replacement: Replacement of items that deteriorate. Problems of choosing between two machines, Replacement of items that fail completely, Problems in mortality and staffing. Inventory problems, Simple deterministic and stochastic models of inventory control. | 9 |

| | | |
|---|---|---|
| IV | Network analysis: Shortest-path problem, Minimum spanning tree problem, Maximum flow problem, Minimum cost flow problem, Network simplex method. Project planning and control with PERT/CPM. | 9 |
| V | Queuing theory: Steady state solution of Markovian queuing models: M/M/1, M/M/1 with limited waiting space. Game theory: Two person zero-sum games, Games with mixed strategies, Graphical solutions, Solutions by linear programming. | 9 |

**Reference / Text Books:**

1. H.A. Taha: Operation Research- An introduction, Macmillan Publishing Co. Inc., NY
2. KantiSwarup, PK Gupta and Man Mohan, Operations Research, S Chand and sons, New Delhi.
3. S.S. Rao, Optimization Theory and Applications, Wiley Eastern Ltd, New Delhi.
4. G. Hadley, Linear Programming, Narosa Publishing House, 1995.
5. F.S. Hillier and G.J. Lieberman, Introduction to Operations Research (Sixth Edition), McGraw Hill International Edition, Industrial Engineering Series, 1995.

If the course is available as Generic Elective then the students of following departments may opt it.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 20 |
| 2) Assignments | 10 |
| 3) ESE | 70 |
| **Total:** | **100** |

Prerequisites for the course:

**Course Learning Outcomes:**

1. Demonstrate a solid understanding of fundamental concepts in operations research, including optimization, linear programming, and decision analysis.
2. Apply mathematical modeling to formulate real-world problems as optimization or decision-making tasks.
3. Analyze the properties and behavior of optimization algorithms, such as the simplex method and network flow algorithms.
4. Combine various techniques, such as expected value and decision criteria, to recommend optimal decisions.
5. Evaluate the performance of queuing models to analyze waiting times and system efficiency. Assess the effectiveness of inventory control models to manage stock levels and minimize costs.
6. Develop examples of applications involving transportation and assignment problems to demonstrate optimal resource allocation.

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: II / Semester: III**

<table>
<tr><td colspan="2">Programme:<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>Class: M.Sc.(Mathematics)</td><td colspan="2">Year: II<br><br>Semester: III</td></tr>
<tr><td colspan="2">Credits 4<br>Theory: 4<br>Practical: 0</td><td colspan="2">Subject: Mathematics</td></tr>
<tr><td colspan="2">Course Code: MSM-233</td><td colspan="2">Title: Integral Equations and Calculus of Variations</td></tr>
<tr><td colspan="4">Course Objectives:<br>1. To Understand the concept of classification of linear integral equations. And Conversion of initial and boundary value problems into integral equation, Conversion of integral equations into differential equations.<br>2. To Understand the concept of Fredholm Integral Equations and Solution of integral equations with separable kernels, Eigenvalues and Eigenfunctions. Solution by the successive approximations etc.<br>3. To Understand the concept of Volterra Integral Equations and Solution of integral equations by transform methods.<br>4. To Understand the concept of Basic concepts of the calculus of variations such as functionals, extremum, variations, function spaces and Euler`s equation with the cases of one variable and several variables, Variational derivative etc.<br>5. To Understand the concept of General Variation and Variational problems with moving boundaries, Broken extremals: Weierstrass–Erdmann conditions.</td></tr>
<tr><td colspan="4">Nature of Paper: Core</td></tr>
<tr><td colspan="4">Minimum Passing Marks/Credits: 40% Marks</td></tr>
<tr><td colspan="4">L: 4<br>T: 0<br>P: 0 (4 Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)</td></tr>
<tr><td>Unit</td><td colspan="2">Contents</td><td>No. of Lectures Allotted</td></tr>
<tr><td>I</td><td colspan="2">Preliminary Concepts: Definition and classification of linear integral equations. Conversion of initial and boundary value problems into integral equations. Conversion of integral equations into differential equations. Integro-differential equations.</td><td>9</td></tr>
<tr><td>II</td><td colspan="2">Fredholm Integral Equations: Solution of integral equations with separable kernels, Eigenvalues and Eigenfunctions. Solution by the successive approximations, Numann series and resolvent kernel. Solution of integral equations with symmetric kernels, Hilbert-Schmidt theorem, green's</td><td>9</td></tr>
</table>

| | | |
|---|---|---|
| | function approach. Fredholm method of solution and Fredholm theorems. | |
| III | Volterra Integral Equations: Successive approximations, Neumann series and resolvent kernel. Equations with convolution type kernels. Solution of integral equations by transform methods: Singular integral equations, Hilbert-transform, Cauchy type integral equations. | 9 |
| IV | Calculus of Variations: Basic concepts of the calculus of variations such as functionals, extremum, variations, function spaces, the brachistochrone problem. Necessary condition for an extremum, Euler`s equation with the cases of one variable and several variables, Variational derivative. Invariance of Euler`s equations. Variational problem in parametric form. | 9 |
| V | General Variation: Functionals dependent on one or two functions, Derivation of basic formula, Variational problems with moving boundaries, Broken extremals: Weierstrass –Erdmann conditions. | 9 |

**Reference / Text Books:**


1. Jerry, Abdul J., Introduction to Integral Equations with applications, Clarkson University Wiley Publishers (II Edition) 1999
2. Chambers, Ll. G., Integral Equations: A short Course, International Text Book Company Ltd. 1976
3. Kanwal R. P., Linear Integral Equations, BirkhäuserBosten, II Edition 1997
4. Harry Hochstadt, Integral Equations, John Wiley & Sons 1989
5. Gelfand, I. M., Fomin, S. V., Calculus of Vaiations, Dover Books 2000


If the course is available as Generic Elective then the students of following departments may opt it.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 20 |
| 2) Assignments | 10 |
| 3) ESE | 70 |
| **Total:** | **100** |

Prerequisites for the course:

**Course Learning Outcomes:**

1. Demonstrate a solid understanding of key concepts in integral equations, including Fredholm and Volterra equations, and their classifications.
2. Apply appropriate methods, such as the method of successive approximations and the resolvent kernel method, to solve different types of integral equations.
3. Analyze the principles of the calculus of variations, including functionals, Euler-Lagrange equations, and natural boundary conditions.
4. Synthesize the Euler-Lagrange equation to derive extremal solutions for various functionals.
5. Evaluate the applicability of different functionals and boundary conditions in solving variational problems.
6. Develop examples of applications involving eigenvalue problems and eigenfunction expansions

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: II / Semester: III**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D.<br>**Class:** M.Sc.(Mathematics) | Year: II<br><br>Semester: III |
| **Credits 4**<br>Theory: 4<br>Practical: 0 | **Subject: Mathematics** |
| **Course Code: MSM - 234** | **Title: GRAPH THEORY** |

**Course Objectives:**
1. To understand the concept of Trees and Fundamental Circuits and network flows.
2. To understand the concept of Vector Spaces Associated with Graphs, Galois fields and orthogonal vectors and spaces.
3. To understand the concept of Planar Graphs and Graph coloring.
4. To understand the concept of Directed Graphs, directed paths and connectedness, Euler digraphs, de Brujin sequences, tournaments.

**Nature of Paper:** CORE

**Minimum Passing Marks/Credits:** 40%

L: 4
T: 0
P: 0 (4 Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | Introduction to Graphs: Definition of a graph, finite and infinite graphs, incidence of vertices and edges, types of graphs, subgraphs, walks, trails, paths, cycles, connectivity, components of a graph, Eulerian and Hamiltonian graphs, travelling salesman problem, vertex and edge connectivity, matrix representation of graphs, incidence and adjacency matrices of graphs. | 9 |
| II | Trees and Fundamental Circuits: Definition and properties of trees, rooted and binary trees, counting trees, spanning trees, weighted graphs, minimum spanning tree, fundamental circuit, cut set, separability, network flows. | 9 |
| III | Vector Spaces Associated with Graphs: Galois fields, Vector spaces associated with graphs, orthogonal vectors and spaces. | 9 |
| IV | Planar Graphs and Graph coloring: Planar graphs, Kuratowski's graphs, detection of planarity, Euler's formula for planar graphs, geometric and combinatorial duals of a planar graphs, coloring of graphs, chromatic | 9 |

| | | |
|---|---|---|
| | numbers, chromatic polynomial, chromatic partitioning, Four color theorem. | |
| V | Directed Graphs: Types of digraphs, digraphs and binary relations, directed paths and connectedness, Euler digraphs, de Brujin sequences, tournaments | 9 |

**Reference / Text Books:**


1. Deo N., “Graph Theory with Applications to Engineering and Computer Science”, Prentice Hall India 2004
2. West D. B., "Introduction to Graph Theory ", Prentice Hall India (2nd Ed.) 2009
3. Clark J. and Holton J. A.,"A First Look at Graph Theory", World Scientific 1991
4. Wilson R. J., “Introduction to Graph Theory”, Pearson Education (4th Ed.) 1996
5. Chartrand G. and Zhang P., "Introduction to Graph Theory", Tata McGraw Hill 2007 .
6. Aldous J. M., Wilson R. J. and Best S., “Graphs and Applications: An Introductory Approach”, Springer 2003


If the course is available as Generic Elective then the students of following departments may opt it.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 20 |
| 2) Assignments | 10 |
| 3) ESE | 70 |
| **Total:** | **100** |

Prerequisites for the course:

**Course Learning Outcomes:**

1. Define grap, connectivity, trees, vector space with graphs and different types of graphs.
2. Explain graphs, subgraphs, eulerian, Hamiltonian graphs, directed and graph coloring and properties of trees, rooted and binary trees.
3. Calculate vertex, edge connectivity, fundamental circuit, and paths and connectedness of directed graphs.
4. Analyse the finite and infinite graphs, countin trees, spanning trees, galois fields, and eulers formula for planar graphs.
5. Evaluate travelling salesman problem,matrix representation of graph, cut set, separability, network flows and justify the euler digraphs.
6. Formulate some graphs formula, trees formula and directed graphs formula, and counting vector space and orthogonal vector spaces.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: II / Semester: IV**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D.<br>**Class:** M.Sc. (Mathematics) | Year: II<br><br>Semester: IV |
| **Credits 4**<br>Theory: 4<br>Practical: 0 | **Subject: Mathematics** |
| **Course Code: MSM-241** | **Title: Fluid Dynamics** |

**Course Objectives:**

1. Understand the concept of fluid and its physical properties along with Kinematics of fluids-Methods of describing fluid motion etc.
2. Understand the concept of General theory of stress and rate of strain in a real fluid – Symmetry of stress tensor, Principal axes and Principle values of stress tensor, Constitutive equation for Newtonian fluid.
3. Understand the concept of One and two dimensional in viscid incompressible flow-Equation of continuity and motion using stream tube, , Circulation, Velocity potential, Irrotational flow and Remember Some theorems about rotational and irrotational flows.
4. Understand the concept of Vortex motion and its elementary properties, Integration of equations of motion, Stream function in two dimensional motion, Complex variable technique, flow past a circular cylinder and Sources, Sinks and Doublets. Dynamical similarity and Remember some important theorems.
5. Understand the concept of Incompressible viscous fluid flows- Steady flow between two parallel plates and Plane couette flow, Plane poiseuille flow, Generalized plane couette flow, Steady flow of two immiscible fluids between two rigid parallel plates etc.

**Nature of Paper: Core**

**Minimum Passing Marks/Credits: 40% Marks**

L: 4
T: 0
P: 0 (4Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | Concept of fluid and its physical properties, Continuum hypothesis, Kinematics of fluids-Methods of describing fluid motion, Translation, Rotation and deformation of fluid elements, Stream Lines, Path lines and Streak lines, concepts of Vorticity. | 9 |
| II | General theory of stress and rate of strain in a real fluid –Symmetry of stress tensor, Principal axes and Principle values of stress tensor, | 9 |

| | | |
|---|---|---|
| | Constitutive equation for Newtonian fluid. Conservation laws- Conservation of mass, Conservation of momentum, Conservation of energy. | |
| III | One and two dimensional inviscid incompressible flow-Equation of continuity and motion using stream tube, Circulation, Velocity potential, Irrotational flow, Some theorems about rotational and irrotational flows–Stoke's theorem, Kelvin's minimum energy theorem, Gauss theorem, Kelvin's circulation theorem. | 9 |
| IV | Vortex motion and its elementary properties, Integration of equations of motion - Bernoulli's equation, Stream function in two dimensional motion, Complex variable technique, flow past a circular cylinder, Blasius theorem, Milne's circle theorem, Sources, Sinks and Doublets. Dynamical similarity, Buckingham's pie theorem, Non-dimensional numbers and their physical significance | 9 |
| V | Incompressible viscous fluid flows- Steady flow between two parallel plates (non-porous and porous) - Plane couette flow, Plane poiseuille flow, Generalized plane couette flow, Steady flow of two immiscible fluids between two rigid parallel plates, Steady flow through tube of uniform circular cross section, Steady flow through annulus under constant pressure gradient. | 9 |

**Reference / Text Books:**


1. S. W. Yuan, FOUNDATIONS OF FLUID MECHANICS, Prentice Hall of India Private Limited, New-Delhi, 1976.
2. R. K. Rathy, AN INTRODUCTION OF FLUID DYNAMICS Oxford and IBH Publishing company, New Delhi, 1976.
3. G. K. Betchelor, AN INTRODUCTION OF FLUID MECHANICS, Oxford University Books, New Delhi, 1994.
4. F. Charlton, TEXT BOOK OF FLUID DYNAMICS, C.B.S. Publishers, Delhi. 1985
5. M.D. Raisinghania, Fluid dynamics with complete Hydrodynamics and boundary Layer Theory. S. Chand Publishing, 2013.


If the course is available as Generic Elective then the students of following departments may opt it.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 20 |
| 2) Assignments | 10 |
| 3) ESE | 70 |
| **Total:** | **100** |

Prerequisites for the course:

**Course Learning Outcomes:**

1. Define continuum hypothesis, various kinds of flow, stream lines, path lines and streak lines, stress and strain, circulation, velocity potential, sinks and doublets. State important theorem of fluid dynamics.
2. Explain the concept of stress and strain, discuss the conservation of mass, momentum and energy.
3. Calculate the velocity potential, compute the path lines, stream lines and streak lines.
4. Analyse incompressible viscous fluid flow between two parallel plates, infer between rotational and irrotational flows.
5. Decide the nature of the flow, build methods to decide fluid motion.
6. Construct important results and theorem related to fluid flow.

**IIMTU-NEP IMPLEMENTATION**
**Year: II / Semester: IV**

<table>
<tr><td colspan="2">Programme:<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>Class: M.Sc.(Mathematics)</td><td colspan="2">Year: II<br><br>Semester: IV</td></tr>
<tr><td colspan="2">Credits: 4<br>Theory: 4<br>Practical: 0</td><td colspan="2">Subject: Mathematics</td></tr>
<tr><td colspan="2">Course Code:MSM- 242</td><td colspan="2">Title: Number Theory</td></tr>
<tr><td colspan="4">Course Objectives:<br>1. To understand the concept of division algorithm, tau function, sigma function, phi function, congruences, primitive roots and perfect numbers.<br>2. To Understand and apply the Diophantine equation, Chinese reminder theorem, mobius inversion formula, indices theory and representation of integers.<br>3. Definition and application of Euclidean algorithm, primality testing, tau, phi, sigma function and integer modulon.<br>4. To Understand the concept of congruences (linear and quadratic ) and perfect numbers.</td></tr>
<tr><td colspan="4">Nature of Paper: Core</td></tr>
<tr><td colspan="4">Minimum Passing Marks/Credits:40% Marks</td></tr>
<tr><td colspan="4">L: 4<br>T: 0<br>P: 0 (4 Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)</td></tr>
<tr><td>Unit</td><td colspan="2">Contents</td><td>No. of Lectures Allotted</td></tr>
<tr><td>I</td><td colspan="2">The Division Algorithm, the gcd, The Euclidean Algorithm, Diophantine equation ax + by = c. The fundamental theorem of arithmetic. The Sieve of Eratosthenes. The Goldbach conjecture.</td><td>9</td></tr>
<tr><td>II</td><td colspan="2">Theory of Congruences – Basic properties of Consequence, Linear Congruences, Chinese remainder theorem, Fermat’s Theorem, Wilson’s Theorem. Statement of Prime number theorem. Some primality testing.</td><td>9</td></tr>
<tr><td>III</td><td colspan="2">Number-Theoretic Functions – The functions T and Sigma. The mobius inversion formula, The Greatest integer function, Euler’s Phi function – Euler Theorem, Properties of the Phi-function, Applications to Cryptography.</td><td>9</td></tr>
<tr><td>IV</td><td colspan="2">The order of an integer modulo n, Primitive roots for primes, The theory of indices, Euler’s criterion, Legendre’s symbol and its properties, Quadratic reciprocity, Quadratic congruences with composite moduli.</td><td>9</td></tr>
</table>

| | | |
|---|---|---|
| V | Perfect Numbers, Representation of integers as sum of two squares and sum of more than two squares. | 9 |

**Reference / Text Books:**

1. Davis M. Burton: Elementary Number Theory, USB (Indian Reprint), 1991.
2. U. Dudley, Elementary Number Theory, Freeman & Co.
3. George Andrews, Number Theory.

If the course is available as Generic Elective then the students of following departments may opt it.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 20 |
| 2) Assignments | 10 |
| 3) ESE | 70 |
| **Total:** | **100** |

Prerequisites for the course:

**Course Learning Outcomes:**

1. Demonstrate a comprehensive understanding of basic number theory concepts, including divisibility, prime numbers, and the fundamental theorem of arithmetic.
2. Apply the Euclidean algorithm and properties of greatest common divisors to solve problems involving integers.
3. Analyze Diophantine equations and explore techniques to find integer solutions, such as Pell's equation and quadratic Diophantine equations.
4. Evaluate the properties of prime numbers, including distribution, primality tests, and prime factorization algorithms.
5. Combine various tools to prove theorems related to quadratic reciprocity and arithmetic functions.
6. Develop examples of Diophantine equations or congruences that illustrate specific number theory phenomena.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year : II / Semester : IV**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D.<br>**Class:** M.Sc.(Mathematics) | Year: II<br><br>Semester: IV |
| **Credits 4**<br>Theory: 4<br>Practical: 0 | **Subject: Mathematics** |
| **Course Code: MSM-243A** | **Title: Measure Theory** |

**Course Objectives:**

1. To Understand the concept of Countable and uncountable sets, Infinite sets and the Axiom of Choice, Cardinal numbers and its arithmetic and Decimal, Binary and Ternary Expansion, Cantor's Ternary set some important theorems.
2. To Understand the concept of Algebra's of sets,Lebesgue outer measure, Measure of open and closed sets, Borel sets, Measurable sets, Regularity.
3. To Understand the concept of Measurable functions, Algebra of measurable functions, Step functions, Characteristic functions, Borel and Lebesgue measurability etc.
4. To Understand the concept of The Lebesgue Integral, Riemann and Lebesgue integral, The Lebesgue integral of a bounded function over a set of finite measure, the integral of non-negative functions.
5. To Understand the concept of The Lebesgue Integral, Riemann and Lebesgue integral, The Lebesgue integral of a bounded function over a set of finite measure, the integral of non-negative functions.

**Nature of Paper: Optional**

**Minimum Passing Marks/Credits: 40% Marks**

L: 4
T: 0
P: 0 (4 Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | Countable and uncountable sets, Infinite sets and the Axiom of Choice, Cardinal numbers and its arithmetic, Schroeder-Burstein theorem, Cantor's theorem and continuum hypothesis, Zorn's Lemma, Well-ordering theorem, Decimal, Binary and Ternary Expansion, Cantor's Ternary set. | 9 |
| II | Algebra's of sets, Lebesgue outer measure, Measure of open and closed sets, Borel sets, Measurable sets, Regularity, A non-measurable sets. | 9 |

| | | |
|---|---|---|
| III | Measurable functions, Algebra of measurable functions, Step functions, Characteristic functions, Borel and Lebesgue measurability, Little wood's three principles, Convergence almost everywhere and convergence in measure, Egoroff's and Reisz- Fisher Theorems. | 9 |
| IV | The Lebesgue Integral, Riemann and Lebesgue integral, The Lebesgue integral of a bounded function over a set of finite measure, the integral of non-negative functions, The general Lebesgue integral. | 9 |
| V | Functions of Bounded Variation, Lebesgue Differentiation Theorem, Differentiation of Monotone Functions, Differentiation of an Integral, Absolute Continuity. The Lp-Space, Convex function, Jensen's Holder's and Minkowsky's inequality, Completeness of Lp-space. | 9 |

**Reference / Text Books:**

1. H.L. Royden: Real analysis 4th Edition MacMillan Publishing Co. Inc. N.Y.
2. S. Goldberg: Real analysis Oxford and IBH New Delhi.
3. P.K. Jain & V.P. Gupta: Lebesgue Measure and Integration, New Age International (P) 10 Ltd., New Delhi.
4. G de Barra: Measure Theory and Integration, New Age International (P) Ltd., New Delhi.
5. Inder K. Rana, An Introduction to Measure and Integration, Narosa Publishing House, Delhi, 1997.
6. Walter Rudin, Real & Complex Analysis, Tata McGraw – Hill Publishing Co. Ltd., New Delhi, 1966.

If the course is available as Generic Elective then the students of following departments may opt it.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 20 |
| 2) Assignments | 10 |
| 3) ESE | 70 |
| **Total:** | **100** |

Prerequisites for the course:

**Course Learning Outcomes:**

1. Demonstrate a comprehensive understanding of fundamental concepts in measure theory, including sigma-algebras, measures, and measurable functions.
2. Utilize theorems like the Monotone Convergence Theorem and Dominated Convergence Theorem to analyze properties of integrable functions.
3. Analyze different modes of convergence, such as point wise and uniform convergence, for sequences of measurable functions.
4. Synthesize techniques for constructing measures on different spaces, such as product measures and induced measures.
5. Evaluate the measurability of complex sets using measurable functions and measurable functions' properties.
6. Develop examples of applications involving measures and integrals to model physical phenomena or solve practical problems.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: II / Semester: IV**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D.<br>**Class:** M.Sc.(Mathematics) | Year: II<br><br>Semester: IV |
| **Credits 4**<br>Theory: 4<br>Practical: 0 | **Subject: Mathematics** |
| **Course Code: MSM-243B** | **Title: Theory of Partial Differential Equations** |

**Course Objectives:**

1. To understand the basic concept of Simultaneous differential equations of the first order and first degree. Integral curves of vector fields. Methods of solution of dx/P = dy/Q = dz/R. Orthogonal Trajectories of a system of curves on a surface.
2. To understand the concept of First Order PDE,Initial value problem for quasi-linear first order equations: Existence and uniqueness of solution and Charpit's method, Solutions satisfying given conditions.
3. To understand the concept of Second Order PDE, Classification and canonical forms of second order equations in two variables and Characteristic curves of second order equations in two variables.
4. To understand the concept of Elliptic Equations, Green's function for Laplace equation, method of Images, eigen function method for finding Green's function.
5. To understand the concept of Hyperbolic Equation: One and two dimensional wave equation, Parabolic Equations: solution of homogeneous and non-homogeneous diffusion equation.

**Nature of Paper: Optional**

**Minimum Passing Marks/Credits: 40% Marks**

L: 4
T: 0
P: 0 (4 Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | Introduction: Surfaces and curves. Simultaneous differential equations of the first order and first degree. Integral curves of vector fields. Methods of solution of dx/P = dy/Q = dz/R. Orthogonal Trajectories of a system of curves on a surface. Pfaffian differential forms and equations. Solution of Pfaffian differential equations in three variables. | 9 |

| | | |
|---|---|---|
| II | First Order PDE: Partial differential equations, Origins and classification of first order PDE, Initial value problem for quasi-linear first order equations: Existence and uniqueness of solution, Nonexistence and non-uniqueness of solutions. Surfaces orthogonal to a given system of surfaces. Nonlinear PDE of first order, Cauchy method of Characteristics, Compatible systems of first order equations, Charpit's method, Solutions satisfying given conditions. Jacobi's method | 9 |
| III | Second Order PDE: The origin of second order PDE. Equations with variable coefficients, Classification and canonical forms of second order equations in two variables. Classification of second order equations in n variables. Characteristic curves of second order equations in two variables. Importance of characteristic curves. | 9 |
| IV | Elliptic Equations: Laplace equation in Cartesian, polar, spherical and cylindrical coordinates and its solution by Fourier series method, Poisson equation in 2D. Green's function for Laplace equation, method of Images, eigen function method for finding Green's function. | 9 |
| V | Hyperbolic Equation: One and two dimensional wave equation, solution by method of characteristics and Fourier series method. Parabolic Equations: solution of homogeneous and non-homogeneous diffusion equation (1D). Duhamel's principle. | 9 |

**Reference / Text Books:**


1. Zachmanoglou, E.C., Thoe, D.W., "Introduction to Partial Differential Equations with Applications", Dover Publications. 1986
2. Sneddon, I. N., "Elements of Partial Differential Equations", McGraw-Hill Book Company. 1988
3. Amarnath, T., "An Elementary Course in Partial Differential Equations", Narosa Publishing House (II Edition). 2012
4. Rao, K. S., "Introduction to Partial Differential Equations", PHI Learning Pvt. Ltd. (2nd Edition). 2012
5. Lawrence C. Evans, "Partial Differential Equations", American Mathematical Society 2010


If the course is available as Generic Elective then the students of following departments may opt it.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 20 |
| 2) Assignments | 10 |
| 3) ESE | 70 |
| **Total:** | **100** |

Prerequisites for the course:

**Course Learning Outcomes:**

1. Demonstrate a comprehensive understanding of key concepts in partial differential equations, including classification, order, and linear vs. nonlinear PDEs.
2. Apply appropriate solution methods, such as separation of variables, method of characteristics, and Fourier/Laplace transforms, to solve various types of PDEs.

3. Analyze the well-posedness and existence of solutions for initial value problems and boundary value problems of different types of PDEs.
4. Assess the behavior of solutions to model physical phenomena like heat conduction, wave propagation, or fluid flow.
5. Design real-world scenarios where PDEs can be applied, such as in modeling diffusion processes, wave behavior, or potential fields.
6. Develop examples of applications involving partial differential equations to analyze and solve problems in engineering, physics, or other domains.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: I / Semester: I**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. **Class: M.Sc. (Physics)** | Year: I<br>Semester: I |
| Credits:**4**<br>Theory:**4** | **Subject: Physics** |
| **Course Code: MSPH-111** | **Title: Mathematical Physics** |
| **Course Objectives:** The purpose of the undergraduate Physics program at the university level is to provide the key knowledge of the fact of science understanding of the law of physics and laboratory resources to prepare students for careers as professionals in various industries and research institutions. | |
| **Nature of Paper: Core** | |
| **Minimum Passing Marks/Credits: 40% Marks** | |
| L: 04<br>T: 00<br>P: 00(In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits) | |

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | **MATRICES & TENSORS**<br>Orthogonal, Hermitian, Unitary and Normal matrices, Pauli and Dirac matrices, Orthogonality conditions, Tensor analysis: Introduction and definitions (Covariant and contravariant tensors, Addition, Multiplication & rank of tensors, Contraction, Direct product, Quotient rule), Pseudo and dual tensors, Levi-Civita symbol, Metric tensor, Christoffel symbols as derivatives of the metric tensor. | 08 |
| II | **COMPLEX VARIABLES**<br>Functions of complex variables, Analytic function, Cauchy integral theorem and Cauchy integral formula, Taylor and Laurent series, Theorem of residues, Contour integrals and evaluation of definite integrals. | 08 |
| III | **SPECIAL FUNCTIONS**<br>Legendre, Bessel, Hermite, Laguerre equations and their solutions & polynomials, Recursions relations, Orthogonality and generating functions, Associated Legendre polynomials. | 08 |
| IV | **INTEGRAL TRANSFORMS**<br>First and second order shifting theorems, Fouriers series, Fourier integral, Fourier transformes(FT), Dirac- delta functions and its FT, Laplace transforms (LT), Inverse LT by partial fractions, LT of | 08 |

| | | |
|---|---|---|
| | derivative and integral function. | |
| V | **PARTIAL DIFFERENTIAL EQUATION**<br>Laplace equation and its solution in rectangular, cylindrical and spherical co-ordinates; Poisson equation (Green's function solution), Two-dimensional wave equation, Vibrating membrane (rectangular and circular). | **08** |

**Reference / Text Books:**

- Mathematical Physics - B.S. Rajput
- Mathematical Methods for Physics - G Arfken
- Mathematical Methods for Physics- G.Arfken
- Applied Mathematics for Physicists & Engineer- Pipes &Harvill
- Matrices and Tensors for Physicists- A .W. Joshi
- Advanced Engineering Mathematics- E. Kreyszig
- Mathematics for Physicists- Mary L. Boas
- Special functions - E.D. Rainville
- Special functions –W. W. Bell
- Mathematical Methods for Physicists & Engineers- K.F. Reily, MPH Hobson & SJ Bence

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1. Class tasks/ Sessional Examination<br>2. Assignments<br>3. ESE | 10 + 10<br>10<br>70 |
| **Total:** | **100** |

Prerequisites for the course: Physics and Mathematics in B.Sc.

**Course Learning Outcomes:**

- Draw and intercept groups of various elementary functions and their combination.
- Understood the vector quantities as entities with Cartesian components which satisfy appropriate rule of transformation under rotation of the axes.
- To understand the methods to sole first and second order differential $r^4$.
- Understand the matrices and Tensor problems.
- To understand the complex variable and special functions problems.

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: I/ Semester: I**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. **Class: M.Sc. (Physics)** | Year: I<br>Semester: I |
| Credits:**4**<br>Theory:**4** | **Subject: Physics** |
| **Course Code**:**MSPH-112** | **Title: CLASSICAL MECHANICS** |

**Course Objectives:**
The primary objective is to teach the students Classical Mechanics at a level more advanced than what they have learnt in B.Sc. This is a course which forms the basis of Physics of many areas of Physics.

Nature of Paper: **Core**

**Minimum Passing Marks/Credits: 40% Marks**

L: 04
T: 00
P: 00(In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| **I** | **LAGRANGIAN FORMALISM AND VARIATIONAL PRINCIPLE**<br>Mechanics of a particle and system of particles, Conservation laws, Constraints, Degree of freedom, Generalised coordinates, D'Alembert's principle, Lagrange's equation of motion from D' Alembert's principle, Application of Lagrange's equation of motion to a particle and system of particles, Conservation theorem, Hamilton's variational principle, Euler- Lagrange's differential equation. | **08** |
| **II** | **HAMILTONIAN FORMALISM**<br>Need of Hamiltonian procedure, Legendre's transformation and Hamiltonian equations of motion, Physical significance of Hamiltonian, Cyclic coordinates, Hamiltonian equations in cylindrical and spherical coordinates and their applications, Application of Hamiltonian equation of motion to a particle and system of particles. | **08** |
| **III** | **LEAST ACTION PRINCIPLE AND CANONICAL TRANSFORMATIONS**<br>The principle of least action (no proof), Canonical or contact transformations, Their advantages and examples, Condition for a transformation to be canonical, Infinitesimal contact transformations (ICT), Poisson's Brackets: Definition and properties, Invariance with respect to canonical transformations, Equation of motion in Poisson | **08** |

| | | |
|---|---|---|
| | Bracket form, Jacobian's identity. | |
| IV | **MOTION UNDER CENTRAL FORCES**<br>Equivalent one body problem, General features of central force motion, Study of orbits, Virial Theorem, Kepler's laws of planatery motion, Laplace-Runge-Lenz vector, Unbound motion, Scattering in a central force field, Lagrangian and Hamiltonian formulation of relativistic mechanics. | **08** |
| V | **MECHANICS OF RIGID BODIES AND THEORY OF SMALL OSCILLATIONS**<br>Coordinates for rigid body motion, Euler's angles, Angular momentum of a rigid body, Moments and products of inertia, Principal axes transformation, Euler's equation of motion of a rigid body, Stable and unstable equilibriums, Lagrange's equation of motion for small oscillaitons, Normal co-ordinates and normal mode, Frequencies of vibration, Free vibration of linear triatomic molecules. | **08** |

**Reference / Text Books:**


- Classical Mechanics- N .C Rana and P.S. Joag (Tata Mcgraw-Hill, 1991)
- Classical Mechanics- H. Goldstien (Addison Wesley, 1980)
- Mechanics- A. Sommerfeld (Academic Press, 1952)
- Introduction to Dynamics- I. Perceival and D. Richards (Canbridge Univ. Press)


**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1. Class tasks/ Sessional Examination | 10 + 10 |
| 2. Assignments | 10 |
| 3. ESE | 70 |
| **Total:** | **100** |

Prerequisites for the course: Physics and Mathematics in B.Sc

**Course Learning Outcomes:**

- Gain a comprehensive understanding of the fundamental principles of mechanics, including conservation laws, constraints, degrees of freedom, and generalized coordinates.
- Apply Lagrangian formalism to describe the motion of particles and systems of particles, and solve problems involving D'Alembert's principle, Lagrange's equation of motion, and conservation theorems.
- Develop proficiency in using Hamiltonian formalism to analyze complex mechanical systems, including Legendre's transformation, Hamilton's equations of motion, and their application to various coordinate systems.
- Understand the concept of canonical transformations and their significance in analyzing mechanical systems, including conditions for canonical transformations, Poisson brackets, and the invariance principle with respect to canonical transformations.
- Analyze the motion of particles under central forces, study various orbit types, Kepler's laws, and apply Lagrangian and Hamiltonian formulations to describe the motion of celestial bodies.
- Acquire knowledge of rigid body dynamics, including Euler's angles, angular momentum, and moments of inertia. Additionally, grasp the concepts of small oscillations, stable and unstable equilibriums, and the formulation of equations of motion for small oscillations using Lagrange's approach.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: I / Semester: I**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. **Class: M.Sc. (Physics)** | Year: I<br><br>Semester: I |
| Credits:**4**<br>Theory:**4** | **Subject: Physics** |
| **Course Code:MSPH-113** | **Title: QUANTUM MECHANICS – I** |
| **Course Objectives:**<br>The primary objective is to teach the students the physical and mathematical basis of quantum mechanics for non-relativistic systems | |
| **Nature of Paper: Core** | |
| **Minimum Passing Marks/Credits: 40% Marks** | |
| L: 03<br>T: 01<br>P: 00(In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits) | |

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | **SCHRODINGER WAVE MECHANICS AND APPLICATION**<br>Motion of wave packet, Schrödinger equation, Normalised and orthogonal wave functions, Stationary state solution, Expectation values of dynamical variables, Probability current density, Ehrenfet's theorem, Momentum eigen functions and their applications, Coordinate and momentum representation, Rectangular potential barrier and its applications to □ - decay, Particle in 1-D infinite deep potential well. | **08** |
| II | **BOUND STATE PROBLEMS**<br>One dimensional and three-dimensional harmonic oscillators, one dimensional finite square well, spherically symmetric systems and potentials, Rigid rotator, Hydrogen atom and its normal state. | **08** |
| III | **OPERATORS**<br>Algebra of operators, Linear operators, Eigen function and eigen values of operators, Orthogonal and complete set of eigen function, Dirac, Bra and Ket space, Heisenberg's uncertainty relations derived from operators, Hermitian operator and its properties, Matrix representation of operators, Change of basic functions, Unitary and similarity transformations, Equation of motion. Schrödinger, Heisenberg and interaction pictures. | **08** |
| IV | **ANGULAR MOMENTUM**<br>Commutation Algebra, Commutation relation between position and momentum, Commutation relation for orbital angular momentum (L), Spin angular momentum (S) and total angular momentum (J), Eigen | **08** |

| | | |
|---|---|---|
| | value spectrum for J2 and Jz , Matrix elements of Jx, Jy, Jz, Addition of angular momentum, C.G. coefficients (no derivation) and their uses. | |
| V | **IDENTICAL PARTICLES AND SPIN**<br>Physical meaning of identity, Exchange symmetry of wave functions, Symmetric and antisymmetric wave functions, Pauli's exclusion principle and its connection with statistical mechanics, Collision of identical particles, Spin angular momentum, Effect of spin on energy states of an atom (He-atom), Spin orbit interaction and spin correction, Symmetric and antisymmetric wave functions of hydrogen molecule (H2). | **08** |

**Reference / Text Books:**

- Quantum Mechanics - L. I. Schiff (McGraw-Hill)
- Quantum Mechanics - Merzbacher
- Quantum mechanics - B. Craseman and J D Powell (Addison Wesley)
- Quantum Mechanics - Mathews and Venkatesan
- Quantum Mechanics - A. P Messiah

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1. Class tasks/ Sessional Examination | 10 + 10 |
| 2. Assignments | 10 |
| 3. ESE | 70 |
| **Total:** | **100** |

Prerequisites for the course: Physics and Mathematics in B.Sc

**Course Learning Outcomes:**

- Grasp the fundamental principles of wave mechanics, including Schrödinger's equation, wave packets, normalized wave functions, and stationary state solutions.
- Analyze bound state problems in various potentials, such as harmonic oscillators, finite square wells, and spherically symmetric systems. Understand the behavior of particles in these potentials.
- Develop proficiency in using operators to describe quantum systems, including understanding the algebra of operators, eigenvalues, eigenvectors, and Hermitian operators. Apply operators to derive Heisenberg's uncertainty relations.
- Gain insight into angular momentum concepts, including commutation relations, eigenvalue spectra, and addition of angular momentum. Understand the connection between angular momentum and the behavior of particles.
- Understand the significance of identical particles in quantum mechanics, including exchange symmetry of wave functions, Pauli's exclusion principle, and the effects of spin on atomic and molecular energy states.
- Apply quantum mechanics principles to real-world scenarios, such as analyzing particle behavior in potential barriers, understanding the energy states of atoms and molecules, and studying the collision of identical particles.

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: I / Semester: I**

| | | |
|---|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D.<br>**Class: M.Sc. (Physics)** | | Year: I<br><br>Semester: I |
| Credits:**4**<br>Theory:**4** | **Subject: Physics** | |
| **Course Code: MSPH-114** | **Title: INTRODUCTION ELECTRONIC COMPONENTS & CIRCUITS** | |
| **Course Objectives:**<br>To give an understanding about generation, propagation, reception and detection of electromagnetic waves in free space and optical signals in guided media relating to fiber optic communication. Analyze the contribution of inherent noise produced by components, devices and circuits commonly used in instrumentation/communication systems and learn the effective methods of noise reduction. | | |
| **Nature of Paper: Core** | | |
| **Minimum Passing Marks/Credits: 40% Marks** | | |
| L: 03<br>T: 01<br>P: 00(In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits) | | |

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | **REVIEW :** Network & network theorems, Diode circuits-Rectifiers & smoothing circuits, Voltage multipliers, Limiters & clampers, Photodiode and LED, Zener diode, Varactor diode and tunnel diode, Transistor fundamentals, Transistor biasing, CE and CC amplifier and their small signal equivalent circuits. | **08** |
| II | **FIELD EFFECT TRNASISTER (FET) AND FREQUENCY EFFECTS :** FET and MOSFET device characteristics, FET biasing, FET amplifier, Lead and lag networks, Miller's theorem, High frequency FET and BJT analysis, Amplifier frequency response. | **08** |
| III | **OP-AMP THEORY WITH NEGATIVE FEED BACK:** The differential amplifier, DC and AC analysis of a differential amplifier, CMMR, The OP-AMP, OP-AMP DC offset characteristics, Freuqncy response, Slew rate and power bandwidth, Types of negative feedback: Non–inverting voltage feedback, Effect on input and output impedences, Non–inverting current feedback, Inverting voltage and current feedback, Band width, Closed loop gain and BW. | **08** |
| IV | **OP-AMP CIRCUITS:** Inverting amplifier, Non-inverting amplifier, Summing amplifier, Active filters, Comparators, The Schmitt trigger, Integrator, Differentiator, Waveform conversion, Waveform generator, | **08** |

| | | |
|---|---|---|
| | Current to voltage and voltage to current converters, Low pass, band pass and band reject filters, Brief study of timer 555. | |
| **V** | **THE OSCILLATORS, VOLTAGE REGULATORS AND THYRISTORS :** The positive feedback and oscillations, Wein bridge oscillator, RC and LC oscillators, The unwanted oscillations and stability, Multivibrators. Zener diode regulators, transistor series voltage regulators, Negative feedback voltage regulators, Transistor shunt voltage regulator, The SCR and its applications, UJT and its applications. | **08** |

**Reference / Text Books:**

- Solid State Electronics - Ben G. Streetman, PHI
- Semiconductor Devices-Physics and Technology- S. M .Sze Wiley (1985)
- Introduction to Semiconductor devices - M.S. Tyagi, John Wiley & Sons
- Electronic Devices & Circuits- G.K. Mithal
- Electronic Principles (3/e)- A.P. Malvino, TMH
- Op-Amps & Linear integrated circuits - Ramakanth A. Gayakwad, PHI, Second Edition, 1991

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1. Class tasks/ Sessional Examination | 10 + 10 |
| 2. Assignments | 10 |
| 3. ESE | 70 |
| **Total:** | **100** |

Prerequisites for the course: Physics in B.Sc

**Course Learning Outcomes:**

- Gain a comprehensive understanding of basic circuit analysis principles, including network theorems, diode circuits, rectifiers, smoothing circuits, and voltage multipliers.
- Develop proficiency in working with various types of diodes, including Zener diodes, varactor diodes, tunnel diodes, photodiodes, and LEDs. Understand their characteristics and applications in electronic circuits.
- Gain a strong foundation in transistor fundamentals, biasing techniques, and amplifier configurations such as Common Emitter (CE) and Common Collector (CC). Learn to analyze small signal equivalent circuits.
- Understand the characteristics of Field Effect Transistors (FETs) and Metal-Oxide-Semiconductor FETs (MOSFETs). Analyze FET biasing, amplifiers, and frequency effects. Explore Miller's theorem and analyze amplifier frequency responses.
- Learn about the theory and characteristics of operational amplifiers. Explore different types of negative feedback configurations, including inverting and non-inverting amplifiers, summing amplifiers, active filters, integrators, differentiators, and waveform generators.
- Understand the principles of oscillators, including positive feedback, Wein bridge oscillator, and RC/LC oscillators. Explore voltage regulation techniques using Zener diodes and transistor regulators. Gain insight into the applications of semiconductor devices like SCR and UJT in electronic circuits.

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: I / Semester: I**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D.<br>**Class: M.Sc. (Physics)** | Year: I<br><br>Semester: I |
| Credits: **04**<br>Practical:**04** | **Subject: Physics** |
| **Course Code:MSPH-111P** | **Title: GENERAL PHYSICS LAB** |

**Course Objectives:**
The major objective of this course is to revise the basic concepts of electronics/nuclear physics through standard set of experiments. In addition, the continuous evaluation process allows each and every student to not only understand and perform the experiment but also suitably correlate them with the corresponding theory.

Nature of Paper: **Core**

**Minimum Passing Marks/Credits: 50% Marks**

L: 00
T: 00
P: 04 (In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| | **Lab Experiment List** | |
| | 1. Studies with Michelson's Interferometer Determination of wavelength separation of sodium D-lines.<br>2. Studies with Michelson's Interferometer Determination of the thickness of mica sheet.<br>3. Wave the length of sodium light by using Fresnel Bi-prism.<br>4. Verification of Cauchy's relation.<br>5. Determination of optical constants of metal in thin film form.<br>6. Young's modulus determination by optical method.<br>7. Studies of phenomena with polarized light-Analysis of elliptically polarized light using /4 plates and Babinet's compensator.<br>8. Ultrasonic interferometer<br>9. Studies with Edser-Butler Plate<br>10. Verification of Rayleigh's criterion for the limit of resolution of spectral lines usingPrism spectrum<br>11. Verification of Rayleigh's criterion for the limit of resolution of spectral lines usinggrating spectrum.<br>12. Planck's constant<br>13. Design and study of different Network theorems<br>14. Measurement of the wavelength of He-Ne Laser light using ruler<br>15. To study the Faraday effect using He-Ne Laser | **50** |

| | | |
|---|---|---|
| | 16. To find the conductivity (Dark and Phtoconductivity) of a thin film semicondutor at room temperature, low temperature and high temperature. | |

**Reference / Text Books:**

1. "Optics" by Eugene Hecht Publisher: Pearson Education
2. "Electronic Devices and Circuit Theory" by Robert L. Boylestad and Louis Nashelsky Pearson Education
3. "Introduction to Solid State Physics" by Charles Kittel John Wiley & Sons

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1. Record File | 15 |
| 2. Viva Voce | 5 |
| 3. Class Interaction | 10 |
| **Total:** | **30** |

Prerequisites for the course:

- **PREREQUISITE:** Opted / Passed Semester I, Theory Papers

**Course Learning Outcomes:**

- Develop proficiency in operating and calibrating advanced optical instruments such as Michelson's interferometer, Fresnel bi-prism, ultrasonic interferometer, and Edser-Butler Plate to make precise measurements of various physical properties.
- Gain hands-on experience in conducting experiments to determine optical properties such as wavelength separation, thickness of materials, and the optical constants of thin films using techniques like interferometry and polarization analysis.
- Learn to characterize materials by verifying Cauchy's relation, determining Young's modulus optically, and studying phenomena involving polarized light, contributing to an in-depth understanding of material behavior.
- Apply Rayleigh's criterion to experimentally verify the limit of resolution for spectral lines using both prism and grating spectra, enhancing your skills in optical spectroscopy.
- Develop the ability to design and analyze circuits using different network theorems. Gain practical insight into circuit behavior, Wein bridge oscillators, oscillators, voltage regulators, and related electronic components.
- Apply quantum physics concepts to measure Planck's constant, study the Faraday effect using lasers, and analyze semiconductor properties like conductivity at different temperatures. This provides hands-on experience in real-world applications of theoretical principles.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: I / Semester: II**

<table>
<tr><td colspan="2">Programme: Certificate/Diploma/Degree/ UG(R)/PG/Ph.D.<br>Class: M.Sc. (Physics)</td><td colspan="2">Year: I<br><br>Semester: II</td></tr>
<tr><td colspan="2">Credits:4<br>Theory:4</td><td colspan="2">Subject: Physics</td></tr>
<tr><td colspan="2">Course Code:MSPH-121</td><td colspan="2">Title: E.M. THEORY & ELECTRODYNAMICS</td></tr>
<tr><td colspan="4">Course Objectives:<br>This course aims to introduce the student to topics in Electromagnetic Theory, Relativity and the Relativistic formulation of electromagnetism. The course reviews and builds on the students' knowledge of Relativity and introduces the formulation of relativity in 4-vector notation. It also builds up a covariant formulation of electrodynamics and includes a study of motion of charges in fields as well as radiation from moving charges as well as antennae.</td></tr>
<tr><td colspan="4">Nature of Paper: Core</td></tr>
<tr><td colspan="4">Minimum Passing Marks/Credits: 40% Marks</td></tr>
<tr><td colspan="4">L: 03<br>T: 01<br>P: 00 (In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)</td></tr>
<tr><td>Unit</td><td colspan="2">Contents</td><td>No. of Lectures Allotted</td></tr>
<tr><td>I</td><td colspan="2">ELECTROSTATICS<br>Boundary value problems, Conductor and uniqueness theorem, Method of images, Image and induced surface charge, Force and energy, Problem of sphere and charge, Multipole expansion potential- Monopole and dipole terms in detail, Electric fields of a dipole, Dielectrics- deceptive parallel, Force and energy in dielectric system.</td><td>08</td></tr>
<tr><td>II</td><td colspan="2">MAGNETOSTATICS AND FIELDS IN MATTER<br>The divergence and curl of B, Ampere's law, Magnetic vector potential, Boundary conditions and multipole Expansion, Magnetisation-Dia, para and ferromagnets, Effect of Magnetic field in atomic orbits, Bound currents and their interpretation, Magnetic field inside matter, Ampere's law in magnetised materials, Linear and nonlinear media</td><td>08</td></tr>
<tr><td>III</td><td colspan="2">ELECTRODYNAMICS<br>Maxwell's equation and magnetic charge, Equation inside matter, Boundary conditions, Potential formulations, Scalar and vector potentials, Gauge transformations, Coulomb and Lorentz gauge, Lorentz force law in potential form, Energy and momentum, Newton's third law in electrodynamics, Poynting theorem.</td><td>08</td></tr>
</table>

| | | |
|---|---|---|
| IV | **ELECTROMEGNETIC WAVES**<br>Polarisation, Boundary condition, Reflection and refraction, E.M. waves in non-conducting media, Monochromatic plane wave in vacuum, Energy and momentum of E.M. waves, Reflection and transmission at normal incidence and at oblique incidence, Dispersion -Frequency dispersion, Frequency dependence of □, □ and □ in non-conductors. Waveguides: Rectangular and circular waveguides. | **08** |
| V | **ELECTROMAGNETIC RADIATION**<br>Dipole radiation, Retarded potentials, Electric dipole radiation, Magnetic dipole radiation, Radiation from a point charge, Radiation from an arbitrary distribution of charge and currents, Lineard-Wichart potentials, Field of a point charge in motion, Power radiated by a point charge. | **08** |

**Reference / Text Books:**

- Introduction to Electrodynamics - Griffith D.J
- Classical Electricity and Magnetism - Panofsky & Phillips
- Plasma Physics - Bittencourt
- Classical Electrodynamics –Bittencourt
- Electricity & Magnetism - A. Kip, McGraw Hill

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1. Class tasks/ Sessional Examination | 10 + 10 |
| 2. Assignments | 10 |
| 3. ESE | 70 |
| **Total:** | **100** |

Prerequisites for the course: Physics and Mathematics in B.Sc

**Course Learning Outcomes:**

- Acquire a deep understanding of advanced electromagnetic concepts, including boundary value problems, method of images, multipole expansion, and electric and magnetic fields inside matter.
- Gain proficiency in analyzing the behavior of magnetic fields in various materials, including dia, para, and ferromagnetic substances. Understand the effects of magnetic fields on atomic orbits and the concept of magnetization.
- Develop expertise in Maxwell's equations and their applications, including potential formulations, gauge transformations, and the Lorentz force law. Study the energy, momentum, and Poynting theorem related to electromagnetic fields.
- Understand the principles of electromagnetic wave propagation, including polarization, reflection, refraction, and dispersion. Explore the behavior of electromagnetic waves in various media, including non-conducting ones, and analyze waveguides.
- Study electromagnetic radiation and its characteristics, including dipole radiation, retarded potentials, and radiation from moving charges. Learn to calculate radiation from point charges and arbitrary charge distributions, as well as analyze radiation patterns.
- Develop practical skills in solving complex problems related to electromagnetism, including calculating electromagnetic wave properties, understanding boundary conditions, and analyzing electromagnetic radiation from various sources.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: I / Semester: II**

| | |
|---|---|
| **Programme:**<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>**Class: M.Sc. (Physics)** | Year: **I**<br><br>Semester: **II** |
| Credits:**4**<br>Theory:**4** | **Subject: Physics** |
| **Course Code:MSPH-122** | **Title: STATISTICAL MECHANICS** |

**Course Objectives:**
This course aims to introduce the student to topics in Electromagnetic Theory, Relativity and the Relativistic formulation of electromagnetism. The course reviews and builds on the students' knowledge of Relativity and introduces the formulation of relativity in 4-vector notation. It also builds up a covariant formulation of electrodynamics and includes a study of motion of charges in fields as well as radiation from moving charges as well as antennae.

**Nature of Paper: Core**

**Minimum Passing Marks/Credits: 40%**

L: 03
T: 01
P: 00 (In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | **BASIC PRINCIPLES OF STATISTICAL MECHANICS**<br>Thermodynamic potentials, Thermodynamic equilibria, Nernst's heat theorem, Chemical potential, Phase space, Ensembles, Density distribution of phase space, Liouville's theorem, Microstate and macrostates, Thermodynamical probability, Most probable distribution, Maxwell-Boltzmann distribution law, Law of equipartition of energy. | **08** |
| II | **METHODS OF ENSEMBLES**<br>Microcanonical ensemble- Perfect gas in microcanonical ensemble, Entropy, Gibbs Paradox, Partition function and its correlation with thermodynamic quantities, Canonical Ensemble- Thermodynamic function and partition functions, Grand canonical ensemble- Thermodynamic function and partition functions, Theory of imperfect gases, Equation of state and virial co-efficients. | **08** |
| III | **THEORY OF IDEAL GAS**<br>The ideal quantum gas, Bose-Einstein statistics, Fermi-Dirac statistics and Maxwell-Boltzmann statistics, Evaluation of constants $\alpha$ and $\beta$ and their thermodynamic interpretation, Black body radiation and Planck's radiation, Grand canonical ensemble and the quantum | **08** |

| | | |
|---|---|---|
| | statistics. | |
| IV | **IDEAL B/E GAS**<br>Energy and pressure of a gas, Gas degeneracy, Bose-Einstein condensation, Thermal properties of B/E gas, Liquid He, Landau's theory of liquid He-II, Feyman's theory of liquid He-II. | **08** |
| V | **IDEAL FERMI GAS**<br>Energy and pressure of a gas, Weakly degenerate and strongly degenerate, Thermodynamic functions of degenerate F/D gas, Electron gas, Pauli theory of paramagnetism and Landau diamagnetism, White Dwarfs , Neutron stars. | **08** |

**Reference / Text Books:**

1. Statistical Mechanics – R. K. Pathria
2. Statistical Mechanics - S.K. Sinha
3. Statistical Mechanics – K. Huang
4. Statistical and Thermal Physics- F. Reif
5. Statistical Mechanics – K. Huang
6. Statistical Mechanics - Landau &Lifshitz
7. Statistical Physics - E.S. R. Gopal
8. Introduction to Statistical Physics - Pointon

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1. Class tasks/ Sessional Examination | 10 + 10 |
| 2. Assignments | 10 |
| 3. ESE | 70 |
| **Total:** | **100** |

Prerequisites for the course: Physics and Mathematics in B.Sc

**Course Learning Outcomes:**

- Develop a solid understanding of the foundational principles of statistical mechanics, including thermodynamic potentials, equilibria, Nernst's heat theorem, chemical potential, and the concept of phase space.
- Gain proficiency in applying different ensemble methods—microcanonical, canonical, and grand canonical—to describe the statistical behavior of thermodynamic systems. Understand the correlation between partition functions and thermodynamic quantities.
- Acquire in-depth knowledge of the behavior of quantum gases, including Bose-Einstein and Fermi-Dirac statistics. Learn to evaluate constants $\alpha$ and $\beta$, and explore the thermodynamic interpretation of these values.
- Study the properties of ideal Bose-Einstein gases, including energy, pressure, gas degeneracy, Bose-Einstein condensation, and thermal properties. Analyze unique phenomena like Bose-Einstein condensates and liquid helium behavior.
- Understand the characteristics of ideal Fermi gases, both weakly and strongly degenerate, and delve into the thermodynamic functions of Fermi-Dirac gases. Explore applications in areas like electron gas, paramagnetism, and diamagnetism.
- Apply the concepts of statistical mechanics to astrophysical scenarios, such as the study of white dwarfs and neutron stars, deepening your understanding of how statistical mechanics principles extend to real-world systems.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: I / Semester: II**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D.<br>**Class: M.Sc. (Physics)** | Year: I<br><br>Semester: II |
| Credits:**4**<br>Theory:**4** | **Subject: Physics** |
| **Course Code:MSPH-123** | **Title: QUANTUM MECHANICS – II** |

**Course Objectives:**
The primary objective is to teach the students various approximation methods in quantum mechanics. The important topic of quantum scattering is also dealt with. Relativistic quantum theory like Klein-Gordon equation and Dirac equation is also covered.

**Nature of Paper: Core**

**Minimum Passing Marks/Credits: 40% Marks**

L: 03
T: 01
P: 00 (In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | **STATIONARY STATE PERTURBATION THEORY**<br>Non-degenerate case, First order and second order stationary perturbation theory, Degenerate case, Zeeman effect (without electron spin), First order Stark effect in H-Atom, The Variation method and its application to ground state of He and Vander-Waals interaction, WKB approximation, Connection formula for barrier penetration, Application of WKB method to theory of  decay. | 08 |
| II | **TIME DEPENDENT PERTURBATION THEORY AND SEMICLASSICAL THEORY OF RADIATION**<br>The time dependent perturbation theory, Transition probability, FG rule, Harmonic perturbation, Adiabatic and sudden approximation, Radiation theory- Interaction of radiation with atom, Electron dipole transition and forbidden transition, Classical radiation field, Asymptotic form of radiated energy, Dipole radiation, Planck distribution formula, Application of radiation theory-selection rule for a single particle. | 08 |
| III | **SCATTERING THEORY**<br>Laboratory and C.M. frames, Scattering cross section, Wave function for a particle in spherical polar coordinates, Expansion of plane wave in spherical harmonic, Scattering by spherically symmetric potentials (partial wave analysis), Scattering by an attractive potential well, Scattering by a Coulomb field- Rutherford | 08 |

| | | |
|---|---|---|
| | formula, Condition for validity of Born Approximation, Application of Born approximation: (a) Scattering by a square well potential (b) Scattering by a screened Coulomb field. | |
| **IV** | **RELATIVISTIC QUANTUM MECHANICS**<br>The Klien-Gordon equation, Dirac relativistic equation and its covariant form, Dirac free particle solution (Plane wave solution), Probability density and current density, Review of electromagnetic potentials, Dirac equation for particle in E.M. field, Magnetic moment of electron, Existence of electron spin, Spin-orbit coupling, Solution of Dirac's equation for a central field (H-atom), Energy Eigen values, Negative energy state and concept of hole. | **08** |
| **V** | **QUANTISATION OF FIELDS**<br>Classical and quantum field equations: Co-ordinates of the field, Time derivative, Classical Lagrangian and Hamiltonian equations, Quantum field equations. Second quantisation, Quantisation of non-relativistic Schrödinger equation, Creation, Annihilation and umber operators, Anticommutation relations, Equation of motion. Electromagnetic field in vacuum: Commutation relation for E and H, Plane wave representation, Quantised field theory, Quantised field momentum, Commutation relations at different times. | **08** |

**Reference / Text Books:**


- Quantum Mechanics - L. I. Schiff (McGraw-Hill )
- Quantum mechanics - B .Craseman and J .D .Powell (Addison Wesley)
- Quantum Mechanics - Mathews and Venkatesan
- Principles of Quantum Mechanics - I.S. Tyagi (Pearson)
- Modern Quantum Mechanics - J.J. Sakurai
- Introduction to Quantum Field Theory, - Paul Roman (John Wiley)
- Quantum Fields - N.N. Bigollubov& D.V. Shrikov


**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1. Class tasks/ Sessional Examination | 10 + 10 |
| 2. Assignments | 10 |
| 3. ESE | 70 |
| **Total:** | **100** |

Prerequisites for the course: Physics and Mathematics in B.Sc

**Course Learning Outcomes:**

- Develop a deep understanding of stationary state perturbation theory, including both non-degenerate and degenerate cases. Learn how to calculate energy corrections to Eigen-states and Eigen values in the presence of external fields using first and second order perturbation theory.
- Acquire proficiency in scattering theory, encompassing topics such as scattering cross sections, partial wave analysis, and Born approximation. Learn how to analyze scattering processes, apply the Born approximation, and derive the Rutherford formula.
- Learn the principles of time-dependent perturbation theory, including transition probabilities, Fermi's Golden Rule, and harmonic perturbation. Understand how radiation interacts with

atoms, including dipole transitions and forbidden transitions.

- Gain insight into relativistic quantum mechanics by studying the Klein-Gordon and Dirac equations. Understand how these equations describe relativistic particles, their spin properties, and their interactions with electromagnetic fields.
- Explore the quantization of fields and learn about second quantization techniques. Understand the concept of creation and annihilation operators, their anti-commutation relations, and their applications in quantized field theory.
- Apply quantum concepts learned in the course to real-world scenarios. Understand the application of perturbation theory, scattering theory, and relativistic quantum mechanics to phenomena such as Zeeman effect, Stark effect, and radiation-matter interactions.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: I / Semester: II**

<table>
<tr><td colspan="2">Programme:<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>Class: M.Sc. (Physics)</td><td>Year: II<br><br>Semester: II</td></tr>
<tr><td>Credits:4<br>Theory:4</td><td colspan="2">Subject: Physics</td></tr>
<tr><td>Course Code: MSPH-124</td><td colspan="2">Title: SOLAR & NON-CONVENTIONAL ENERGY</td></tr>
<tr><td colspan="3">Course Objectives:<br>This course looks at the operating principle of a range of non-conventional energy resources, materials used, characterization, and key performance characteristics. The technologies looked at will include, Solar energy, Wind, Batteries, Fuel cells, and Geothermal conversion. The advantages and limitations of these technologies in comparison to conventional sources of energy will also be examined.</td></tr>
<tr><td colspan="3">Nature of Paper: Core</td></tr>
<tr><td colspan="3">Minimum Passing Marks/Credits: 40% Marks</td></tr>
<tr><td colspan="3">L: 03<br>T: 01<br>P: 00 (In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)</td></tr>
</table>

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | **INTRODUCTION**<br>Various non-conventional energy resources- Introduction, availability, classification, relative merits and demerits. Solar Cells: Theory of solar cells. Solar cell materials, solar cell array, solar cell power plant, limitations. | **08** |
| II | **SOLAR THERMAL ENERGY**<br>Solar radiation, flat plate collectors and their materials, applications and performance, focussing of collectors and their materials, applications and performance; solar thermal power plants, thermal energystorage for solar heating and cooling, limitations. | **08** |
| III | **GEOTHERMAL ENERGY**<br>Resources of geothermal energy, thermodynamics of geo-thermal energy conversion-electrical conversion, non-electrical conversion, environmental considerations. Magneto-hydrodynamics (MHD): Principle of working of MHD Power plant, performance and limitations. Cells: Principle of working of various types of fuel cells and their working, performance and limitations. | **08** |
| IV | **THERMO-ELECTRICAL AND THERMIONIC CONVERSIONS** | **08** |

| | | |
|---|---|---|
| | Principle of working, performance and limitations. Wind Energy: Wind power and its sources, site selection, criterion, momentum theory, classification of rotors, concentrations and augments, wind characteristics. Performance and limitations of energy conversion systems. UNIT-V Bio-mass: Availability of bio-mass and its conversion theory. | |
| V | **OCEAN THERMAL ENERGY CONVERSION (OTEC)** Availability, theory and working principle, performance and limitations. Wave and Tidal Wave: Principle of working, performance and limitations. Waste Recycling Plants. | **08** |

**Reference / Text Books:**


- Raja etal, “Introduction to Non-Conventional Energy Resources” Scitech Publications.
- John Twideu and Tony Weir, “Renewal Energy Resources” BSP Publications, 2006.
- M.V.R. KoteswaraRao, “Energy Resources: Conventional & Non-Conventional” BSP Publications 2006.
- D.S. Chauhan,”Non-conventional Energy Resources” New Age International.
- C.S. Solanki, “Renewal Energy Technologies: A Practical Guide for Beginners” PHI Learning.
- Peter Auer, "Advances in Energy System and Technology". Vol. 1 & II Edited by Academic Press.


**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1. Class tasks/ Sessional Examination | 10 + 10 |
| 2. Assignments | 10 |
| 3. ESE | 70 |
| **Total:** | **100** |

Prerequisites for the course: Physics in B.Sc.

**Course Learning Outcomes:**

- Develop a comprehensive understanding of various non-conventional energy resources, including their availability, classification, and the relative merits and demerits of each. Gain insight into the broad spectrum of alternative energy options.
- Acquire knowledge about solar cells, their theory, materials, array configurations, and power plant setups. Understand the limitations and challenges associated with solar cell technology.
- Learn about solar thermal energy, including the concepts of solar radiation, flat plate collectors, concentrating collectors, thermal energy storage, and solar thermal power plants. Gain an understanding of the performance and applications of these systems.
- Study geothermal energy resources, thermodynamics of conversion, and environmental considerations. Understand the working principle, performance, and limitations of Magneto-hydrodynamics (MHD) power plants. Explore the principles of fuel cells, thermoelectric, and thermionic conversions.
- Acquire knowledge about wind energy sources, site selection, rotor types, wind characteristics, and the performance and limitations of wind energy conversion systems. Understand biomass availability, conversion theory, and its role in sustainable energy solutions.
- Learn about Ocean Thermal Energy Conversion (OTEC), its availability, working principle, and performance. Explore wave and tidal wave energy systems, their working principles, and limitations. Understand the concept of waste recycling in the context of sustainable energy practices.

**IIMTU-NEP IMPLEMENTATION**
**Year: I / Semester: II**

| | | |
|---|---|---|
| **Programme**: Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. **Class:M.Sc. (Physics)** | | Year: **I** Semester: **II** |
| Credits:**04** Practical: **04** | **Subject: Physics** | |
| **Course Code:MSPH-121P** | **Title: BASIC ELECTRONICS LAB** | |
| **Course Objectives:** The major objective of this course is to revise the basic concepts of electronics/components uses physics through standard setup of experiments. In addition, the continuous evaluation process allows each and every student to not only understand and perform the experiment but also suitably correlate them with the corresponding theory. | | |
| Nature of Paper: **Core** | | |
| **Minimum Passing Marks/Credits:** 50% Marks | | |
| L: 00<br>T: 00<br>P: 04 (In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits) | | |

| **Unit** | **Contents** | **No. of Lectures Allotted** |
|---|---|---|
| | **Lab Experiment List** | |
| | 1. (a) Design and study of low voltage regulated power supply and measure its regulation characteristics<br>(b) Design and study of IC 723 and 3 terminal IC regulator-based power supply<br>2. Design and study of a CE transistor amplifier and study its frequency response, Input and output impedance.<br>3. Design and study of a CC transistor amplifier and estimate its input, output impedances and frequency response.<br>4. Design a two stage RC coupled BJT amplifier with and without feedback and study frequency response for two different gains.<br>5. Study of FET characteristics, Load line, Calculation of IDss and pinch off voltage.<br>6. Design and study of FET & MOSFET amplifier. Study and construction of a Push-Pull amplifier.<br>7. Study and draw V-I characteristics of SCR, its design and application circuit using SCR.<br>8. Design and study of UJT relaxation oscillator. To study wave form generation and storage oscilloscope.<br>9. Study of pin connection and biasing of various linear IC's and timer | **48** |

555.
10. Design and study of OP-AMP as inverting, Non-inverting and summing amplifier.
11. Design and study of OP-AMP as subtracter, integrator and differentiator.
12. Design and study of OP-AMP as Schmitt trigger and measure its hysteresis characteristics.
13. Design and study of as table, monostable and bistablemultivibrator using OP-AMP.
14. Design and study of a Wein bridge oscillator using OP-AMP.
15. Design and study of high pass, low pass, band pass and band reject filters using OP-AMP.

**Reference / Text Books:**

1. "Electronic Devices and Circuit Theory" by Robert L. Boylestad and Louis Nashelsky, Pearson Education
2. "Op-Amps and Linear Integrated Circuits" by Ramakant A. Gayakwad, Prentice Hall
3. "Practical Electronics for Inventors" by Paul Scherz and Simon Monk, McGraw-Hill Education
4. "Fundamentals of Electric Circuits" by Charles K. Alexander and Matthew N.O. Sadiku , McGraw-Hill Education

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1. Record File | 15 |
| 2. Viva Voce | 5 |
| 3. Class Interaction | 10 |
| **Total:** | **30** |

Prerequisites for the course:
- **PREREQUISITE:** Opted / Passed Semester I, Theory Papers

**Course Learning Outcomes:**
- Develop practical skills in designing and constructing various electronic circuits, including power supplies, amplifiers, oscillators, and filters, enabling you to work with real-world electronic components.
- Gain proficiency in designing Common Emitter (CE) and Common Collector (CC) transistor amplifiers. Learn to analyze their frequency responses, input/output impedances, and performance characteristics.
- Learn how to design and analyze different configurations of operational amplifier (OP-AMP) circuits, including inverting, non-inverting, summing, subtracter, integrator, differentiator, and Schmitt trigger.
- Acquire skills in designing and constructing various types of oscillators and multivibrators using OP-AMPs, including astable, monostable, bistablemultivibrators, and Wein bridge oscillators.
- Study the pin connections and biasing of linear integrated circuits (ICs) and timer IC 555, providing you with insights into using these essential components in electronic designs.
- Gain an understanding of filter design principles by designing and studying high pass, low pass, band pass, and band reject filters using operational amplifiers. Learn to analyze their frequency responses and applications.

**IIMTU-NEP IMPLEMENTATION**
**Year: II / Semester:III**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D.<br>**Class: M.Sc. (Physics)** | Year: II<br><br>Semester: III |
| Credits:**4**<br>Theory:**4** | **Subject: Physics** |
| **Course Code**:**MSPH-231** | **Title: SOLID STATE PHYSICS** |

**Course Objectives:**
This course intends to provide knowledge of conceptual solid-state physics. In addition, this course aims to provide a general introduction to theoretical and experimental topics in solid state physics.

**Nature of Paper: Core**

**Minimum Passing Marks/Credits: 40% Marks**

L: 04
T: 0
P: 00 (In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | **CRYSTAL BINDING AND LATTICE VIBRATION IN SOLIDS**<br>Ionic bonding, Evaluation of Madelung constant, covalent crystals, Exchange energy calculation, Molecular bonding and Vander-Waals interaction. Vibration of one dimensional solid, The linear diatomic lattice, Acoustic and optical modes of vibrations, Phonon, Momentum of phonon, Einstein & Debye models and T3 Law. | **08** |
| II | **DEFECTS IN CRYSTALS AND FREE ELECTRON THEORY**<br>Point defects, Line defects and planer faults, The role of dislocations in plastic deformation and crystal growth, X-ray and electron microscopy techniques for observation of imperfections in crystals. Energy levels and density of orbits (in one dimension), Fermi-Dirac distribution, Free electron gas in three dimension, Electrical conductivity and effect of impurities, Thermal conductivity of free electron gas, Wiedemann -Franz law. | **08** |
| III | **ENERGY BANDS IN SOLIDS AND SEMICONDUCTOR THEORY**<br>Wave function in a periodic lattice and Bloch theorem, Kroning-Penny model, The nearly free electron approximation, The tight binding approximations, Number of orbitals in a band, Classifying material as semiconductor and band gap, Intrinsic and extrinsic | **08** |

| | | |
|---|---|---|
| | semiconductor, Mobility, Drift velocity and conductivity of intrinsic semiconductors, Carrier concentration in semiconductors, Impurity semiconductors and thermal ionization of impurities, Impurity states and band model. | |
| IV | **TRANSPORT PROPERTIES AND MAGNETIC RESONANCE**<br>Boltzmann transport equation, Sommerfeld theory of electrical conductivity, Relaxation time, Hall effect, Experimental determination of Hall coefficient, Residual resistivity, Temperature dependent resistivity, Principle of magnetic resonance, Nuclear magnetic resonance, Electron spin resonance, Resonance, Fluorescence, Theory of Mossbauer effect, Isomer shift, Quadrupole interaction, magnetic hyperfine interaction. | **08** |
| V | **SUPERCONDUCTIVITY AND FERROMAGNETISM**<br>The BCS theory, Transition temperature, Meissner effect, Critical field, Type I and type II superconducting materials, Cooper pairs, Joesphson tunneling, Superconductivity at high temperatures (elementary).Weiss theory of ferromagnetism, Heisenberg model and molecular field theory, Spin waves and magnons, Curie-Weiss law for susceptibility. | **08** |

**Reference / Text Books:**


- Solid State Physics – C.Kittel
- Solid State Physics - A.J. Dekker
- Cryatallography for Solid State Physics- Verma & Srivastava
- Introduction to Solids - Azaroff
- Elementary Solid State Physics - Omar
- Solid State Physics : Aschroft&Mermin
- Principle of Condensed Matter Physics – Chaikim & Lubensky


**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1. Class tasks/ Sessional Examination | 10 + 10 |
| 2. Assignments | 10 |
| 3. ESE | 70 |
| **Total:** | **100** |

Prerequisites for the course: Physics and Mathematics in B.Sc

**Course Learning Outcomes:**

- Develop a deep understanding of various types of crystal bonding, including ionic, covalent, and molecular bonding. Learn to evaluate Madelung constants, calculate exchange energies, and analyze Vander-Waals interactions.
- Gain proficiency in analyzing lattice vibrations in one-dimensional solids, including diatomic lattices. Understand the concepts of acoustic and optical modes of vibrations, phonons, and the Einstein and Debye models.
- Learn about point defects, line defects, and planar faults in crystals. Understand the role of dislocations in plastic deformation and crystal growth. Explore techniques for observing imperfections in crystals using X-ray and electron microscopy.

- Study energy bands in solids, including the wave function in a periodic lattice and Bloch's theorem. Understand the concepts of nearly free electron approximation, tight binding approximations, intrinsic and extrinsic semiconductors, band gaps, and carrier concentration.
- Acquire knowledge about transport properties in solids, including the Boltzmann transport equation, electrical conductivity, Hall effect, and relaxation time. Learn about principles of magnetic resonance, including nuclear magnetic resonance (NMR) and electron spin resonance (ESR).
- Understand the BCS theory of superconductivity, Meissner effect, critical field, Cooper pairs, and Josephson tunneling. Explore the principles of ferromagnetism, including the Weiss theory, Heisenberg model, spin waves, and Curie-Weiss law.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: II / Semester: III**

| | | |
|---|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D.<br>**Class: M.Sc. (Physics)** | | Year: II<br><br>Semester: III |
| Credits:**4**<br>Theory:**4** | **Subject: Physics** | |
| **Course Code: MSPH-232** | **Title: ATOMIC & MOLECULAR PHYSICS** | |
| **Course Objectives:**<br>This is an introductory course in atomic and molecular physics. This course introduces the quantum mechanical description of single and multi-electron atoms. Through fundamental studies of atoms, you will better understand the construction of the periodic table. The physical foundation underlying the formation of molecular bonds will also be studied. | | |
| **Nature of Paper: Core** | | |
| **Minimum Passing Marks/Credits: 40% Marks** | | |
| L: 04<br>T: 0<br>P: 00 (In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits) | | |

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | **SPECTRA OF ALKALI & ALKALINE ELEMENTS AND X-RAY SPECTRA**<br>Quantum states of an electron atoms, Atomic orbitals, Pauli's principle, Different series in alkali spectra, Term values and quantum defect, Ritz combination principle, Penetrating and non-penetrating orbits, Spin orbit interaction, Spectra of alkali and alkaline elements, Energy state of helium atom, Spectra of helium and mercury, Characteristics of X-ray spectra, Fine structure of X-ray levels, Spin relativity doublets, Fluorescence yield and Auger effect. | **08** |
| II | **COMPLEX SPECTRA**<br>Hamiltonian of complex spectra atom, L-S and J-J coupling, Term values in equivalent and non-equivalent electron systems, Hunde's rule, Lande interval rule, Energy level diagrams and selection rules in complex spectra, Regularities in complex spectra, Fine and Hyperfine structure of spectral lines, Zeeman effect, Paschan -Back effect and Stark effect. | **08** |
| III | **MOLECULAR BINDING AND ROTATION -VIBRATION SPECTRA**<br>Molecular orbital method, The hydrogen molecule ion, Van der-Waals forces for H-atom, Born and Oppenheimer approximation, Rotational | **08** |

| | | |
|---|---|---|
| | spectra of linear and diatomic molecules, Vibrating diatomic molecule, Molecule as anharmonic oscillator, Fine structure of vibration-rotation bands, Vibrational spectra of YX2 type molecules, Isotope effects in vibrational bands. | |
| IV | **ELECTRONIC AND RAMAN SPECTRA**<br>Frank-Condon principle, Vibrational coarse structure, Rotational fine structure of electronic vibration transition, Raman spectra : Classical and quantum theory of Raman effect, Rotational Raman effect, Structure determination from Raman and IR spectroscopy. | **08** |
| V | **LASERS**<br>Spontaneous and stimulated emission, Temporal and spatial coherences, Pumping process, Types ofLaser:Solid state Laser (Ruby), Gas Lasers (Helium-Neon and Carbon dioxide) and Semiconductor laser (Ga- As), Population inversion, Properties of Laser beams, Laser Applications: Distance measurement, Laser interferometery, Holography. | **08** |

**Reference / Text Books:**


- Introduction to Atomic spectra- H.E. White
- Fundamentals of molecular spectroscopy - C. B.Banwell
- Spectroscopy Vol I, II & III - Walker &Straughen
- Molecular spectroscopy - JeaneL . McHale
- Molecular spectroscopy - J.M. Brown
- Introduction to Molecular Spectroscopy - G.M. Barrow
- Spectra of atoms and Molecules- Jeanne L. McWale
- Laser spectroscopy & Instrumentation - Demtroder
- Lasers- B.B. Laud
- Principles of Lasers- O. Svelto
- Laser Applications –Sirohi


**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1. Class tasks/ Sessional Examination | 10 + 10 |
| 2. Assignments | 10 |
| 3. ESE | 70 |
| **Total:** | **100** |

Prerequisites for the course: Physics and Mathematics in B.Sc

**Course Learning Outcomes:**

- Develop a deep understanding of atomic spectra, including the quantum states of electrons in atoms, atomic orbitals, Pauli's principle, different series in alkali spectra, and term values. Gain insights into the spectra of alkali and alkaline elements as well as the fine structure of X-ray levels.
- Acquire proficiency in analyzing complex spectra, including Hamiltonian of complex spectra atoms, L-S and J-J coupling, term values, selection rules, and energy level diagrams. Understand regularities, fine and hyperfine structures, Zeeman effect, Paschen-Back effect, and Stark effect.
- Study molecular orbital methods, molecular binding forces, Born-Oppenheimer approximation, and molecular rotations. Gain insights into rotational spectra, vibrating

diatomic molecules, anharmonic oscillators, and vibrational spectra of molecules.

- Understand the Frank-Condon principle, vibrational coarse structure, and rotational fine structure of electronic vibration transitions. Explore classical and quantum theories of Raman effect, rotational Raman effect, and how Raman and IR spectroscopy aid in structure determination.
- Develop knowledge of laser principles, including spontaneous and stimulated emission, temporal and spatial coherences, and the pumping process. Understand the operation of different types of lasers such as solid-state lasers, gas lasers, and semiconductor lasers, along with properties of laser beams.
- Gain insight into laser applications, including distance measurement, laser interferometry, and holography. Understand the role of lasers in various fields and their importance in spectroscopic techniques for studying molecular and atomic properties.

**IIMTU-NEP IMPLEMENTATION**
**Year: II / Semester: III**

<table>
<tr><td colspan="2">Programme:<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>Class: M.Sc. (Physics)</td><td colspan="2">Year: II<br><br>Semester: III</td></tr>
<tr><td>Credits:4<br>Theory:4</td><td colspan="3">Subject: Physics</td></tr>
<tr><td>Course Code:MSPH-233</td><td colspan="3">Title: NUCLEAR & PARTICLE PHYSICS</td></tr>
<tr><td colspan="4">Course Objectives:<br>The primary objective is to introduce the basic concept of Nuclear & Particle Physics and impart of knowledge for particle and radiations detectors.</td></tr>
<tr><td colspan="4">Nature of Paper: Core</td></tr>
<tr><td colspan="4">Minimum Passing Marks/Credits: 40% Marks</td></tr>
<tr><td colspan="4">L: 03<br>T: 01<br>P: 00 (In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)</td></tr>
<tr><td>Unit</td><td colspan="2">Contents</td><td>No. of Lectures Allotted</td></tr>
<tr><td>I</td><td colspan="2">NUCLEAR INTERACTION AND NUCLEAR REACTIONS<br>Nucleon: nucleon interaction, Exchange forces and tensor forces, Meson theory of nuclear forces, Nucleon- nucleon scattering, Effective range theory-Spin dependence of nuclear forces, Charge independence and charge symmetry of nuclear forces, Iosospin formalism, Yukawa interaction. Compound nucleus, Scattering matrix, Reciprocity theorem, Breit-Wigner formula.</td><td>08</td></tr>
<tr><td>II</td><td colspan="2">NUCLEAR MODELS<br>Liquid drop model, Bohr-Wheeler theory of fission, Experimental evidence for shell effects, Shell model, Spin-orbit coupling, Magic numbers, Angular momenta and parities of nuclear ground states, Qualitative discussion and estimates of transition rates, Magnetic moments and Schmidt lines, Collective model.</td><td>08</td></tr>
<tr><td>III</td><td colspan="2">NUCLEAR DECAY<br>Alpha decay, Beta-decay, Fermi theory of beta decay, Shape of the beta spectrum, Total decay rate, Angular momentum and parity selection rules, Comparative half lives, Allowed and forbidden transitions, Selection rules, Parity violation, Two component theory of neutrino decay, Multipole transitions in nuclei : Angular momentum and parity, Selection rules, Internal conversion, Nuclear isomerism.</td><td>08</td></tr>
<tr><td>IV</td><td colspan="2">ELEMENTARY PARTICLES<br>Types of interaction between elementary particles, Hadrons and leptons,</td><td>08</td></tr>
</table>

| | | |
|---|---|---|
| | Symmetry and conservation laws, Elementary ideas of CP and CPT invariance, Classification of hadrons, Lie algebra, SU(2), SU(3) multiplets, Quark Model, Gell-Mann, Okubo mass formula for octet and decuplet hadrons, Charm, Bottom and top quarks. | |
| V | **NUCLEAR INSTRUMENTATION**<br>Ionization chamber, Geiger-Muller counter, Scintillation counter, Semiconductor detecctor, Bubble chamber, Spark chamber, Nuclear Emulsions, Cerenkov Counters, Van De Graff accelerator, Cyclotron, Phase stability principle, Synchrotrons, Colliding beam, Betatron, Basic introduction to large hadron collider (LHC). | **08** |

**Reference / Text Books:**


- Nuclear Physics(2nd Ed.) - I. Kalplan, Narosa, Madras, 1989.
- Atomic nucleus - R. D. Evans, McGraw Hill, N York.
- Concepts of Nuclear Physics - B.L. Cohen, MGH, Bombay, 1971.
- Nuclear Physics - R.R. Roy and B.P. Nigam, Wiley- Eastern Ltd., 1983.
- Introduction to Experiemntal Nuclear Physics - R.M. Singru, John Wiley & Sons
- Introductuctory Nuclear Physics - S.K. Khatroz, Nuclear Instrumentation Kenneth S.Kiane, Wiley, New York, 1988.
- Atomic and Nuclear Physics vol.2 - Ghoshal,
- Introduction to nuclear Physics- H.A. Enge, Addison -wesley, 1975.
- Introduction to high energy Physics - P.H.Perkins, Addison-wesley, London, 1982.
- Quarks, Leptons - F. Halzen and A.D. Martin, John Wiley & sons, N York.
- Modern Elementary Particle Physics- G. Kare, Edition Wiseley.


**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1. Class tasks/ Sessional Examination | 10 + 10 |
| 2. Assignments | 10 |
| 3. ESE | 70 |
| **Total:** | **100** |

Prerequisites for the course: Physics and Mathematics in B.Sc.

**Course Learning Outcomes:**

- Develop a deep understanding of nuclear interactions, including nucleon-nucleon interaction, exchange forces, and meson theory. Gain insights into nucleon-nucleon scattering, effective range theory, and the spin dependence of nuclear forces.
- Acquire proficiency in analyzing different nuclear models, such as the liquid drop model and the shell model. Understand the concepts of magic numbers, angular momenta, parities of nuclear ground states, and collective models.
- Gain knowledge of nuclear decay processes, including alpha and beta decay. Understand Fermi's theory of beta decay, shape of the beta spectrum, angular momentum and parity selection rules, and selection rules for allowed and forbidden transitions.
- Learn about elementary particles, their interactions, and conservation laws. Explore the concepts of symmetry, CP and CPT invariance, hadron classification, Lie algebra, quark model, and Gell-Mann-Okubo mass formula.
- Understand various nuclear instrumentation techniques, including ionization chambers, Geiger-Muller counters, scintillation counters, and semiconductor detectors. Gain insights

into particle detection using bubble chambers, spark chambers, and nuclear emulsions.

- Acquire knowledge of particle accelerators, including Van de Graff accelerators, cyclotrons, and synchrotrons. Learn about accelerator principles, phase stability, colliding beams, and get an introduction to large hadron colliders like the LHC.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: II / Semester: III**

<table>
<tr><td colspan="2">Programme: Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>Class: M.Sc. (Physics)</td><td>Year: II<br><br>Semester: III</td></tr>
<tr><td>Credits:4<br>Theory:4</td><td colspan="2">Subject: Physics</td></tr>
<tr><td>Course Code:MSPH-234A</td><td colspan="2">Title: DIGITAL ELECTRONICS & MICROPROCESSOR</td></tr>
<tr><td colspan="3">Course Objectives:<br>To enhance the understanding of basic design principles and constructional details of specialized semiconductor devices used for high frequency applications in modern communication networks and systems. To understand the use of semiconducting devices for diverse applications acting as signal/light sources, detection of signals and transduction of analog signals used in day to day electronics.</td></tr>
<tr><td colspan="3">Nature of Paper: Specialization-1 (Elective)</td></tr>
<tr><td colspan="3">Minimum Passing Marks/Credits: 40% Marks</td></tr>
<tr><td colspan="3">L: 04<br>T: 0<br>P: 00 (In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)</td></tr>
</table>

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | **NUMBER SYSTEM AND LOGIC CIRCUITS**<br>Number systems - Decimal, Binary, Octal, Hexa decimal and their interconversions, The ASCII code, EXCESS-3 code, Gray code and BCD code, Binary addition and subtraction, 2's complements arithmetic, Half adder and full adder, Binary multiplication and division, Transistor as a switch, OR, AND, NOT and NAND logic gates, Boolean algebra: Boolean laws and theorem, Demorgan's theorem, Logic families : RTL, DTL, TTL, ECL, Sum of product and product of sum methods, K-Map; pairs, quads and octets, K-map simplification, Min-term and max- term analysis. | **08** |
| II | **DATA PROCESSING CIRCUITS AND FLIP FLOP**<br>Multiplexer and demultiplexer, Decoder, BCD to decimal decoders, Encoders, Parity generators, Checker, Seven segment display, RS, JK, M/S JK, T & D clocked and edge triggered flip-flop and their timing diagrams. | **08** |
| III | **REGISTERS AND COUNTERS**<br>Buffer register, Shift register, Controlled shift register, Ripple counter, Frequency counters, Ring counters, Up and down counters, Electronic counters: Counting unit, Gate generator, Universal counter and its modes of operation. | **08** |

| | | |
|---|---|---|
| IV | **D/A & A/D CONVERSION AND SEMICONDUTOR MEMORIES**<br>A/D converters: Successive approximation A/D converters, Voltage to time A/D converter, Voltage to frequancy A/D converters and dual-slope integrator A/D converters, D/A conversion techniques, Digital voltmeter, Accuracy and consideration, Memory addressing, ROMS, RAMS, DRAMS. | **08** |
| V | **MICRO COMPUTERS & INSTRUCTIONS SETS**<br>Digital computers, Computer languages, From large computers to single-chip micro-computers, Microprocessor architecture and its operations, Memory, Input/output (I/O), The 8085 MPU, Instructions classification, instruction format, How to write and execute a simple programme, Instruction timings and operation status, Data transfer (copy) Instructions, Arithmetic operations, Logic operations, Branch operations, Writing assembly language programs, Debugging a program. | **08** |

**Reference / Text Books:**


- Digital Principles and Application- A.P. Malvino and Donald P. Leach , TMH, New Delhi
- Digital Integrated Electronics - Taub H. and Schilling B., McGraw, Singapore, 2001
- Digital Design - M. Morris Mano, PHI, 1998
- Microprocessor Architecture, Programming and Applications with 8085/8086 by Ramesh S.Gaonkar, Wiley-Eastern Ltd., 1987
- Microprocesor and Interfacing, Programmkig and Hardware -Douglas V. Hall, second edition, Mcgraw Hill International Edition, 1992.


**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1. Class tasks/ Sessional Examination | 10 + 10 |
| 2. Assignments | 10 |
| 3. ESE | 70 |
| **Total:** | **100** |

Prerequisites for the course: Physics and Mathematics in B.Sc

**Course Learning Outcomes:**

- Understand various number systems like decimal, binary, octal, and hexadecimal, and learn how to convert between them. Comprehend the concept of codes like ASCII, EXCESS-3, Gray, and BCD. Gain proficiency in performing binary arithmetic operations and working with 2's complement. Master the basics of logic gates (OR, AND, NOT, NAND) and Boolean algebra, including laws, theorems, and De Morgan's theorem.
- Learn about data processing circuits such as multiplexers, demultiplexers, decoders, encoders, and parity generators. Acquire knowledge about the functioning of seven-segment displays. Understand various types of flip-flops (RS, JK, T, D) and their timing diagrams.
- Gain proficiency in working with registers, including buffer and shift registers. Understand the concept of counters, including ripple counters, frequency counters, and ring counters. Learn about electronic counters, their components, and modes of operation.
- Acquire knowledge about digital-to-analog (D/A) and analog-to-digital (A/D) conversion techniques. Understand successive approximation, voltage-to-time, and dual-slope integrator A/D converters. Learn about D/A conversion techniques and their application in digital voltmeters. Gain insights into accuracy considerations.

- Learn about memory addressing and various types of semiconductor memories like ROMs, RAMs, and DRAMs. Understand the working principles and characteristics of these memories.
- Comprehend the architecture and operation of microprocessors, focusing on the 8085 MPU. Learn how to write and execute simple assembly language programs. Gain proficiency in instruction classification, instruction format, and writing assembly language programs. Understand the debugging process for assembly language programs.

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: II / Semester: III**

| | | |
|---|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D.<br>**Class:M.Sc. (Physics)** | | Year: II<br><br>Semester: III |
| Credits:**4**<br>Theory:**4** | **Subject: Physics** | |
| **Course Code: MSPH-234B** | **Title: CONDENSED MATTER PHYSICS** | |
| **Course Objectives:**<br>The overriding is outlined of the condense matter physics and have all the basic information that is needed to understand the operation and the building of liquid crystal displays. | | |
| **Nature of Paper: Specialization-2 (Elective)** | | |
| **Minimum Passing Marks/Credits: 40% Marks** | | |
| L: 03<br>T: 01<br>P: 00 (In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits) | | |

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | **FERRO-ELECTRICS**:<br>General properties of ferroelectric materials. The dipole theory of ferroelectricity, objection against dipole theory, Pizo and pyroelectrics (elementary idea) | **08** |
| II | **ORDERED PHASES OF MATTER:**<br>Translational and orientational order, Liquid crystal phases; nematic, smectic, cholesteric, Landau Theory of isotropic-nematic phase transitions, Physics of LCD devices, Quasi-crystals. | **08** |
| III | **Liquid Crystals:** Classification of liquid crystals: Thermotropic and lyotropic, Nematic, Smectic, cholesteric, Ferroelectric liquid crystals (LCs), Blue phase LCs, the molecular structure of LCs, the structure-property relationship of thermotropic liquid crystals. Molecular and mean field theory, Birefringence phenomena, polarizing microscopy, texture identifications and defects, Electric & Magnetic effects, and Optical properties of liquid crystals. | **08** |
| IV | **Liquid crystal composites**: polymer and nano-materials dispersed liquid crystals composites, polymer liquid crystals, molecular dynamics between LCs and Dopants. | **08** |
| V | **Liquid crystal applications:** present and future displays, manufacturing of LCDs, twisted nematic, super-twisted nematic, LED, IPS-based displays and overview of LC in advanced fields. | **08** |

**Reference / Text Books:**

- Introduction to Liquid crystal Chemistry and Physics: Peter J. Cooling and M. Hird, Taylor and Francis, (1997).
- The physics of Liquid Crystals, P.G. De. Gennes, Oxford University Press, (1993).
- Liquid Crystals, 2nd edition, S. Chandrasekhar, Cambridge University Press, (1992).
- Liquid Crystal fundamental, S. Singh, D. A. Dunmur, World Scientific, (2002)
- Handbook of Polymer Science and Technology, M. H. Ferry, CBS, Vol. 2 (2012)
- Polymer Science, Gowarikar, John wiley and Sons, (1986)
- Principles of Polymer Science, Bahadur and Sastry, Narosa Publishing House,(2002).

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1. Class tasks/ Sessional Examination | 10 + 10 |
| 2. Assignments | 10 |
| 3. ESE | 70 |
| **Total:** | **100** |

Prerequisites for the course: Physics and Mathematics in B.Sc

**Course Learning Outcomes:**

- Gain a solid understanding of the general properties of ferroelectric materials. Comprehend the dipole theory of ferroelectricity and the objections raised against it. Learn about piezoelectric and pyroelectric effects as elementary ideas related to ferroelectricity.
- Acquire knowledge about translational and orientational order in materials. Learn about the different phases of liquid crystals, including nematic, smectic and cholesteric phases. Understand Landau's theory of isotropic-nematic phase transitions and its application to liquid crystal devices like LCDs.
- Classify liquid crystals into thermotropic and lyotropic categories. Understand the properties and characteristics of different liquid crystal phases, such as nematic, smectic, cholesteric, and ferroelectric phases. Explore the molecular structure and structure-property relationships of thermo tropic liquid crystals.
- Learn about liquid crystal composites, including polymer and nano-material dispersed composites. Understand how liquid crystals interact with polymers and nanoparticles. Gain insights into molecular dynamics and interactions between liquid crystals and dopants.
- Explore the present and future applications of liquid crystals, particularly in displays. Understand the manufacturing processes of various types of liquid crystal displays (LCDs), including twisted nematic, super-twisted nematic, and in-plane switching (IPS) displays. Learn about the use of liquid crystals in advanced fields.
- Develop skills in using techniques like polarizing microscopy to analyze birefringence phenomena, texture identification, and defects in liquid crystals. Gain knowledge of the electric, magnetic, and optical effects exhibited by liquid crystals and their implications in practical applications.

**IIMTU-NEP IMPLEMENTATION**
**Year: II / Semester: III**

<table>
<tr><td colspan="2">Programme: Certificate/Diploma/Degree/ UG(R)/PG/Ph.D.<br>Class: M.Sc. (Physics)</td><td colspan="2">Year: II<br><br>Semester: III</td></tr>
<tr><td colspan="2">Credits:04<br>Practical:04</td><td colspan="2">Subject: Physics</td></tr>
<tr><td colspan="2">Course Code:MSPH-231P</td><td colspan="2">Title: SOLID STATE & ATOMIC AND MOLECULAR LAB</td></tr>
<tr><td colspan="4">Course Objectives:<br>The purpose of study of of this course to provide the practical knowledge by experimental teaching and calculate the different physical parameters of materials.</td></tr>
<tr><td colspan="4">Nature of Paper: Core</td></tr>
<tr><td colspan="4">Minimum Passing Marks/Credits: 40%Marks</td></tr>
<tr><td colspan="4">L: 00<br>T: 00<br>P: 04 (In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)</td></tr>
<tr><td>Unit</td><td colspan="2">Contents</td><td>No. of Lectures Allotted</td></tr>
<tr><td colspan="4">Lab Experiment List</td></tr>
<tr><td></td><td colspan="2">1. Magnetic Susceptibility<br>2. B-H Curve<br>3. Four-Probe method<br>4. Lande ‘g’ factor using E.S.R. Spectrometer<br>5. Hall coefficient<br>6. Determination of Dielectric Constant<br>7. Measurement of the wavelength of He-Ne Laser light using ruler<br>8. To study the Faraday effect using He-Ne Laser<br>9. Determination of e/m of an electron by Zeeman Effect using Febry Perot Etalon<br>10. Measurement of Susceptibility of paramagnetic solution by Quinke’s tube method.<br>11. Two Probe methods for resistivity measurement of insulators at different temperatures.<br>12. ‘e/m’ measurement by Braun’s tube and by Magnetron valve method.<br>13. ‘e’ measurement by Millikan oil drop apparatus.<br>14. Determination of wavelength of He-Ne laser beam by Michelson interferometer.<br>15. To study the modulus of rigidity and internal friction in a metal as a funct ioning temperature.<br>16. Measurement and analysis of fluorescence spectrum of $I_2$ vapour.</td><td>60</td></tr>
</table>

**Reference / Text Books:**

1. "Introduction to Solid State Physics" by Charles Kittel, John Wiley & Sons.
2. "Introduction to the Theory of Ferromagnetism" by AmikamAharoni, Oxford University Press.
3. "Solid State Physics" by Ashcroft and Mermin, Cengage Learning.
4. "Principles of Electronic Materials and Devices" by S. O. Kasap, McGraw-Hill Education.
5. "Introduction to Solid State Physics" by M. A. Omar, Pearson Education.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1. Record File | 15 |
| 2. Viva Voce | 5 |
| 3. Class Interaction | 10 |
| **Total:** | **30** |

Prerequisites for the course:

- **PREREQUISITE:** Opted / Passed Semester I & II Theory Papers

**Course Learning Outcomes:**

- Develop a deep understanding of magnetic susceptibility, its significance in characterizing materials' magnetic behavior, and how it relates to the response of materials to external magnetic fields.
- Gain hands-on experience in generating and interpreting B-H curves, enabling the understanding of how magnetic materials respond to changing magnetic fields and the concept of magnetic hysteresis.
- Acquire proficiency in the four-probe method, a commonly used technique for accurately measuring electrical resistivity and conductivity of materials, paving the way for precise electrical characterization.
- Learn how to operate and analyze data from an ESR spectrometer to determine the Lande 'g' factor, a crucial parameter in understanding electron spin behavior in a magnetic field.
- Understand the Hall coefficient measurement method, which provides insight into the charge carrier concentration and mobility in materials, allowing for the characterization of conductive properties.
- Gain practical knowledge of optical phenomena by conducting experiments involving He-Ne laser light, Faraday effect, and Michelson interferometer. Explore how light interacts with different materials and its effects.

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: II / Semester: III**

| | |
|---|---|
| **Programme:**<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>**Class: M.Sc. (Physics)** | Year: II<br><br>Semester: IV |
| Credits:**4**<br>Theory:**4** | **Subject: Physics** |
| **Course Code:MSPH-241A** | **Title: Communication Electronics-I** |
| **Course Objectives:**<br>To give an understanding about generation, propagation, reception and detection of electromagnetic waves in free space and optical signals in guided media relating to fiber optic communication. Analyze the contribution of inherent noise produced by components, devices and circuits commonly used in instrumentation/communication systems and learn the effective methods of noise reduction. | |
| **Nature of Paper: Specialization-1 (Elective)** | |
| **Minimum Passing Marks/Credits: 40%Marks** | |
| L: 03<br>T: 01<br>P: 00 (In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits) | |

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | **AMPLITUDE MODULATION**<br>Communication systems, Modulation, Bandwidth requirements, Noise: External noise, Internal noise, Noise calculation, Noise figure, Amplitude modulation: Theory, Generation of AM, Basic requirement, Modulated transistor amplifiers, Single side band (SSB) techniques: Evolution of SSB, Suppression of carrier and unwanted side band, Demodulation: Envelop detection, Product detector. | **08** |
| II | **ANGLE MODULATION**<br>Theory of frequency and phase modulation- Mathematical representation of FM, Frequency spectrum of FM wave, Phase modulation, Intersystem comparisons, Noise and frequency modulation- Effects of noise on carrier, Pre-emphasis de-emphasis, Comparison of wide band and narrow band FM, Stereo Phonic FM multiplex system, Generation of FM- FM methods, Direct methods, AFC. | **08** |
| III | **TRANSMISSION LINES, RADIATION AND PROPAGATION**<br>Fundamentals of transmission lines, Characteristics impedence, Losses, Standing waves, Reactance properties of transmission lines, The Smith chart and its applications, Ground (surface) waves, Sky wave propagation- The ionosphere, Space waves, Tropospheric scatter propagation, | **08** |

| | | |
|---|---|---|
| | Extraterrestrial communications. | |
| IV | **ANTENNAS**<br>The elementary doublet, Wire radiator in space, Antenna gain and effective radiated power, Antenna resistance, Bandwidth, Beamwidth and polarisation, Ungrounded antennas, Grounded antennas, Grounding systems, Effects of antenna height, Antenna coupling at medium frequency, Directional antennas-dipole arrays, Folded dipole and applications, The Yagi antenna. | **08** |
| V | **RADIO RECEIVERS**<br>Receiver types- TRF receiver, Superhetrodyne receiver, AM receiver- RF section and characteristic, Frequency changing and tracking, intermediate frequency and IF amplifiers, AGC, Extension of superhetrodyne principle, FM receivers- comparison with AM receiver, Amplitude limiting, Basic FM demodulators. | **08** |

**Reference / Text Books:**

- Principles of communication systems - Taub and Schilling, TMH, 1994
- Electronic Communication System - G. Keneddy
- Communication systems, Third Edition -Simon Haykin, John Wiley &Sons ,Inc. 1994
- Digital and Commuincation system - Roden H.S., PHI
- Analog and Digital Communication - Chakraborty, Dhanpat Rai
- Electronic Communication System - Wayne Tomasi, Peasrson Edition
- Advanced Electronics Communication Systems- Wayne Tomasi, PHI. Edn.
- Communication Electronics – Rody & Coolen

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1. Class tasks/ Sessional Examination | 10 + 10 |
| 2. Assignments | 10 |
| 3. ESE | 70 |
| **Total:** | **100** |

Prerequisites for the course: Physics and Mathematics in B.Sc.

**Course Learning Outcomes:**

- Understand the fundamental concepts of modulation and its significance in communication systems.
- Analyze the bandwidth requirements and noise factors affecting communication systems, including external and internal noise.
- Describe the theory of amplitude modulation (AM), its generation, and the basic requirements for modulated transistor amplifiers.
- Examine the principles of single side band (SSB) techniques, carrier and unwanted sideband suppression, and the methods of SSB generation.
- Gain knowledge of angle modulation, including the theory of frequency modulation (FM) and phase modulation, as well as their mathematical representations and frequency spectra.
- Study the effects of noise on FM and techniques such as pre-emphasis and de-emphasis.
- Understand transmission lines and their characteristics, including impedance, losses, standing waves, and the Smith chart.
- Explore different propagation modes, including ground (surface) waves, sky wave

propagation through the ionosphere, and tropospheric scatter propagation.

- Gain insights into antenna fundamentals, including radiation patterns, antenna gain, polarisation, and the effects of antenna height.
- Study directional antennas, such as dipole arrays and Yagi antennas, along with their applications.
- Learn about radio receiver types, including TRF and superheterodyne receivers.
- Understand the working principles of AM and FM receivers, including RF sections, intermediate frequency amplifiers, AGC, and demodulation techniques.

**IIMTU-NEP IMPLEMENTATION**
**Year: II / Semester: IV**

| | | |
|---|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D.<br>**Class:M.Sc. (Physics)** | | Year: II<br><br>Semester: IV |
| Credits:**4**<br>Theory:**4** | **Subject: Physics** | |
| **Course Code: MSPH-242A** | **Title:** | |
| **Course Objectives:**<br>To enhance the understanding of basic design principles and constructional details of specialized semiconductor devices used for high frequency applications in modern communication networks and systems. To understand the use of semiconducting devices for diverse applications acting as signal/light sources, detection of signals and transduction of analog signals used in day to day electronics. | | |
| **Nature of Paper: Specialization-1 (Elective)** | | |
| **Minimum Passing Marks/Credits: 40%Marks** | | |
| L: 04<br>T: 0<br>P: 00 (In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits) | | |

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | **SIGNAL ANALYSIS & PULSE MODULATION SYSTEMS**<br>System and signals, Signal representation using Fourier series, Signal representation using Fourier transform, Power spectral density. Sampling theorem- Low Pass and Band Pass signals, PAM, Channel BW for a PAM signal, Natural sampling, Flat-top sampling, Signal recovery through Holding, Quantization of signals, Quantisation error, PCM, Differential PCM, Delta modulation, Adaptive delta modulation, Noise in pulse code and delta modulation Systems: Calculation of quantization noise, Output signal power, Output signal-to-noise ratio in PCM, DM. | **08** |
| II | **DIGITAL MODULATION TECHNIQUES**<br>Binary phase shift keying (BPSK), Differential phase shift keying (DPSK), Quadrature phase shift keying (QPSK), M-ary PSK, Quadrature Amplitude phase shift keying (QASK), Binary frequency shift keying (BFSK), M-ary FSK, Minimum shift keying (MSK). | **08** |
| III | **DATA TRANSMISSION**<br>Baseband signal receiver, Probability of error, Optimum filter, White noise, Matched filter and probability of error, Coherent reception, Correlation, PSK, FSK, Non-coherent detection of FSK, Differential PSK, QPSK, Calculation of error probability for | **08** |

| | | |
|---|---|---|
| | BPSK, BFSK and QPSK. | |
| IV | **MICROWAVE COMMUNICATION**<br>Principle of velocity modulation, Reflex klystron and magnertron, Advantages and disadvantages of microwave transmission, Loss in free space, Propagation of microwaves, Atmospheric effects on propagation, Fresnel zone problem, Ground reflection, Antennas used in microwave communication systems. | **08** |
| V | **RADAR SYSTEMS AND SATELLITE COMMUNICATION**<br>Radar block diagram and operation, Radar range equation, Minimum detectable signal, Receiver noise, Radar cross- section, Pulse repetition frequency, Antenna parameters, Radar transmitters and receivers.<br>**Satellite communications:** Orbital and geostationary satellites, Orbital patterns, Look angles, Orbital spacings, Satellite systems, Link modules. | **08** |

**Reference / Text Books:**

- Principles of communication systems, 2/e - Taub and Schilling, TMH
- Digital and Communication system - Roden H.S., PHI
- Analog and Digital Communication - Chakraborty, DhanpatRai
- Electronic Communication System - Wayne Tomasi, Peasrson Edition
- Advanced Electronics Communication Systems - Wayne Tomasi., PhI. Edn.
- Digital and Analog Communication System- K. San Shanmugam, John Wile & Sons
- Microwaves- K.L. Gupta, Wiley Eastern Ltd., New Delhi
- Satellite communication - D.C. Agrawal.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1. Class tasks/ Sessional Examination | 10 + 10 |
| 2. Assignments | 10 |
| 3. ESE | 70 |
| **Total:** | **100** |

Prerequisites for the course: Physics and Mathematics in B.Sc.

**Course Learning Outcomes:**

- Understand the fundamental concepts of signal analysis, including signal representation using Fourier series and Fourier transform, as well as power spectral density.
- Comprehend the importance of the sampling theorem and its application to low pass and band pass signals, along with concepts of pulse amplitude modulation (PAM) and various sampling techniques.
- Gain knowledge of quantization of signals, pulse code modulation (PCM), differential PCM, and delta modulation. Calculate quantization noise and analyze output signal-to-noise ratios.
- Explore digital modulation techniques, including binary phase shift keying (BPSK), differential phase shift keying (DPSK), quadrature phase shift keying (QPSK), and their performance analysis.
- Study data transmission, receiver characteristics, matched filters, coherent and non-coherent detection techniques for various modulation schemes, and calculate error probabilities.
- Learn about microwave communication, including the principles of velocity modulation,

reflex klystron, and magnetron, microwave propagation, atmospheric effects, Fresnel zone, and antenna concepts.
- Understand the operation and components of radar systems, radar range equation, radar cross-section, and the basics of satellite communication, including orbital patterns and geostationary satellites.
- Develop a strong foundation in signal processing, modulation techniques, transmission, and satellite communication systems used in modern communication networks.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: II / Semester: IV**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D.<br>**Class:M.Sc. (Physics)** | Year: II<br><br>Semester: IV |
| Credits:**4**<br>Theory:**4** | **Subject: Physics** |
| **Course Code:MSPH-241B** | **Title: CONDENSED MATTER PHYSICS – I** |
| **Course Objectives:**<br>The emphasis of the provide basic knowledge of course is crystal structure and bonding in solides. This course is also focus on elastic properties thermal properties and dielectric properties of condense matter. | |
| **Nature of Paper: Specialization-2 (Elective)** | |
| **Minimum Passing Marks/Credits: 40%Marks** | |
| L: 04<br>T: 0<br>P: 00 (In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits) | |

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | **CRYSTAL STRUCTURE AND BONDING IN SOLIDS:**<br>Bravais lattice, lattice planes and miller indices, reciprocal lattice, Diffraction conditions, Brillouin zones, Atomic Structure factor; types of crystal binding, cohesive energy of ionic crystals.<br>**Defects and Diffusion in solids:** Point defects: Schottky and Frenkel vacancies, Diffusion, Fick’s law. Color centers, *F*-centers. Line defects (dislocation): Edge and Screw dislocation, Burger’s vector, Slip, Planar (stacking) faults: Grain boundaries: Low angle grain boundaries. | **08** |
| II | **ELASTIC PROPERTIES:**<br>Introduction, Analysis of Stress- strain relations, Elastic Compliance and Stiffness Constants, Elastic Waves in Cubic Crystals.<br>**Thermal Properties:** Phonon heat capacity, Density of states, Debye and Einstein theory of specific heat, Lattice Thermal Conductivity and Umklapp Processes, specific heat of metals. | **08** |
| III | **SEMICONDUCTORS:**<br>Direct and Indirect Absorption Processes, Equations of motion, effective mass, intrinsic carrier concentration, impurity conductivity, Cyclotron resonance and Magnetoresistance in semiconductors<br>**Fermi Surfaces and Metals:**Zone schemes, Fermi surfaces; Hall Effect, Electron, Hole and Open orbits, Quantization of orbits in a magnetic field, the de Hass-van Alphen Effect, External orbits. | **08** |

| | | |
|---|---|---|
| IV | **ELEMENTARY BAND THEORY:** Kronig Penny model. Band Gaps. Conductors, Semiconductors and insulators. P and N type Semiconductors. Conductivity of Semiconductors, mobility, Hall Effect, Hall coefficient | **08** |
| V | **DIELECTRICS:** Macroscopic field, The local field, Lorentz field, The Clausius-Mossotti relation, different contributions to polarization: dipolar, electronic and ionic polarizabilities. | **08** |

**Reference / Text Books:**

- Kittle C "Introduction to Solid State Physics", John Wiley & Sons, 2005.
- Dekkar A J "Solid State Physics", Macmillan India Ltd., New Delhi, 2004.
- Azaroff L V "Introduction to Solids", Tata McGraw-Hill Publishing Company, New Delhi, 1992.
- Ashcroft N W and Mermin N D "Solid State Physics", Thomson Asia Pte. Ltd., 2006. Singh, R.J., Solid State Physics, Pearson, Press, 2012

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1. Class tasks/ Sessional Examination | 10 + 10 |
| 2. Assignments | 10 |
| 3. ESE | 70 |
| **Total:** | **100** |

Prerequisites for the course: Physics and Mathematics in B.Sc

**Course Learning Outcomes:**

- Understand the fundamentals of crystal structures and their description using Bravais lattice, Miller indices, and reciprocal lattice concepts. Recognize different types of crystal binding and calculate cohesive energy of ionic crystals.
- Grasp the concepts of point defects in crystals, including Schottky and Frenkel vacancies, diffusion processes, and the formation of color centers and F-centers. Understand line defects like edge and screw dislocations, their effects, and stacking faults.
- Comprehend the stress-strain relations and elastic properties of materials, including the analysis of elastic compliance, stiffness constants, and elastic waves in cubic crystals. Understand the thermal properties of materials such as phonon heat capacity, specific heat theories, and lattice thermal conductivity.
- Gain knowledge about semiconductor physics, including the processes of direct and indirect absorption, equations of motion, effective mass, intrinsic carrier concentration, impurity conductivity, and magnetoresistance.
- Learn the concept of Fermi surfaces, including zone schemes and their relevance to metals. Understand the Hall Effect, electron and hole orbits, quantization of orbits in a magnetic field, and the de Hass-van Alphen Effect.
- Develop insights into elementary band theory, including the Kronig Penny model, band gaps, classification of conductors, semiconductors, and insulators. Understand the behavior of P and N-type semiconductors, along with concepts of conductivity, mobility, and the Hall coefficient.
- Grasp the principles of dielectrics, including macroscopic and local fields, the Clausius-Mossotti relation, and various contributions to polarization. Understand dipolar, electronic, and ionic polarizabilities and their effects on dielectric behavior.

**IIMTU-NEP IMPLEMENTATION**
**Year: II / Semester: IV**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D.<br>**Class: M.Sc. (Physics)** | Year: II<br><br>Semester: IV |
| Credits:**4**<br>Theory:**4** | **Subject: Physics** |
| **Course Code: MSPH-242B** | **Title: CONDENSED MATTER PHYSICS – II** |

**Course Objectives:**
The field of condense has undergone rapid expansion and diversification as a result of dia, para and ferromagnetism ferroelectrics and optical properties of material is relate too.

**Nature of Paper: Specialization-2 (Elective)**

**Minimum Passing Marks/Credits: 40% Marks**

L: 04
T: 0
P: 0 (In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | **DIA-, PARA- AND FERRO-MAGNETISM:**<br>Classification of magnetic materials, the origin of permanent magnetic dipoles, diamagnetic susceptibility, Langevin's classical theory of diamagnetism; Classical theory of Para magnetism, Quantum theory of Para magnetism, Quenching of orbital angular momentum, Cooling by adiabatic demagnetization, Paramagnetic susceptibility of conduction electrons; Ferromagnetism, Spontaneous magnetization in ferromagnetism, The Weiss molecular field, The interaction of the Weiss field, Ferromagnetic domains, Bloch wall, Spin waves, Quantization of spin waves, Thermal excitations of magnons. | **08** |
| II | **ANTIFERRO AND FERRI-MAGNETISM:**<br>The two sub lattice model, exchange interaction, Neel's Temperature; Structure of ferrites, Saturation magnetization, Neel's theory of ferrimagnetism, Curie temperature and susceptibility of ferrimagnets. | **08** |
| III | **SUPERCONDUCTIVITY:**<br>Superconductivity, zero resistivity, critical temperature, Meissner effect, Type I and Type II superconductors, specific heat and thermal conductivity, London Equations, BCS theory, Ginzburg-Landau theory, Josephson Effect: dc Josephson Effect, a c Josephson Effect, macroscopic quantum interference, High temperature superconductivity (elementary). | **08** |
| IV | **FERRO-ELECTRICS**:<br>General properties of ferroelectric materials. The dipole theory of Ferro-electricity, objection against dipole theory, Pizo and pyro-electrics | **08** |

| | | |
|---|---|---|
| | (elementary idea) | |
| V | **OPTICAL PROPERTIES**:<br>Optical constants and their physical significance, Kramer-Kroning relations, Electronic interband transitions, Frenkel and Mott-Wannierexcitons.<br>**Ordered phases of matter:** Translational and orientational order, Liquid crystal phases; nematic, sematic, cholestric, Landau Theory of isotropic-nematic phase transitions, Physics of LCD devices, Quasi crystals | **08** |

**Reference / Text Books:**


- Kittle C "Introduction to Solid State Physics", John Wiley & Sons, 2005.
- Dekkar A J "Solid State Physics", Macmillan India Ltd., New Delhi, 2004.
- Ashcroft N W and Mermin N D "Solid State Physics", Thomson Asia Pte. Ltd., 2006
- Omar M Ali, "Elementary solid state physics, Principles and applications", Pearson Press, 2011
- Hamley Ian W, "Introduction to Soft Matter: Synthetic and Biological Self-Assembling Materials", John Wiley, 2007
- Colling P J, "Liquid Crystals", Princeton Univ. Press, Second Edition, 2002


**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1. Class tasks/ Sessional Examination | 10 + 10 |
| 2. Assignments | 10 |
| 3. ESE | 70 |
| **Total:** | **100** |

Prerequisites for the course: Physics and Mathematics in B.Sc.

**Course Learning Outcomes:**

- Understand the classification of magnetic materials into diamagnetic, paramagnetic, and ferromagnetic categories. Comprehend the origin of permanent magnetic dipoles, Langevin's classical theory of diamagnetism, and both classical and quantum theories of paramagnetism.
- Learn about the concepts of cooling by adiabatic demagnetization, paramagnetic susceptibility of conduction electrons, and the behavior of ferromagnetic materials including spontaneous magnetization, Weiss molecular field, and Bloch wall. Understand spin waves and their quantization, as well as thermal excitations of magnons.
- Grasp the fundamentals of antiferro and ferrimagnetism, including the two sub-lattice model, exchange interaction, Neel's temperature, and the structure and properties of ferrites.
- Gain insights into superconductivity, covering zero resistivity, critical temperature, Meissner effect, and the distinction between Type I and Type II superconductors. Understand the London equations, BCS theory, Ginzburg-Landau theory, and the Josephson effect.
- Explore the properties of ferroelectric materials, including their general characteristics and the dipole theory of ferroelectricity. Understand the concepts of piezoelectricity and pyroelectricity.
- Develop knowledge about optical properties, including optical constants, Kramer-Kronig relations, electronic interband transitions, and excitons. Understand the concepts of translational and orientational order in ordered phases of matter, such as liquid crystal phases and isotropic-nematic phase transitions.

**IIMTU-NEP IMPLEMENTATION**
**Year: II / Semester: IV**

| | | | |
|---|---|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D.<br>**Class: M.Sc. (Physics)** | | Year: II<br><br>Semester: IV | |
| Credits:**2**<br>Theory:**2** | **Subject: Physics** | | |
| **Course Code: MSPH-243** | **Title: COMPUTATIONAL METHOD & PROGRAMMING** | | |
| **Course Objectives:**<br>The emphasis of the course is on different application of computational methods are given. The course will teach the students to plot the graph by curve fitting methods numerical technique and C-Programming methods. | | | |
| **Nature of Paper: Core** | | | |
| **Minimum Passing Marks/Credits: 40%Marks** | | | |
| L: 04<br>T: 00<br>P: 00 (In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits) | | | |
| **Unit** | **Contents** | **No. of Lectures Allotted** | |
| | **Mathematical Physics** | | |
| I | **COMPUTATIONAL METHODS SOLUTIONS OF ALGEBRAIC & TRANSCENDENTALEQUATIONS**<br>Algebraic & transcendental equations, Numerical solution, Method of bisection, Method of false position, Newton-Raphson iteration, Direct iterative method, Convergence. | **08** | |
| II | **INTERPOLATION & CURVE FITTINGS**<br>Errors in polynomial interpolation, Finite differences, Differences of a polynomial, Newton's formula for interpolation, Central differences, Interpolation formulae- Gauss's, Stirling & Bessel formula- Interpolation with unevenly space points-Lagranges interpolation formula, Errors in Lagranges interpolation formula, Curve fitting - Least square curve fitting, Weighted least square approximation. | **08** | |
| III | **NUMERCAL DIFFERENTIATION AND INTEGRATION**<br>Numercal differentiation, Errors in numerical differentiation, Cubic spline method, Numerical integration. Trapezoidal rule, Simpson's 1/3 rule, Simpson's 3/8 rule– use of cubicsplines, Newton's cotes integration, Gaussian integration. | **08** | |
| IV | **C PROGRAMMING**<br>Introduction to algorithms, C character set, Identifiers and key | **08** | |

| | | |
|---|---|---|
| | words, Data types, Declarations, Expressions, Statements and symbolic constants, #include, #define, Preparing and running a complete C program; Arithmetic, Relational, Logical, Assignments and conditional operators; Precedence rule, Associative law; If-else, Switch, Break, Continue statements; While, Do-while, For statements, Nested loops; Go to statements; One and two dimensional arrays, Basic concept ofpointer. | |
| V | **FUNCTIONS:** Defining and accessing, Formal and actual parameters, Function prototypes, Recursion, Storage classes (basic concept); Structures: Defining and processing; Data files: Open, Close, Create, and Process. | **08** |

**Reference / Text Books:**

- Introductory Methods of Numerical Analysis –Sastry.
- Numerical Methods in Engg. & Sciences - Grewal B.S. Khanna Pub. NDelhi.
- Numerical Analysis – Rajaraman.
- Computers Today - Byron D.H. McHill.
- Programming in ANSI C - E. Balaguruswamy,TMH.
- Numerical Method for Scientific &Engg Computation - Jain, Iyengar, Wiley,1987.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1. Class tasks/ Sessional Examination | 10 + 10 |
| 2. Assignments | 10 |
| 3. ESE | 70 |
| **Total:** | **100** |

Prerequisites for the course: Physics and Mathematics in B.Sc

**Course Learning Outcomes:**

- Solve algebraic and transcendental equations using computational methods such as bisection, false position, and Newton-Raphson iteration.
- Apply interpolation techniques, including Newton's and Lagrange's interpolation, to approximate data points and curve fitting.
- Perform numerical differentiation and integration using methods like cubic splines, trapezoidal rule, and Simpson's rules.
- Develop programming skills in C, covering basic syntax, control structures, and array manipulation.
- Create and manage functions, including recursion and working with storage classes.
- Gain proficiency in handling structures, data files, and basic file operations using C programming.

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: II / Semester: IV**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D.<br>**Class: M.Sc. (Physics)** | Year: **II**<br><br>Semester: **IV** |
| Credits:**02**<br>Practical:**02** | **Subject: Physics** |
| **Course Code: MSPH-241AP** | **Title: COMMUNICATION ELECTRONICS LAB** |

**Course Objectives:**
This course is designed for communication students at the basic level to advanced level experimental practice and know uses of ICs.

**Nature of Paper: Specialization-1**

**Minimum Passing Marks/Credits: 50%Marks**

L: 00
T: 00
P: 04 (In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| **Unit** | **Contents** | **No. of Lectures Allotted** |
|---|---|---|
| | **Lab Experiment List** | |
| | 1. Using IC 7400 construct<br>2. (i) And gate (ii) OR gate (iii) NOR gate (iv) NAND gate (v) NOT gate<br>3. Using IC 7400 construct gates and<br>4. Verify the truth table for every gate.<br>5. Using IC 7476 Verily the truth table for JK flip-flop.<br>6. Construct T type and D type flip flop and verify truth table.<br>7. Using 1C 7476: Design a Mod-s synchronous counter and study it.<br>8. Using 1C 7476: Design a Mod-16 up counter and study it.<br>9. Construct the circuit to study wave forms of function generator IC 566.<br>10. By varying the control voltage study the response of circuit.<br>11. Show modulated wave forms.<br>12. Design and cost the response oi’ the circuit. (ii) From the graph find cutoff frequency.<br>13. Design and construct circuit for low pass filter using IC 714.<br>14. Study the response of the circuit. (ii) From the graph find cutoff frequency.<br>15. Construct a R-2R ladder network by using 1C 741 to study D/A converter.<br>16. ii) By giving different digital ip study the response of the | 50 |

| | | |
|---|---|---|
| | circuit.<br>17. Arithmetic operations using microprocessors 8085 / 8086<br>18. D/A converter interfacing and frequency / temperature measurement with microprocessor 8085 / 8086 10<br>19. A/D converter interfacing and AC/DC voltage / current measurement using microprocessor 8085/8086 | |

**Reference / Text Books:**

1. "Digital Principles and Applications" by Donald P. Leach, Albert Paul Malvino, and Goutam Saha
2. "Digital Electronics: Principles, Devices and Applications" by Anil K. Maini
3. "Microprocessor Architecture, Programming, and Applications with the 8085/8080A" by Ramesh S. Gaonkar
4. "Microprocessor 8085 and Its Interfacing" by Mathur Sunil
5. "Modern Digital Electronics" by R.P. Jain

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1. Record File | 15 |
| 2. Viva Voce | 5 |
| 3. Class Interaction | 10 |
| **Total:** | **30** |

Prerequisites for the course:

- **PREREQUISITE:** Opted / Passed Semester I & II, Theory Papers

**Course Learning Outcomes:**

- Construct basic logic gates (AND, OR, NOR, NAND, NOT) using IC 7400.
- Implement various logic gates using IC 7400.
- Verify truth tables for logic gates implemented with IC 7400.
- Verify the truth table for a JK flip-flop using IC 7476.
- Construct T-type and D-type flip-flops, and verify their truth tables.
- Design and analyze synchronous counters (Mod-s and Mod-16) using IC 7476.

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: II / Semester: IV**

| | |
|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. **Class: M.Sc. (Physics)** | Year: II<br><br>Semester: IV |
| Credits:**02**<br>Practical:**02** | **Subject: Physics** |
| **Course Code:MSPH-241BP** | **Title: CONDENSED MATTER PHYSICS LAB** |

**Course Objectives:**
After completion of this course students will be able to:-

- To Understand the ploting the graph by extrapolation method and calculate the useful parameter of the material.
- To understand the experimental technic for finding the physical parameter values.

**Nature of Paper: Specialization-2**

**Minimum Passing Marks/Credits: 40%Marks**

L: 00
T: 00
P: 04 (In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| | **Lab Experiment List** | |
| | 1. Indexing of hexagonal systems.<br>2. Precise parameter determination:<br>a. Extrapolation method.<br>b. Cohen's method<br>3. Structure determination of CdTe.<br>4. Universal curves for ferromagnets<br>5. Determination of skin depth<br>6. Phase transition in ferroelectric crystals<br>7. Temperature dependence of susceptibility of a paramagnetic substance<br>8. Characteristics of a solar cell<br>9. Defect formation energy in metals<br>10. Diamagnetic susceptibility of a water molecule.<br>11. Fermi energy of copper<br>12. Dielectric constant of non-polar liquids (benzene)<br>13. Dipole moment of organic molecule (acetone)<br>14. BH curve using integrator<br>15. Measurement of magneto resistance<br>16. Measurement of thermoelectric power. | **50** |

**Reference / Text Books:**

1. "Introduction to Solid State Physics" by Charles Kittel, Publisher: Wiley
2. "Solid State Physics" by Ashcroft and Mermin, Publisher: Cengage Learning
3. "Introduction to the Theory of Ferromagnetism" by Amikam Aharoni, Publisher: Oxford University Press
4. "Introduction to Solid State Physics" by R. K. Puri and V. K. Babbar, Publisher: S. Chand & Company Ltd.
5. "Solid State Physics: Principles and Modern Applications" by John J. Quinn and Kyung-Soo Yi, Publisher: Springer
6. "Introduction to Solid State Physics" by S.O. Pillai, Publisher: New Age International (P) Ltd.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1. Record File | 15 |
| 2. Viva Voce | 5 |
| 3. Class Interaction | 10 |
| **Total:** | **30** |

Prerequisites for the course:

- **PREREQUISITE:** Opted / Passed Semester I & II, Theory Papers

**Course Learning Outcomes:**

- Analyze and apply indexing methods for hexagonal crystal systems.
- Apply precise parameter determination techniques: extrapolation and Cohen's method.
- Apply structural analysis to determine the CdTe crystal structure.
- Understand and use universal curves for characterizing ferromagnetic materials.
- Calculate and interpret the skin depth for electromagnetic waves.
- Describe phase transitions in ferroelectric crystals.
- Analyze the temperature-dependent susceptibility of paramagnetic materials.
- Explain the key characteristics of solar cells.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: II / Semester: IV**

| | | |
|---|---|---|
| **Programme:** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. **Class: M.Sc. (Physics)** | | Year: II<br><br>Semester: IV |
| Credits:**02**<br>Practical:**02** | **Subject: Physics** | |
| **Course Code: MSPH-243P** | **Title: COMPUTATIONAL METHOD & PROGRAMMING LAB** | |
| **Course Objectives:**<br>This course is intended to be an Introduction to a programming Language (C/C++) as well as application for Numerical Analysis. The course would impart training in the structure of the programming language as well as train the students in using programs to numerically solve problems in various areas. In addition, it will also familiarize the students to the Unix environment. | | |
| Nature of Paper: **Core** | | |
| **Minimum Passing Marks/Credits: 40%Marks** | | |
| L: 00<br>T: 00<br>P: 04 (In Hours/Week)<br>Theory - 1 Hr. = 1 Credit<br>Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits) | | |

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| | **Lab Experiment List** | |
| | 1. Jacobi Method of Matrix Diagonalization.<br>2. Solution of transcendental or polynomial equations by the Newton Raphson method<br>3. Linear curve fitting and calculation of linear correlation coefficient.<br>4. Matrix summation, subtraction and multiplication.<br>5. Matrix inversion and solution of simultaneous equation.<br>6. Lagrange interpolation based on given input data.<br>7. Numerical integration using the Simpson's method.<br>8. Numerical integrationg using the Gaussian quadrature method.<br>9. Solution of first order differential equations using the Rung-Kutta method.<br>10. Numerical first order differentiation of a given function.<br>11. Fast Fourier Transform.<br>12. Monte Carlo integration.<br>13. Use of a package for data generation and graph plotting. | **50** |

| | | |
|---|---|---|
| | 14. Test of randomness for random numbers generators | |

**Reference / Text Books:**


1. "Numerical Methods for Scientists and Engineers" by R. W. Hamming, Dover Publications.
2. "Numerical Recipes: The Art of Scientific Computing" by William H. Press, Saul A. Teukolsky, William T. Vetterling, and Brian P. Flannery, Cambridge University Press.
3. "Introduction to Numerical Analysis" by Richard L. Burden and J. Douglas Faires, Cengage Learning.
4. "Numerical Analysis" by Richard L. Burden and J. Douglas Faires, Brooks Cole.
5. "Numerical Methods: Principles, Analysis, and Algorithms" by Anne Greenbaum and Timothy P. Chartier, Princeton University Press.


**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1. Record File | 15 |
| 2. Viva Voce | 5 |
| 3. Class Interaction | 10 |
| **Total:** | **30** |

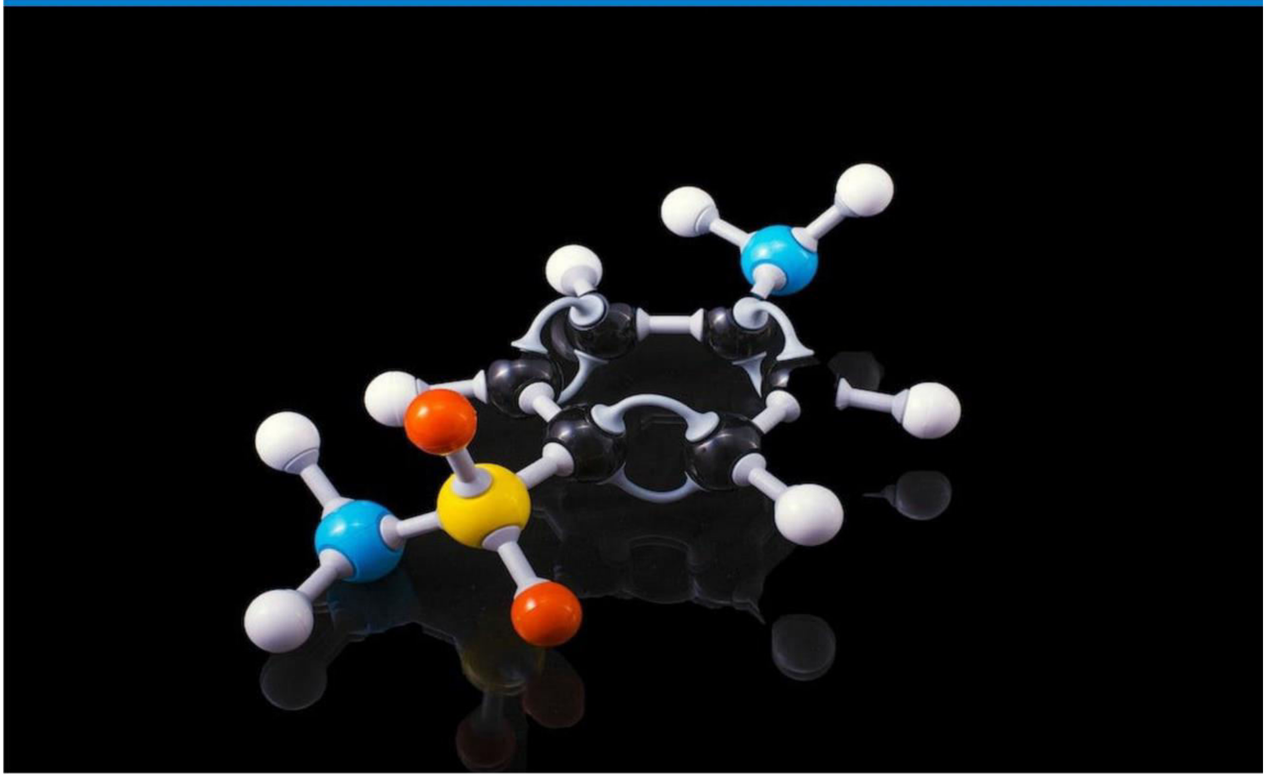
Prerequisites for the course:

- **PREREQUISITE:** Opted / Passed Semester I & II, Theory Papers

**Course Learning Outcomes:**

- Apply Jacobi method for diagonalizing matrices.
- Apply Newton-Raphson method to solve polynomial or transcendental equations.
- Perform linear curve fitting and calculate correlation coefficient.
- Perform matrix operations: summation, subtraction, and multiplication.
- Invert matrices and solve simultaneous equations.
- Implement Lagrange interpolation based on given data.
- Utilize Simpson's method for numerical integration.
- Apply Gaussian quadrature for numerical integration.
- Solve first-order differential equations using Runge-Kutta method.
- Numerically differentiate a given function.

# School
# of
# Basic Sciences
## ACADEMIC HAND BOOK



**ORDINANCE & ACADEMIC REGULATION**
**(As per National Education Policy-2020 & UGC Regulation 2022)**
**DOCTOR OF PHILOSOPHY (Ph.D.)**

**PREAMBLE**

School of Basic sciences & Technology is running Ph.D. programme which covers the all aspects of media research and apply the acquired vastly specialized knowledge, skills, research methods, conduct original and high quality multidisciplinary or interdisciplinary research to generate solutions to complex problems, including real-life problems, relating to the chosen fields of study.

This Ordinance shall apply to the Doctor of Philosophy in Physics, Chemistry, mathematics, Statistics, Environment Studies Programme degree.

This Ordinance shall apply to all programmes leading to the degree of Doctor of Philosophy.

**1. Note**

**(1)** These Regulations as per the (Minimum Standards and Procedure for Award of Ph.D. Degree) Regulations, 2022.

**2. Definitions.- (1)** In these Regulations, unless the context otherwise requires,-

**a)** **"Act"** means the University Grants Commission Act,1956 (3 of 1956);

**b)** **"Higher Educational Institution"** means university/ institute/ College.

**c)** **"Adjunct Faculty"** means a part-time or contingent instructor, but not full-time faculty member hired to teach by a University;

**d)** **"Cumulative Grade Point Average (CGPA)"** means a measure of the overall cumulative performance of a student over all semesters. The CGPA is the ratio of total credit points secured by a student in various courses in all semesters and the sum of the total credits of all courses in all semesters. It is expressed up to two decimal places;

**e)** **"Credit"** means the number of hours of instruction required per week over the duration of a semester. A three-credit course in a semester means three one-hour lectures per week, with each one-hour lecture counted as one credit;

**f)** **"College"** means an institution engaged in higher education and/or research, either established by a University as its constituent unit or is affiliated with it;

**g)** **"Commission"** means the University Grants Commission established under Section 4 of the UGC Act1956;

**h)** **"Course"** means one of the specified units which go to comprise a programme of study;

**i)** **"Course Work"** means courses of study prescribed by the School/Department/ Centre to be undertaken by a student registered for the Ph.D. Degree;

**j)** **"Degree"** means a degree awarded by a University in accordance with the provisions of section 22 (3) of the Act;

**k)** **"External examiner"** means an academician/researcher with published research work who is not part of the Higher Educational Institution where the Ph.D. scholar has registered for the Ph.D. programme;

**l)** **"Foreign Educational Institution"** means–(i) an institution duly established or incorporated in its home country and offering educational programmes at the undergraduate, postgraduate and higher levels in its home country and (ii) which offers programme(s) of study leading to the award of a degree through conventional face-to-face mode, but excluding distance, online, ODL mode;

m) **"Grade Point"** means a numerical weight allotted to each letter grade on a 10-point scale;

n) **"Guide/Research Supervisor"** means an academician/researcher recognized by Higher Educational Institution to supervise the Ph.D. scholar for his/her research;

o) **"Higher Educational Institution"** means a university or institution specified under clause 2 of Regulation 1 of these Regulations;

p) **"Interdisciplinary Research"** means research conducted by a Ph.D. scholar in two or more academic disciplines;

q) **"Open and Distance Learning Mode"** shall have the same meaning as defined under the UGC(Open and Distance Learning Programmes and Online Programmes) Regulations 2020;

r) **"Online Mode"** shall have the same meaning as defined under the UGC (Open and Distance Learning Programmes and Online Programmes) Regulations 2020;

s) **"Plagiarism"** means the practice of taking someone else's work or idea and passing them as one's own;

t) **"Programme"** means a higher education programme pursued for a degree specified by the Commission under sub-section (3) of section 22 of the Act;

u) **"Prospectus"** means any document, whether in print or otherwise, issued for providing fair and transparent information relating to a Higher Educational Institution and programmes, to the general public (including to those seeking admission in such Higher Educational Institutions) by the Higher Educational Institutions;

v) **"Research Proposal"** means a brief write-up giving an outline of the proposed research work which the Ph.D. scholar shall submit along with the application for registration for Ph.D. programme;

w) **"University"** means a Higher Educational Institution established or incorporated by or under a Central Act, a Provincial Act, or a State Act, and shall include any institution for higher education deemed a University under Section 3 of the Act.

x) Words and expressions used and not defined in these Regulations but defined in Act and not consistent with these Regulations shall have the meanings assigned to them in that Act.

3. **Eligibility criteria for admission to the Ph.D. Programme.-**The following are eligible to seek admission to the Ph.D. programme:

**(1) Candidates who have completed:**

I. A 1-year/2-semester master's degree programme after a 4-year/8-semester bachelor's degree programme or a 2-year/4-semester master's degree programme after a 3-year bachelor's degree programme or qualifications declared equivalent to the master's degree by the corresponding statutory regulatory body, with at least 55% marks in aggregate or its equivalent grade in a point scale wherever grading system is followed

Or

equivalent qualification from a foreign educational institution accredited by an assessment and accreditation agency which is approved, recognized or authorized by an authority, established or incorporated under a law in its home country or any other statutory authority in that country to assess, accredit or assure quality and standards of the educational institution.

II. A relaxation of 5% marks or its equivalent grade may be allowed for those belonging to SC/ST/OBC (non-creamy layer)/ Differently-Abled, Economically Weaker Section (EWS) and other categories of candidates as per the decision of the Commission from time to time.

Provided that a candidate seeking admission after a 4-year/8-semester bachelor's degree programme should have a minimum of 75% marks in aggregate or its equivalent grade on a point scale wherever the grading system is followed. A relaxation of 5% marks or its equivalent grade may be allowed for those belonging to SC/ST/OBC (non-creamy layer)/ Differently-Abled, Economically Weaker Section (EWS) and other categories of candidates as per the decision of the Commission from time to time.

**(2) Candidates who have completed the M.Phil.**

programme with at least 55% marks in aggregate or its equivalent grade in a point scale wherever grading system is followed or equivalent qualification from a foreign educational institution accredited by an assessment and accreditation agency which is approved, recognized or authorized by an authority, established or incorporated under a law in its home country or any other statutory authority in that country to assess, accredit or assure quality and standards of educational institutions, shall be eligible for admission to the Ph.D. programme. A relaxation of 5% marks or its equivalent grade may be allowed for those belonging to SC/ST/OBC (non-creamy layer)/Differently-Abled, Economically Weaker Section (EWS) and other categories of candidates as per the decision of the Commission from time to time.

**4. Duration of the Programme.-**

(1) Ph.D. Programme shall be for a minimum duration of three (3) years, including course work, and a maximum duration of six (6) years from the date of admission to the Ph.D. programme.
For part-time candidate the minimum duration of three years (Six RAC/ Semester) excluding course work, and a maximum of six years.

(2) A maximum of an additional two (2) years can be given through a process of re-registration as per the direction of RDC concerned; provided, however, that the total period for completion of a Ph.D. programme should not exceed eight (8) years from the date of admission in the Ph.D. programme.

(3) Provided further that, female Ph.D. scholars and Persons with Disabilities (having more than 40% disability) may be allowed an additional relaxation of two (2) years;

however, the total period for completion of a Ph.D. programme in such cases should not exceed ten (10) years from the date of admission in the Ph.D. programme.

(4) Female Ph.D. Scholars may be provided Maternity Leave/Child Care Leave for up to 240days in the entire duration of the Ph.D. programme.

**5. Procedure for admission. -**

**(1)** The admission shall be based on the criteria notified by the institution, keeping in view the guidelines/norms in this regard issued by the UGC and other statutory/regulatory bodies concerned, and taking into account the reservation policy of the Central/State Government from time to time.

**(2) Admission to the Ph.D. programme shall be made using the following methods:**

**i.** HEIs may admit students who qualify for fellowship/scholarship in UGC-NET/UGC- CSIR NET/GATE/CEED and similar National level tests based on an interview. And/or

**ii.** HEIs may admit students through an Entrance Test conducted at the level of the individual HEI. The Entrance Test syllabus shall consist of 50% of research methodology, and 50% shall be subject- specific.

**iii.** Students who have secured 50 % marks in the entrance test are eligible to be called for the interview.

**iv.** A relaxation of 5 % marks will be allowed in the entrance examination for the candidates belonging to SC/ST/OBC/differently-abled category, Economically Weaker Section (EWS), and other categories of candidates as per the decision of the Commission from time to time.

**v.** HEIs may decide the number of eligible students to be called for an interview based on the number of Ph.D. seats available.

**vi.** Provided that for the selection of candidates based on the entrance test conducted by the HEI, a weightage of 70 % for the entrance test and 30 % for the performance in the interview/viva- voce shall be given.

**(3) Universities and Colleges which are eligible to conduct Ph.D. programmes, shall:**

**i.** Notify a prospectus well in advance on the institution’s website specifying the number of seats for admission, subject/discipline-wise distribution of available seats, criteria for admission, the procedure for admission, and all other relevant information for the candidates;

**ii.** Adhere to the National/State-level reservation policy, as applicable.

**(4)** The Higher Educational Institution shall maintain a list of Ph.D. supervisors (specifying the name of the supervisor, his or her designation, and the department/school/centre), along with the details of Ph.D. scholars (specifying the name of the registered Ph.D. scholar, the topic of his/her research and the date of admission) admitted under them on the website ofthe institution and update this list every academic year.

**6.** **Allocation of Research Supervisor.-** Eligibility criteria to be a Research Supervisor, Co-Supervisor, Number of Ph.D. scholars permissible per supervisor, etc.

**(1)** Permanent faculty members working as Professor/Associate Professor of the Higher Educational Institution with a Ph.D., and at least five research publications in peer-reviewed or refereed journals and permanent faculty members working as Assistant Professors in Higher Educational Institutions with a Ph.D., and at least three research publications in peer-reviewed or refereed journals may be recognized as a Research Supervisor in the university where the faculty member is employed or in its affiliated Post-graduate Colleges/institutes. Such recognized research supervisors cannot supervise research scholars in other institutions, where they can only act as co-supervisors. Ph.D. awarded by a university under the supervision of a faculty member who is not an employee of the university or its affiliated Post- graduate Colleges/institutes would be in violation of these Regulations.

- ❖ For Ph.D. scholars working in Central government/ State government research institutions whose degrees are given by Higher Educational Institutions, the scientists in such research institutions who are equivalent to Professor/Associate Professor/Assistant Professor can be recognized as supervisors if they fulfill the above requirements.
- ❖ Provided that in areas/disciplines where there is no, or only a limited number of peer-reviewed or refereed journals, the Higher Educational Institution may relax the above condition for recognition of a person as Research Supervisor with reasons recorded in writing.
- ❖ Co-Supervisors from within the same department or other departments of the same institution or other institutions may be permitted with the approval of the competent authority.
- ❖ Adjunct Faculty members shall not act as Research Supervisors and can only act as co-supervisors.

**(2)** In case of interdisciplinary/multidisciplinary research work, if required, a Co-Supervisor from outside the Department/ School/ Centre/ College/ University may be appointed.

**(3)** An eligible Professor/Associate Professor/Assistant Professor can guide up to eight (8) / six (6) / four (4) Ph.D. scholars, respectively, at any given time.

**(4)** In case of relocation of a female Ph.D. scholar due to marriage or otherwise, the research data shall be allowed to be transferred to the Higher Educational Institution to which the scholar intends to relocate, provided all the other conditions in these Regulations are followed, and the research work does not pertain to a project sanctioned to the parent Institution/Supervisor by any funding agency. Such scholar shall, however, give due credit to the parent institution and the supervisor for the part of research already undertaken.

**(5)** Faculty members with less than three years of service before superannuation shall not be allowed to take new research scholars under their supervision. However, such faculty members can continue to supervise Ph.D. scholars who are already registered until superannuation and as a co-supervisor after superannuation, but not after attaining the age of 70 years.

**(6)** A faculty member appointed as a Ph.D. supervisor is normally expected to be available to a research scholar in the University until the thesis Viva is held. However, under unavoidable circumstances, such as long leave of more than 12 months; resignation; retirement; or death; a supervisor may not be available to the scholar. In such special cases, appointment of supervisor(s) will be regulated as under:

**(a)** **A supervisor proceeding on long leave of more than 12 months**

**i.** Where co supervisor exists, the supervisor proceeding on long leave for more than 12 months can continue to be a co supervisor provided the RAC is convinced of effective supervision by the co -supervisor.

**ii.** Where a co -Supervisor does not exist, a co-supervisor may be appointed by the RAC with the approval of RDC in cases where a student has not yet submitted his synopsis.

**iii.** Provided, if the synopsis of the thesis has been submitted before the supervisor proceeds on leave, he will continue to be the supervisor and only a caretaker research supervisor will be appointed.

**iv.** Further, if a major revision becomes necessary, and the sole supervisor is on leave, he should be asked to specifically state whether he would effectively help the student carrying out the major revisions within a reasonable time. In case the sole supervisor expresses his inability due to one reason or the other, the caretaker supervisor, if he provides the required help in carrying out the major revision, will automatically be treated as co -Supervisor of that scholar.

**v.** Provided further, if a supervisor proceeds on leave for a period less than 12 months initially, but later extends his leave beyond 12 months, the above procedure will be followed.

**(b)** **A Supervisor retires**.

A faculty member who is due to retire within the next two years can be appointed as a co-supervisor and can continue to be the co Supervisor even after his retirement provided the RAC is convinced of his availability/continued guidance to the student. In other cases, a faculty member on retirement may continue as

**i.** a supervisor, if reemployed or appointed Emeritus Fellow;

**ii.** a co-supervisor, if the synopsis of the thesis has been submitted. Appointment of another supervisor, if necessary, will be as per a(i); and caretaker Supervisor as per a(ii).

**(c)** **A Supervisor resigns**

A new Supervisor will be appointed, if necessary, as per a(i), and a caretaker supervisor as per a(ii).

**(d)** **A Supervisor dies**

A new Supervisor will be appointed, if necessary, on the recommendation of RAC.

(e) Change of Supervisor (s) under exceptional circumstances shall be permitted on recommendation of the RAC with the consent of (i) the student, (ii) the present Supervisor (s), and (iii) the proposed supervisor (s).

(f) If the research program and/or area of the work require modification due to this change, the student's entire course program requirement shall be examined by the RAC. If there is change in the research program and/or area of the work, the registration date may be revised, if found necessary.

**7. Admission of International students in Ph.D. programme**.-

**(1)** Each supervisor can guide up to two international research scholars on a supernumerary basis over and above the permitted number of Ph.D. scholars as specified in clause 6.3 above.

**(2)** The HEIs may decide their own selection procedure for Ph.D. admission of international students keeping in view the guidelines/norms in this regard issued by statutory/regulatory bodies concerned from time to time.

**8. At any point,** the total number of Ph.D. scholars under a faculty member, either as a supervisor or a co-supervisor, shall not exceed the number prescribed in clause 6.3 and clause 7.1.

**9. Course Work.- Credit requirements, number, duration, syllabus, minimum standards for completion, etc.**

**(1)** The Credit requirement for the Ph.D. coursework is a minimum of 12 credits, including a "Research and Publication Ethics" course as notified by UGC vide D.O. No. F.1-1/2018 (Journal/CARE) in 2019 and a research methodology course. The Research Advisory Committee can also recommend UGC recognized online courses as part of the credit requirements for the Ph.D. programme.

| S. NO. | NAME OF PAPER | CREDITS |
|---|---|---|
| 1 | Research Methodology | 4 |
| 2 | New Trends in Mass Media | 4 |
| 3 | Research and Publication Ethics | 2 |
| 4 | Elective Course as per Topic<br>1. Advance Communication Theories and Research<br>2. Traditional Media, Development and Social Change<br>3. Literature Review | 4 |
| 5 | Seminar/Vive Voce /Research Proposal | 2 |

**(2)** All Ph.D. scholars, irrespective of discipline, shall be required to train in teaching /education/pedagogy/writing related to their chosen Ph.D. subject during their doctoral period. Ph.D. scholars may also be assigned 4-6 hours per week of teaching/research assistantship for conducting tutorial or laboratory work and evaluations.

**(3)** A Ph.D. scholar must obtain a minimum of 55% marks or its equivalent grade in the UGC 10-point scale in the course work to be eligible to continue in the programme and submit his or her thesis.

**10.** **RDC (Research Degree Committee of University)** shall ensure uniform Implementation of the Ordinance and provide advice on procedural and related matters. The composition of RDC shall include the following.

| | |
|---|---|
| VC | **(Chairperson)** |
| Dean | (**Member)** |
| Head of the Department | (**Member)** |
| Two Professors other than Supervisors | (**Member)** |
| Supervisor(s) or co-supervisors | (**Member(s)**) |
| Head Ph.D. | Member Secretary |

**Functions of Research Degree Committee:-**

The Committee shall–

1) Suggest measures to create links and develop specific schemes of inter-university and University interaction with industry, agriculture, banks, commerce and community etc.;
2) Prepare University perspective development plans, both short-term and long-term, keeping in view the objectives of the University provided in this Act, and with due regard to the State and National Educational, requirement;
3) Recommend to the Executive Council the research and development and collaborative programmes for the University;
4) Monitor and report the progress of all such approved research and development and collaborative programmes to the Chancellor once a year;
5) Evaluate and assess the use of research and development grants by University, and submit the report to the Executive Council;
6) Shall approve Research Advisory Committee (RAC) for Ph.D.'s as recommended by various academic departments/center/units of University;
7) Organize research and development audit and prepare report thereof for University and also to maintain research and development data of University on session basis according to the provisions of the Statutes, and make necessary recommendations to the Academic Council/Executive Council, as applicable, for implementation;
8) Scrutinize the applications received for Patents and IPRs received from teachers and students of University.
9) The supervisors and Co-Supervisors will be approved by RDC on the recommendations of RAC.

**11.** **Research Advisory Committee and its Functions.-**

**(1)** here shall be a Research Advisory Committee or an equivalent body as defined in the Statutes/Ordinances of the University concerned for each Ph.D. scholar.

The Research Supervisor of the Ph.D. scholar concerned shall be the Convener of this committee, and this committee shall have the following responsibilities:

i. To review the research proposal and finalize the topic of research.

ii. To guide the Ph.D. scholar in developing the study design and methodology of research and identify the course(s) that he/she may have to do.

iii. To periodically review and assist in the progress of the research work of the Ph.D. scholar.

**(2)** Each semester, a Ph.D. scholar shall appear before the Research Advisory Committee to make a presentation and submit a brief report on the progress of his/her work for evaluation and further guidance. The Research Advisory Committee shall submit its recommendations along with a copy of Ph.D. scholar's progress report to the Higher Educational Institution concerned. A copy of such recommendations shall also be provided to the Ph.D. scholar.

**(3)** In case the progress of the Ph.D. scholar is unsatisfactory, the Research Advisory Committee shall record the reasons for the same and suggest corrective measures. If the Ph.D. scholar fails to implement these corrective measures, the Research Advisory Committee may recommend, with specific reasons, the cancellation of the registration of the Ph.D. scholar from the Ph.D. programme.

**12. Evaluation and Assessment Methods, minimum standards/credits for award of the degree, etc.-**

**(1)** Upon satisfactory completion of course work and obtaining the marks/grade prescribed in clause (3) of Regulation 9 above, the Ph.D. scholar shall be required to undertake research work and produce a draft dissertation/thesis.

**(2)** Before submitting the draft dissertation/ thesis, the Ph.D. scholar shall make a presentation before the Research Advisory Committee of the Higher Educational Institution concerned, which shall also be open to all faculty members and other research scholars/students.

**(3)** The Higher Educational Institution concerned shall have a mechanism using well-developed software applications to detect Plagiarism in research work and the research integrity shall be an integral part of all the research activities leading to the award of a Ph.D. degree.

**(4)** A Ph.D. scholar shall submit the thesis for evaluation, along with (a) an undertaking from the Ph.D. scholar that there is no plagiarism and (b) a certificate from the Research Supervisor attesting to the originality of the thesis and that the thesis has not been submitted for the award of any other degree/diploma to any other Higher Educational Institution.

**(5)** The Ph.D. thesis submitted by a Ph.D. scholar shall be evaluated by his/her Research Supervisor and at least two external examiners who are experts in the field and not in employment of the Higher Educational Institution concerned. Such examiner(s) should be academics with a good record of scholarly publications in the field. Wherever possible, one of the external examiners should be chosen from outside India. The viva-voce board shall consist of the Research Supervisor and at least one of the two external examiners and may be conducted online. The viva-voce shall be open to the members of the Research Advisory Committee/faculty members/research scholars, and students. Higher Educational Institutions may formulate appropriate rules/ordinances to effect the provisions of these Regulations.

**(6)** The viva-voce of the Ph.D. scholar to defend the thesis shall be conducted if both the external examiners recommend acceptance of the thesis after incorporating any corrections suggested by them. If one of the external examiners recommends rejection, the Higher Educational Institution concerned shall send the thesis to an alternate external examiner from the approved panel of examiners, and the viva-voce examination shall be held only if the alternate examiner recommends acceptance of the thesis. If the alternate examiner does not recommend acceptance of the thesis, the thesis shall be rejected, and the Ph.D. scholar shall be declared ineligible for the award of a Ph.D.

**(7)** The Higher Educational Institution concerned shall complete the entire process of evaluating a Ph. D. thesis, including the declaration of the viva-voce result, within a period of six (6) months from the date of submission of the thesis.

**13. Academic, research, administrative, and infrastructure requirements to be fulfilled by Colleges for getting recognition for offering Ph.D. programmes.-**

**(1)** Post-graduate Colleges offering 4-year Undergraduate Programmes and/or Post-graduate Programmes, may offer Ph.D. programmes, provided they satisfy the availability of eligible Research Supervisors, required infrastructure, and supporting administrative and research facilities as per these Regulations.

**(2)** Colleges and research institutions established by the central government or a State government whose degrees are awarded by Higher Educational Institutions shall offer Ph.D. programmes provided they have:

**i.** At least two faculty members in a college or two Ph.D.-qualified scientists in the research institution.

**ii.** Adequate infrastructure, administrative support, research facilities and library resources as specified by the HEI.

**14. Ph.D. through Part-time Mode-**

**(1)** Ph.D. programmes through part-time mode will be permitted, provided all the conditions stipulated in these Regulations are fulfilled.

**(2)** The University shall obtain a "No Objection Certificate" through the candidate for a part-time Ph.D. programme from the appropriate authority in the organization where the candidate is employed, clearly stating that:

**i.** The candidate is permitted to pursue studies on a part-time basis.
**ii.** His/her official duties permit him/her to devote sufficient time for research.
**iii.** If required, he/she will be relieved from the duty to complete the course work.

**(3)** Notwithstanding anything contained in these Regulations or any other law, for the time being in force, no University or research institution of the Central government or a State Government shall conduct Ph.D. programmes through distance and/or online mode.

**(4)** The applicant is required to reside at the institute for a period till he/she is admitted for candidacy (This condition of minimum residency period will be automatically waived for candidates who are working in IIMT University or in organizations/institutions located within a distance of 100 KM from the university).

**(5)** (Transfer from Full time to Part-time will be approved by the RDC based on the subjects) (A full-time scholar may be allowed by RDC to convert his registration into part-time registration only after completion of at least 2 years.

**(6)** The part-time mode will be approved by the RDC based on the nature of the subjects (non-experimental).

**15. Grant of M.Phil. Degree.-** Higher Educational Institutions shall not offer the M.Phil. (Master of Philosophy) programme.

**16. Issuing a Provisional certificate.-**Prior to the actual award of the Ph.D. degree, the degree- awarding Higher Educational Institution shall issue a provisional certificate to the effect that the Ph.D. is being awarded in accordance with the provisions of these Regulations.

**17. Award of Ph.D. degrees prior to Notification of these Regulations.-** Award of degrees to candidates registered for the Ph.D. programme on or after July 11, 2009, till the date of Notification of these Regulations shall be governed by the provisions of the UGC (Minimum Standards and Procedure for Award of M.Phil./Ph.D. Degree) Regulations, 2009 or the UGC (Minimum Standards and Procedure for Award of M.Phil./Ph.D. Degrees) Regulations, 2016 as the case may be. Further, the award of degrees to candidates already registered and pursuing Ph.D. shall be governed by these Regulations or UGC (Minimum Standards and Procedure for Award of M.Phil./Ph.D. Degree) Regulations, 2016. Nothing in these Regulations shall impact the M.Phil. degree programmes commencing prior to the enactment of these Regulations.

18. **Depository with INFLIBNET.-** Following the successful completion of the evaluation process and before the announcement of the award of the Ph.D. degree(s), the Higher Educational Institution concerned shall submit an electronic copy of the Ph.D. thesis to INFLIBNET, for hosting the same so as to make it accessible to all the Higher Educational Institutions and research institutions.

**NOTE: - Although all the facts have been included and discussed in the ordinance, if any point is not covered, it will be subject to RDC jurisdiction and its decision will be the final.**

# Evaluation Scheme

<table>
<tr><th colspan="13">Program: Ph.D. in Chemistry<br>Semester: ODD/EVEN</th></tr>
<tr><th rowspan="3">S. No.</th><th rowspan="3">Course Code</th><th rowspan="3">Course Name</th><th rowspan="3">Course Category</th><th colspan="3" rowspan="2">Periods</th><th colspan="5">Marks</th><th rowspan="3">Credit</th></tr>
<tr><th colspan="3">Internal</th><th rowspan="2">External</th><th rowspan="2">Total</th></tr>
<tr><th>L</th><th>T</th><th>P</th><th>CT</th><th>TA</th><th>Total</th></tr>
<tr><td>1</td><td>PRM- 111/121</td><td>Research Methodology</td><td>Core</td><td>4</td><td>0</td><td>0</td><td>20</td><td>10</td><td>30</td><td>70</td><td>100</td><td>4</td></tr>
<tr><td>2</td><td>PCC- 111/121</td><td>Instrumental Methods for Chemical Characterization & Analysis</td><td>Core</td><td>2</td><td>0</td><td>1</td><td>10</td><td>5</td><td>15</td><td>35</td><td>50</td><td>2</td></tr>
<tr><td>3</td><td>PRE- 111/121</td><td>Research & Publication Ethics</td><td>Core</td><td>2</td><td>0</td><td>0</td><td>10</td><td>5</td><td>15</td><td>35</td><td>50</td><td>2</td></tr>
<tr><td>4</td><td>PLR- 111/121</td><td>Seminar on Literature Review</td><td>Core</td><td>2</td><td>0</td><td>0</td><td>50</td><td>-</td><td>50</td><td>0</td><td>50</td><td>2</td></tr>
<tr><th colspan="13">Discipline Specific Elective Courses (Any One)</th></tr>
<tr><td>5</td><td>PCE- 111/121</td><td>Advances in Organic Chemistry</td><td>Elective-1</td><td rowspan="8">4</td><td rowspan="8">0</td><td rowspan="8">0</td><td rowspan="8">20</td><td rowspan="8">10</td><td rowspan="8">30</td><td rowspan="8">70</td><td rowspan="8">100</td><td rowspan="8">4</td></tr>
<tr><td>6</td><td>PCE- 112/122</td><td>Physical Chemistry</td><td>Elective-2</td></tr>
<tr><td>7</td><td>PCE- 113/123</td><td>Principles of Environmental Science & Engineering</td><td>Elective-3</td></tr>
<tr><td>8</td><td>PCE- 114/124</td><td>Water Pollution & Treatment Techniques</td><td>Elective-4</td></tr>
<tr><td>9</td><td>PCE- 115/125</td><td>Nanoscience& Nanotechnology</td><td>Elective-5</td></tr>
<tr><td>10</td><td>PCE- 116/126</td><td>Supramolecular Chemistry</td><td>Elective-6</td></tr>
<tr><td>11</td><td>PCE- 117/127</td><td>Polymer Chemistry</td><td>Elective-7</td></tr>
<tr><td>12</td><td>PCE- 118/128</td><td>Green Chemistry</td><td>Elective-8</td></tr>
<tr><td></td><td></td><td>Total</td><td></td><td>14</td><td>0</td><td>1</td><td></td><td></td><td></td><td></td><td>350</td><td>14</td></tr>
</table>

# Format-3

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: I/ Semester: I**

<table>
<tr><td colspan="2">Programme: Ph.D. (Chemistry)<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>Class: Doctorate</td><td colspan="2">Year: I<br><br>Semester: 1st</td></tr>
<tr><td colspan="2">Credits 4<br>Theory: 4<br>Practical:</td><td colspan="2">Subject: Chemistry</td></tr>
<tr><td colspan="2">Course Code:<br>PRM- 111/121</td><td colspan="2">Title: Research Methodology</td></tr>
<tr><td colspan="4">Course Objectives:<br>To familiarize the research scholar with the fundamentals of scientific research and to gain familiarity about various data collection tools and techniques, data analysis and interpretation along with the application of computer and statistical software in research.</td></tr>
<tr><td colspan="4">Nature of Paper: Core</td></tr>
<tr><td colspan="4">Minimum Passing Marks/Credits: 40% Marks</td></tr>
<tr><td colspan="4">L: 4<br>T: 0<br>P: 0 (In Hours/Week)<br>Theory - 4 Hr. = 4 Credit<br>Practical- 0 Hrs.=0 Credit (0Hrs./Week=0Credits)</td></tr>
<tr><td>Unit</td><td colspan="2">Contents</td><td>No. of Lectures Allotted</td></tr>
<tr><td>I<br><br><br><br><br><br>II<br><br><br><br><br><br>III<br><br><br><br>IV</td><td colspan="2">Scientific Research: meaning and characteristics of scientific research, validity in research, phases/stages in research; types of research- qualitative, quantitative, exponential, exploratory, empirical, descriptive, ex-post facto, case studies, historical studies, philosophical studies, quasi-experimental; ethical problems in research; Review of literature- purpose of the review, sources of the review, preparation of index card for reviewing and abstracting.<br>Problem Identification and Hypothesis Formation: problem- meaning and characteristics of a problem, types of problem, generality and specific of problem; hypothesis- meaning and characteristics of a good hypothesis, types of hypotheses, formulating a hypothesis, ways of stating a hypothesis; testing experimental hypothesis- standard error, test of significance, level of significance, degrees of freedom, errors in hypothesis- type I, type II errors.<br>Sampling and Research Design: meaning and types of sampling; methods of drawing samples, requisites of a good sampling method, sample size, sampling error; meaning and purpose of research design, criteria of a good research design, basic principles of experimental design.<br>Data Collection, Processing and Analysis: methods of data collection – primary data, secondary data; primary data collection – observation method, interview method, questionnaires, schedules, guideline for constructing questionnaires/schedules, secondary data collection of, selection of appropriate method of data collection; coding, editing and tabulation of data, charts and diagrams used in data analysis, bar and pie diagrams and their significance; measures of central tendency, measures of dispersion;</td><td>40</td></tr>
</table>

| | | |
|---|---|---|
| V | correlation and regression analysis - meaning and uses, methods of calculation of coefficients and their analysis and implication. sampling distribution, sampling schemes and sample sizes, confidence interval for the mean, t-statistic, z-statistic, confidence interval for the population variances, hypothesis testing, test of hypothesis for the population mean, population variance and ratio of two population variances; applications of z-test, t-test, f-test and chi-square test, association of attributes and techniques of testing, ANOVA.<br>**Report Writing:** meaning and significance of report writing, types of report, steps in writing report, layout of the research report, precaution in writing research report, developing thesis report, formatting, inside citations, references and bibliography, knowledge of computer, statistical software and their application. | |

**Reference / Text Books:**

1. Research Methodology: Methods & Techniques by C.R. Kothari, New Age International Publishers.
2. Statistical Methods for Research Workers by Fisher R.A., Cosmo Publications, New Delhi.
3. Design and Analysis of Experiments by Montgomery D.C. (2001), John Wiley.
4. Research Methodology: A step by step for beginners by Ramjet Kumar, Sage Publication.
5. Mathematical Economics by R.G.D. Allen.
6. Mathematics for Economics by Mehta & Madanami.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 20 |
| 2) Assignments | 10 |
| 3) ESE | 70 |
| **Total:** | 100 |

Prerequisites for the course: Post Graduations

**Course Learning Outcomes:** On completion of this course, research students will be able to:

- Understand the various methods of fundamental and empirical research.
- Analyze the various sources of data sources used in social science research.
- Evaluate the various statistical tool used in research.

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: I/ Semester: 1st**

| | |
|---|---|
| **Programme:** Ph.D. (Chemistry)<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>**Class:** Doctorate | Year: I<br><br>Semester: 1st |
| **Credits: 02**<br>Theory: **02**<br>Practical: | **Subject:** Chemistry |
| **Course Code:**<br>PRE-111/121 | **Title:** Research and Publication Ethics |

**Course Objectives:**

On completion of the course research students should be able to:

- Define and explain the process of media research ethics.
- Conduct media research by making use of any of the research ethics.
- To gain a better understanding of the ethics in research
- To enable the student to analyze value of research ethics in conducting research in physical education.
- Demonstrate and apply basic principles of ethics to research movement and implements used in various sports.

**Nature of Paper:** Core

**Minimum Passing Marks/Credits: 40% Marks**

L:2
T:0
P:0 (In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | **Philosophy and Ethics**<br>Introduction to Philosophy: Definition, Nature and Scope, Concept and Branches,<br>Ethics: Definition, Moral Philosophy<br>Nature of Moral Judgments and Reactions | 8-12 |
| II | **Scientific Conduct**<br>Ethics With Respect to Science and Research Intellectual Honesty and Research Integrity.<br>Scientific Misconduct: Falsification, Fabrication, and Plagiarism Redundant Publication: Duplicate and Overlapping Publications Salami Slicing<br>Selective Reporting and Misrepresentation Of Data. | 8-12 |
| III | **Publication Ethics**<br>Publication Ethics: Definition, Introduction and Importance.<br>Best Practices/ Standard Settings Initiatives and Guidelines: COPE, WAME Etc.<br>Publication Misconducts: Definitions, Concepts, Problem That Lead to Unethical Behavior and Vice-Versa Types.<br>Violation of Publication Ethics, Authorship and Contributions. Identification | 8-12 |

| | | |
|---|---|---|
| | of Publication Misconduct, Complaints and Appeals, Predatory Publishers and Journals. | |
| IV | **PRACTICE:**<br>**Open Access Publishing**<br>Open Access Publications and Initiatives, SHERPA/Romeo Online Resource to Check Publisher Copyright and Self-Archiving Policies. Software Tool to Identify Predatory Publications Developed by SPPU.<br>Journal Finder/Journal Suggestion Tools Viz. JANE, Elsevier Journal Finder and Springer Journal Suggested | 8-12 |
| V | **Publication Misconduct**<br>Group Discussion: Subject Special Ethical Issues, FFP, Authorship, Conflicts of Interest, Complain and Appeals: Examples of Fraud From India and Abroad. Software Tool: Use of Plagiarism Software<br>Like TRINITIN, URKAND and Other Open Source Software Tools | 8-12 |
| VI | **Database and Research Matrices**<br>Database: Indexing Databases, Citation Databases: Web of Science, Scopus Etc.<br>Research Metrics: Impact Factor of Journal As Per Journal Citation Report, SNIP. SJR, IIP, Cite Score. Metrics: H-Index, G-Index, I10 Index, Altimetrics. | 8-12 |

**Reference / Text Books:**


- Bird, A. (2006). Philosophy of Science. Routledge. MacIntyre, Alasdair (1967) A Short History of Ethics. London. P. Chaddah, (2018) Ethics in Competitive Research: Do not get scooped; do not get plagiarized, ISBN:978-9387480865
- National Academy of Sciences, National Academy of Engineering and Institute of Medicine. (2009). On Being a Scientist: A Guide to Responsible Conduct in Research: Third Edition. National Academies Press.
- Resnik, D. B. (2011). What is ethics in research & why is it important. National Institute of Environmental Health Sciences, 1-10. Retrieved from https://www.niehs.nih.gov/research/resources/bioethics/whatis/index.cfm Beall, J. (2012). Predatory publishers are corrupting open access. Nature, 489(7415), 179-179.
- https://doi.org/10.1038/489179a Indian National Science Academy (INSA), Ethics in Science Education, Research and Governance (2019), ISBN:978-81-939482-1-7.
- http://www.insaindia.res.in/pdf/Ethics Book.pdf


**Evaluation/Assessment Methodology**

| | Max. Marks |
|---|---|
| 1) Class tasks/ Seasonal Examination | 5 |
| 2) Presentations /Seminar | |
| 3) Assignments | 5 |
| 4) Research Project Report | 5 |
| Seminar On Research Project Report | |
| 5) ESE | 35 |
| **Total:** | 50 |

Prerequisites for the course: Command over Hindi and English

**Course Learning Outcomes:** On completion of this course, research students will be able to:

- Explain the process of media research ethics.
- Conduct media research by making use of any of the research ethics.
- To gain a better understanding of the ethics in research
- To enable the student to analyze value of research ethics in conducting research in physical education.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: I/ Semester: I**

<table>
<tr><td colspan="2">Programme: Ph.D. (Chemistry)<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>Class: Doctorate</td><td colspan="2">Year: I<br><br>Semester: I</td></tr>
<tr><td colspan="2">Credits 2<br>Theory: 2<br>Practical:</td><td colspan="2">Subject: Chemistry</td></tr>
<tr><td colspan="2">Course Code:<br>PLR-111/121</td><td colspan="2">Title: SEMINAR ON LITERATURE REVIEW</td></tr>
<tr><td colspan="4">Course Objectives:<br>The main objective of this course is to undertake a thorough review of available literature on the topic selected by the research scholar</td></tr>
<tr><td colspan="4">Nature of Paper: Core</td></tr>
<tr><td colspan="4">Minimum Passing Marks/Credits: 40% Marks</td></tr>
<tr><td colspan="4">L: 2<br>T: 0<br>P: 0 (In Hours/Week)<br>Theory - = 2 Credit<br>Practical- = Credit (4Hrs./Week=4Credits)</td></tr>
<tr><td>Unit</td><td colspan="2">Contents</td><td>No. of Lectures Allotted</td></tr>
<tr><td></td><td colspan="2">The research scholar will review the important studies conducted at the national and international level either by individuals or organizations including government agencies and present the methodology adopted and important findings emerged from these studies. Based on this review of literature the researcher will identify the research gaps existing in the available literature and thus justifying the need for the present study.<br>The researcher is supposed to follow the pattern adopted in the standard national and international research journals. However, as an illustration the pattern for reporting review of literature is as under:<br>The research scholar has to submit a draft copy of the review of literature duly recommended by his supervisor(s) to the concerned school of the university. The review of literature shall be evaluated by subject expert nominated by the Vice Chancellor who shall submit his assessment/recommendations to the university as to whether the review of literature be accepted or accepted with minor suggestions; referred to the scholar for submission in revised form; or cannot be accepted in the present form and to be resubmitted. If the subject expert recommends the revision or re-submission, the research scholar shall be required to submit the revised draft copy of the review of literature after incorporating the recommendations and suggestions through the research supervisor for the review of DRC whose decision shall be final for grading of the research scholar’s performance in the literature review.</td><td></td></tr>
</table>

| Evaluation/Assessment Methodology | |
|---|---|
| | **Max. Marks** |
| 1) Class tasks/ Sessional Examination<br>2) Assignments<br>3) ESE | **50**<br>**0**<br>**0** |
| **Total:** | 50 |
| Prerequisites for the course: Post Graduations | |
| **Course Learning Outcomes:**<br>On completion of this course, research students will be able to learn about literature survey and its presentation skill through power point presentation. | |

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: I/ Semester: I**

<table>
<tr><td colspan="2">Programme: Ph.D. (Chemistry)<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>Class: Doctorate</td><td>Year: I<br><br>Semester: I</td></tr>
<tr><td>Credits 2<br>Theory: 2<br>Practical:</td><td colspan="2">Subject: Chemistry</td></tr>
<tr><td>Course Code:<br>PPC-111/121</td><td colspan="2">Title: Instrumental Methods for Chemical Characterization & Analysis</td></tr>
<tr><td colspan="3">Course Objectives:</td></tr>
<tr><td colspan="3">Nature of Paper: Core</td></tr>
<tr><td colspan="3">Minimum Passing Marks/Credits: 40% Marks</td></tr>
<tr><td colspan="3">L: 2<br>T: 0<br>P: 0 (In Hours/Week)<br>Theory - = 2 Credit<br>Practical- = Credit (Hrs./Week=Credits)</td></tr>
</table>

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | Absorption Spectroscopy: Introduction and importance; Principles and instrumentation; Interferences - Chemical & Spectral and evaluation methods; Applications of Atomic Absorption Spectroscopy for qualitative and quantitative analysis. UV-Visible spectroscopy: Theory, Rules and identification of functional groups | 40 |
| II | IR, FT-IR and Raman spectroscopy: Introduction; basic principles; Instrumentation; Detectors, Qualitative, Quantitative analysis and Applications. Raman spectroscopy – identification of some organic functional groups. Solving some problems related IR and Raman spectroscopy. | |
| III | Nuclear magnetic resonance spectroscopy: High resolution NMR – chemical shift- Spin-Spin splitting (j-value) Spin decoupling ; spin tickling, shift reagents; structure determination, applications of proton NMR and problems 13-C NMR –Principle, rules, applications and problems. | |
| IV | Mass Spectroscopy and allied techniques: Introduction; Basic principles, ionizing sources, types of ions, detectors and applications. Rules, modes of fragmentation of various organic molecules and problems.Principle and applications of GC-MS, HPLC-MS, GC-FTIR. | |
| V | X-ray fluorescence and Thermal Analysis: Principle, energy dispersive X-ray fluorescence, wavelength dispersive X-ray fluorescence, X-ray photo electronic spectroscopy, chemical shift, application of XPES and XRF. Principles, basic instrumentation and applications of TG, DTA and DSC.differential scanning calorimetry. Cyclic voltametry – Principle, instrumentation and applications. | |

| **Reference / Text Books:** | |
|---|---|
| **Evaluation/Assessment Methodology** | |
| | **Max. Marks** |
| 1) Class tasks/ Sessional Examination<br>2) Assignments<br>3) ESE | **10**<br>**5**<br>**35** |
| **Total:** | 50 |
| Prerequisites for the course: Post Graduations | |
| **Course Learning Outcomes:**<br>Students should learn about:<br>1. Various spectroscopic techniques used to characterize the materials such as IR, FTIR, RAMAN, NMR, etc.<br>2. Variuos separation techiques mainly chromatography.<br>3. Various electrochemical techniques such as voltammetry, potentiometry etc.<br>4. X-Ray based techniques. | |

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: I/ Semester: I**

| | | |
|---|---|---|
| **Programme:** Ph.D. (Chemistry)<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>**Class:** Doctorate | Year: I<br><br>Semester: I | |
| **Credits 4**<br>Theory: 4<br>Practical: | **Subject: Chemistry** | |
| **Course Code:**<br>**PCE-111/121** | **Title: ADVANCES IN ORGANIC CHEMISTRY** | |
| **Course Objectives:** | | |
| **Nature of Paper: Elective-1** | | |
| **Minimum Passing Marks/Credits: 40% Marks** | | |
| L: 4<br>T: 0<br>P: 0 (In Hours/Week)<br>Theory - = 4 Credit<br>Practical- = Credit (Hrs./Week=Credits) | | |

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | Structural Elucidation by Spectroscopic Methods: Application of UV, IR and NMR spectroscopy, mass spectroscopy in structural analysis of organic compounds. | **40** |
| II | Oxidation: Oxidation of hydrocarbons; alkenes, alcohols, aldehydes and ketones Oxidative coupling reactions. Use of Pb(OAC)4, NBS, CrO3, SeO2, MnO2, KMnO4, OsO4, Per acids and Ti(III) Nitrate.<br>Reduction: Catalytic hydrogenation (homogenous and heterogeneous), reduction by dissolving metals, reduction by hydride transfer reagents, reduction with hydrazine and diamide. | |
| III | Disconnection approach: Introduction, Principle, Functional group inversion, Disconnection of mono cyclic substituted organic Compounds. | |
| IV | Phase Transfer catalyst: Principle & applications of three catalysts: Tetra butyl Ammonium bromide, Crown ethers, Ethyl TriphenylPhosphonium Bromide | |
| V | Design Organic Synthesis: Retro synthesis the disconnection approach – basic Principles Convergent and linear synthesis with examples; Retro synthesis of bi cyclic and tri cyclic systems. | |

**Reference / Text Books:**


1. Dielectric properties amd molecular behavior by N.E.-Hill and W.E. Vughan, Van Nostrand Londan.
2. Molecular structures and properties of liquid crystals by G.W. Gray, Academic press, New York.
3. Molecular crystals and liquis crystals by Virendra Bhadur, Gordon and Breach Science Publishers New York.
4. Liquid crystal displayed by Ernst Lueder John Willey & sons Ltd, New York.

| | |
|---|---|
| 5. The physics of liquid crystal II edition by De Gennes & J. Prost Oxford Press. | |
| **Evaluation/Assessment Methodology** | |
| | **Max. Marks** |
| 1) Class tasks/ Sessional Examination<br>2) Assignments<br>3) ESE | **20**<br>**10**<br>**70** |
| **Total:** | 100 |
| Prerequisites for the course: Post Graduations | |
| **Course Learning Outcomes:**<br>Students should be able learn about<br>1. Various spectroscopic techniques used for structural elucidation of organic compounds.<br>2. To know the various reagents used in organic chemistry.<br>3. To learn the advanced methodology for organic synthesis. | |

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: I/ Semester: I**

<table>
<tr><td colspan="2">Programme: Ph.D. (Chemistry)<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>Class: Doctorate</td><td colspan="2">Year: I<br><br>Semester: I</td></tr>
<tr><td colspan="2">Credits 4<br>Theory: 4<br>Practical:</td><td colspan="2">Subject: Chemistry</td></tr>
<tr><td colspan="2">Course Code:<br>PCE-112/122</td><td colspan="2">Title: PHYSICAL CHEMISTRY<br>Practical</td></tr>
<tr><td colspan="4">Course Objectives:</td></tr>
<tr><td colspan="4">Nature of Paper: Elective-2</td></tr>
<tr><td colspan="4">Minimum Passing Marks/Credits: 40% Marks</td></tr>
<tr><td colspan="4">L: 4<br>T: 0<br>P: 0 (In Hours/Week)<br>Theory - = 4 Credit<br>Practical- = Credit (Hrs./Week=Credits)</td></tr>
<tr><td>Unit</td><td colspan="2">Contents</td><td>No. of Lectures Allotted</td></tr>
<tr><td>I</td><td colspan="2">Photochemistry: Types of Photochemical reactions; Laws of Absorption (Grothuss-Draper law & Einstein's law); Quantum yield; Primary & Secondary Photochemical processes; Joblonski Diagram: Fluorescence, Phosphorescence, Inter-System Crossing; Internal Conversion-Vibrational Cascade and Chemiluminescence. Kinetics of Photochemical reactions; Dissociation of HI; Reaction between Hydrogen and Chlorine; Reaction between Hydrogen and Bromine; Reaction between Hydrogen and Oxygen; Explosion limits.</td><td rowspan="4">40</td></tr>
<tr><td>II</td><td colspan="2">Catalysis: Types of Catalytic Reagents; Types of Catalysis (Homogeneous and Heterogeneous catalysis); Catalytic activity; Acidity Functions; Theory of Homogeneous catalysis; Theory of Heterogeneous catalysis (Chemical theory & Adsorption theory); Kinetics of heterogeneous reactions.</td></tr>
<tr><td>III</td><td colspan="2">Enzyme Catalysis: Specificity in Enzyme Catalyzed reactions; Michaelis - Menten mechanism; Influence of Concentration on Enzyme-Catalyzed reactions; Influence of Temperature on Enzyme Catalyzed reactions; Acid-base catalysis.</td></tr>
<tr><td>IV</td><td colspan="2">Chemical Kinetics: Fast reactions; Rate constants of fast reactions; Their determination by Stopped flow method, Relaxation method, Flash photolysis and Nuclear Magnetic Resonance methods. Ionic reactions; Influence of solvent on the rate of reactions (single & double sphere A.C. model); Primary salt effect; Secondary salt effect; Influence of frequency factor; Influence of ionic strength.</td></tr>
</table>

| | | |
|---|---|---|
| **V** | Surface Chemistry: Adsorption; Factors influencing adsorption; Surface area and its measurements; Adsorption isotherm curves; Langmuir's adsorption isotherm- its limitations; B.E.T. Adsorption isotherm-its applications; Negative adsorption; Positive adsorption; Chemisorption; Physisorption and Determination of surface area. | |
| **Reference / Text Books:** | | |
| **Evaluation/Assessment Methodology** | | |
| | | **Max. Marks** |
| 1) Class tasks/ Sessional Examination<br>2) Assignments<br>3) ESE | | **20**<br>**10**<br>**70** |
| | **Total:** | 100 |
| Prerequisites for the course: Post Graduations | | |

**Course Learning Outcomes:**

Students should be able to learn

1. Various aspects of photochemistry.
2. The concept of various types of catalysis.
3. The concept of enzyme catalysis.
4. Various aspects of reaction kinetics.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: I/ Semester: I**

| | |
|---|---|
| **Programme:** Ph.D. (Chemistry)<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>**Class:** Doctorate | Year: I<br><br>Semester: I |
| **Credits 4**<br>Theory: 4<br>Practical: | **Subject: Chemistry** |
| **Course Code:**<br>**PCE-113/123** | **Title: PRINCIPLES OF ENVIRONMENTAL SCIENCE & ENGINEERING** |
| **Course Objectives:** | |
| **Nature of Paper: Elective-3** | |
| **Minimum Passing Marks/Credits: 40% Marks** | |
| L: 4<br>T: 0<br>P: 0 (In Hours/Week)<br>Theory - = 4 Credit<br>Practical- = Credit (Hrs./Week=Credits) | |

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | Ecology, Environment and Energy Resources: Principles of ecology; ecosystem- structure and functions; biomes and biodiversity; biogeochemical cycles; environment- management and pollution; sustainable development; energy resources- renewable and non-renewable. | 40 |
| II | Environmental Chemistry, Environmental Health and Toxicology: Environmental segments- atmosphere, hydrosphere, lithosphere; Chemical interactions; Toxic chemicals in environment; environmental health hazards; Biochemical effects- arsenic, lead, mercury, carbon monoxide, nitrogen oxides, sulfur dioxide, ozone and PAN, cyanide, pesticides; Measuring toxicity and Risk assessment. | |
| III | Air Pollution & Control Technologies: Air pollution- types and sources; Air pollutants classification and properties; Meteorological aspects of air pollution; Air pollution-sampling and measurement; Control methods- particulate and gaseous emissions; Automobile pollution. | |
| IV | EIA, Environmental Law and Policy Concept of EIA; EIA methodologies; Impact prediction and assessment-air, water, biological, socio-economic; Concepts of Environmental Audit; Environmental education; Environmental Policy; Environmental Law and regulations; Citizen participation. | |
| V | Solid and Hazardous Waste Management: Waste-definition and types; Generation; Collection; Segregation; transport; Treatment; Disposal Methods; Waste Processing and management; Creation of TSDF; Impacts of waste; legal and administrative regulations. | |

**Reference / Text Books:**


1. Ecology- E.P. Odum, 1983, Holt-Saunders International Edition
2. Environmental Chemistry- A.K. De, New Age International Publication Co., New Delhi, 1990

| | |
|---|---|
| 3. A Text Book of environmental – C.S. Rao, Wiley Eastern Limited., 1993 | |
| **Evaluation/Assessment Methodology** | |
| | **Max. Marks** |
| 1) Class tasks/ Sessional Examination<br>2) Assignments<br>3) ESE | **20**<br>**10**<br>**70** |
| **Total:** | 100 |
| Prerequisites for the course: Post Graduations | |
| **Course Learning Outcomes:**<br>To learn about ecology and various dependent terms come under it. Environmental awareness and hazardous materials. Its various kinds and various policies to regulate the ecology concerns. | |

**IIMTU-NEP IMPLEMENTATION**
**Year: I/ Semester: I**

| | | | |
|---|---|---|---|
| **Programme:** Ph.D. (Chemistry)<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>**Class:** Doctorate | | Year: I<br><br>Semester: I | |
| **Credits 4**<br>Theory: 4<br>Practical: | **Subject: Chemistry** | | |
| **Course Code:**<br>**PCE-114/124** | **Title: WATER POLLUTION & TREATMENT TECHNIQUES** | | |
| **Course Objectives:** | | | |
| **Nature of Paper: Elective-4** | | | |
| **Minimum Passing Marks/Credits: 40% Marks** | | | |
| L: 4<br>T: 0<br>P: 0 (In Hours/Week)<br>Theory - = 4 Credit<br>Practical- = Credit (Hrs./Week=Credits) | | | |

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | Water Pollutants and Water Treatment: Types and Sources, Heavy metals-metalloids- organic inorganic- biological- radioactive pollutants, eutrophication, potable water and carrying capacity of rivers, Methods of Water Purification, primary treatment- sedimentation- flotation, secondary (biological) treatment- design and principles in biological treatment facilities- activated sludge process- trickling filters – low cost waste treatment systems and their design, tertiary treatment. | **40** |
| II | Industrial Waste Water Treatment: Sources, Characteristics, methodology and process for the treatment of industrial wastes of sugar industry- beverage industry- tannery industry- textile mill waste industry- fertilizer plant- steel plant- oil refinery- pharmaceutical [plant- paper and pulp mill] | |
| III | Advanced Waste Water Treatment: Introduction, removal of suspended solids, removal of dissolved solids, Ammonia removal, phosphorous removal. Chemical oxidation, recovery of materials from process effluents. | |
| IV | Sewage Treatment and Disposal: Self purification of streams- BOD and its importance- treatment methods- primary, secondary and tertiary levels-disinfections of treated sewage effluent- septic tank design- effluent disposal methods- disposal on land, sewage sickness- disposal by dilution- design of biological treatment units- sludge characteristics, unit operations in sludge disposal, conventional and high rate digesters- disposal of sludge- gas utilization. | |

| | | |
|---|---|---|
| **V** | Phytoremediation Treatment: Introduction, current trends in role of phytoremediation- examples of species potential in absorbing heavy metals and pollutants in waste water- root zone treatment technology- microbial remediation- role of bacteria and the microbes in cleaning of sewage waters- oil spilled waters- domestic waste waters- polluted agricultural runoff- bio medical waste retaining waters. | |

**Reference / Text Books:**


1. Water Supply and Sanitary Engineering, G.S. Birdie & J.S. Brides, Dhanpat Rai & sons 1993.
2. A treatise on Rural, Municipal, and industrial waste management KVSG Murali Krishna
3. Environmental Sanitation (Social and preventive medicine) Dr. P.V. Rama Raju& KVSG Murali Krishna
4. Waste water engineering, treatment and reuse by Metcalf and Eddy, fifth edition, Tata McGraw Hill.


**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | **20** |
| 2) Assignments | **10** |
| 3) ESE | **70** |
| **Total:** | 100 |

Prerequisites for the course: Post Graduations

**Course Learning Outcomes:**

To learn about water pollution and pollution caused by industries and Various methodologies for its remediation.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: I/ Semester: I**

| | |
|---|---|
| **Programme:** Ph.D. (Chemistry)<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>**Class:** Doctorate | Year: I<br><br>Semester: I |
| **Credits 4**<br>Theory: 4<br>Practical: | **Subject: Chemistry** |
| **Course Code:**<br>**PCE-115/125** | **Title: NANOSCIENCE & NANOTECHNOLOGY** |
| **Course Objectives:** | |
| **Nature of Paper: Elective-5** | |
| **Minimum Passing Marks/Credits: 40% Marks** | |
| L: 4<br>T: 0<br>P: 0 (In Hours/Week)<br>Theory - = 4 Credit<br>Practical- = Credit (Hrs./Week=Credits) | |

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| **I** | Definition, Types of nanostructures, Properties and Applications: One dimensional, Two dimensional and Three dimensional nanostructured materials, Quantum Dots shell structures, metal oxides, semiconductors, composites, mechanical-physical-chemical properties, application as ferroelectric materials, coating, molecular electronics and nanoelectronics, biological and environmental, membrane based application, polymer based application, nanocatalysis, basic principle. Synthesis and preparation of Nanomaterials and Synthetic Techniques: Synthesis of bulk nanostructured materials - Sol Gel processing- bulk and nano composite materials - Grinding - high energy ball milling – injection moulding - extrusion - melt quenching and annealing, Self assembly-Self Assembled Monolayers (SAM) - Vapour Liquid Solid (VLS) approach - Chemical Vapour Deposition (CVD) - Langmuir- Blodgett (LB) films - Spin coating - Templatedself assembly Electrochemical approaches: Thin films -Epitaxy -Lithography. | **40** |
| **II** | Carbon nanostructures: Synthesis, separation and characterization of Fullerene and its derivatives, applications, toxicity. Carbon nanotube (CNT), structure, synthesis and functionalization of CNT, electronic, vibrational, mechanical and optical properties of CNT, applications. Graphene, structure, synthesis and functionalization of Graphene, Graphene composites, electronic applications of Graphene, Graphene Oxide. The environmental effects of carbon based nanomaterials. Nanosensors: Introduction to sensors. Characteristics and terminology - static and dynamic characteristics. Micro and nano-sensors, Fundamentals of sensors, micro fluids, Packaging and characterization of sensors, Sensors for aerospace and defense, Organic and inorganic nanosensors, Biosensors: Magnetic Nanoparticles for Imaging and Therapy, Clinical diagnostics, generation of biosensors, Nanomaterial based biosensors, | |

| | | |
|---|---|---|
| | Biosensors based on nucleotides and DNA, Electron transfer of biomolecules, Photodetectors, Nanophotonics, Nanoelectronic Devices, Biosensors. | |

**Reference / Text Books:**

1. Chemistry of nanomaterials : Synthesis, properties and applications - CNR Rao et.al.
2. Nanoparticles: From theory to applications, Wiley Weinheim, 2004 - G. Schmidt.
3. Processing & properties of structural naonmaterials - Leon L. Shaw
4. Environmental Chemistry for a Sustainable World, Volume 1: Nanotechnology and Health Risk Editors: Lichtfouse, Schwarzbauer, Robert
5. Advances in Nanotechnology and the Environment, CRC Press, Taylor and Francis Group - Juyoung Kim
6. Chemical Sensors and Biosensors, Wiley; New York, Chichester, 2002 - Brian R Eggins.
7. Biosensors: A Practical Approach, Oxford University Press, 2004 - J. Cooper & C. Tass,
8. Nanomaterials for Biosensors, Wiley - VCH, 2007 - Cs. Kumar
9. Nanostructures and Nanomaterials: Synthesis, properties and applications, Imperial College Press, 2004 - G.Cao
10. Handbook of Nanoscience, Engg. and Technology, CRC Press, 2002 - W. Gaddand, D. Brenner, S. Lysherski and G. J. Infrate (Eds)
11. Carbon Nanotubes: Properties and Applications- Michael J. O'Connell
12. Nanotubes and Nanowires, RCS Publishing - CNR Rao and A Govindaraj
13. Nanoscale materials -Liz Marzan and Kamat
14. Carbon Nanomaterials for Environmental and Biological Applications, Bergmann and Machado. Springer.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | **20** |
| 2) Assignments | **10** |
| 3) ESE | **70** |
| **Total:** | 100 |

Prerequisites for the course: Post Graduations

**Course Learning Outcomes:**

To learn about nano science and nanotechnology. Its uses in chemistry and why it is so important in chemistry.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: I/ Semester: I**

| | | |
|---|---|---|
| **Programme:** Ph.D. (Chemistry)<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>**Class:** Doctorate | | Year: I<br><br>Semester: I |
| **Credits 4**<br>Theory: 4<br>Practical: | **Subject: Chemistry** | |
| **Course Code:**<br>**PCE-116/126** | **Title: SUPRAMOLECULAR CHEMISTRY** | |
| **Course Objectives:** | | |
| **Nature of Paper: Elective-6** | | |
| **Minimum Passing Marks/Credits: 40% Marks** | | |
| L: 4<br>T: 0<br>P: 0 (In Hours/Week)<br>Theory - = 4 Credit<br>Practical- = Credit (Hrs./Week=Credits) | | |

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | Supramolecular Chemistry: Concepts of Supramolecular Chemistry: Definition, Nature of supramolecular interactions, Host-guest interaction, Molecular recognition, Types of recognition. Cation-binding Hosts: Concepts, Cation receptors, Synthesis and structure of crown ethers, lariat ethers, podands, cryptands, spherands, calixarenes, Selectivity of cationcomplexation, Macrocyclic and template effects. Anion-binding Hosts: Concepts, Anion host design, Anion receptors, Shape and selectivity, Cation hosts to anion hosts, pH effect. Neutral receptors: Clathrates, cavitands, cyclodextrins, cyclophanes. Self-assembly molecules: Design, synthesis and properties of the molecules, Self assembling by H-bonding, Metal-ligand interactions and other weak interactions, metallomacrocycles, catenanes, rotaxanes, helicates and knots. Applications of Supramolecular Chemistry: Rational Design, molecular electronic devices, molecular wires, molecular rectifiers, molecular switches, molecular logic. cyclodextrins as enzyme mimics, ion channel mimics, supramolecular reactivity and catalysis. | **40** |

**Reference / Text Books:**


1. Supramolecular Chemistry, Wiley, 2000- J.
2. “Supramolecular Chemistry” by Jonathan W Steed and Jerry L Atwood
3. Supramolecular Chemistry” by Peter J Cragg
4. An Introduction to Supramolecular Chemistry” by Das A
5. “Supramolecular Chemistry” by Jonathan W Steed and Jerry L Atwood
6. “Supramolecular Chemistry – Fundamentals and Applications” by Katsuhiko Ariga and Toyoki Kunitake
7. “Bioorganic, Bioinorganic and Supramolecular Chemistry” by P S Kalsi
8. “Supramolecular Chemistry: From Molecules to Nanomaterials” by Jonathan W Steed and Philip

A Gale

9. "Supramolecular Chemistry: Synthesis of porphyrinoids and related macrocycles and their non-covalent interactions" by Shaina D Jain
10. "Introduction to Supramolecular Chemistry" by Helena Dodziuk

| **Evaluation/Assessment Methodology** | |
|---|---|
| | **Max. Marks** |
| 1) Class tasks/ Sessional Examination<br>2) Assignments<br>3) ESE | **20**<br>**10**<br>**70** |
| **Total:** | 100 |

Prerequisites for the course: Post Graduations

**Course Learning Outcomes:**
Students should lear about various concepts regarding supramolecular chemistry and its importance in chemistry reaserch.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: I/ Semester: I**

| | |
|---|---|
| **Programme:** Ph.D. (Chemistry)<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>**Class:** Doctorate | Year: I<br><br>Semester: I |
| **Credits 4**<br>Theory: 4<br>Practical: | **Subject: Chemistry** |
| **Course Code:**<br>**PCE-117/127** | **Title: POLYMER CHEMISTRY** |
| **Course Objectives:** | |
| **Nature of Paper: Elective-7** | |
| **Minimum Passing Marks/Credits: 40% Marks** | |
| L: 4<br>T: 0<br>P: 0 (In Hours/Week)<br>Theory - = 4 Credit<br>Practical- = Credit (Hrs./Week=Credits) | |

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | Introduction and common applications of polymers. Classification of polymers. Kinetics and mechanism of chain growth and step growth polymerisation. Polymerisation processes (Bulk, Solution, Emulsion and Suspension) | **40** |
| II | Molecular weight, molecular weight distribution and degree of polymerization. Experimental methods for determination of molecular weight. Glass transition temperature: significance and determination. | |
| III | Copolymers: Classification, synthesis and application. Synthesis and applications of biodegradable, biomedical polymers. Conducting Polymers. Inorganic Polymers. Polymer synthesis procedures – ATRP, ROMP, MP, ROP. Commercial thermoplastic and thermosetting polymers- Synthesis, properties and applications. | |
| IV | Spectral and Instrumental analysis of Polymers (IR, UV, NMR, XRD, DSC, TGA, POM).Advanced Polymers: Shape Memory Polymers, Self-Healing Polymers, LCP. Branched polymers (star, dendritic and hyper branched polymers). | |

**Reference / Text Books:**


1. Principles of polymerization, George G. Odian, 4th Edition, A John Wiley & Sons, Inc., Publication, 2004.
2. Textbook of Polymer Science, W. F. Billmeyer, 3rd Edition, A John Wiley & Sons, Inc., Publication, 2007.
3. The Chemistry of Polymers, John W. Nicholson, 3rd Edition, RSC Publishing, 2006.
4. Polymer Chemistry: Properties and Application. A.J Peacock, A. Calhoun. Hanser Gardner Publications, 2006.
5. Polymer Science & Technology – Plastics, Rubbers, Blends and Composites. PremamoyGhosh. 3rd Edition, McGraw Hill Education (India) Private Limited, 2010.

| Evaluation/Assessment Methodology | |
|---|---|
| | **Max. Marks** |
| 1) Class tasks/ Sessional Examination<br>2) Assignments<br>3) ESE | **20**<br>**10**<br>**70** |
| **Total:** | 100 |
| Prerequisites for the course: Post Graduations | |
| **Course Learning Outcomes:**<br>To learn about various types of polymers, its methods of synthesis and importance in chemistry. | |

IIMT UNIVERSITY — MEERUT (U.P.) —

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: I/ Semester: I**

<table>
<tr><td colspan="2">Programme: Ph.D. (Chemistry)<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>Class: Doctorate</td><td colspan="2">Year: I<br><br>Semester: I</td></tr>
<tr><td colspan="1">Credits 4<br>Theory: 4<br>Practical:</td><td colspan="3">Subject: Chemistry</td></tr>
<tr><td colspan="1">Course Code:<br>PCE-118/128</td><td colspan="3">Title: GREEN CHEMISTRY</td></tr>
<tr><td colspan="4">Course Objectives:</td></tr>
<tr><td colspan="4">Nature of Paper: Elective-8</td></tr>
<tr><td colspan="4">Minimum Passing Marks/Credits: 40% Marks</td></tr>
<tr><td colspan="4">L: 4<br>T: 0<br>P: 0 (In Hours/Week)<br>Theory - = 4 Credit<br>Practical- = Credit (Hrs./Week=Credits)</td></tr>
<tr><td>Unit</td><td colspan="2">Contents</td><td>No. of Lectures Allotted</td></tr>
<tr><td></td><td colspan="2">Introduction, Principles & Concepts of Green Chemistry. Waste: Production, Problems, Prevention. Catalysis and Green Chemistry: Oxidations and Reductions, C-C Bond Formation, Organometallic Chemistry & Catalysis Organic Solvents: Environmentally Benign Solutions (Focus on water, ionic liquid, fluorous solvents and super critical CO2).<br>Design for energy efficiency Renewable Resources: Chemicals from Biomass, Utilization of CO2 and other feed stocks. Focus on the application of innovative technology the development of greener" routes to improve industrial processes and to produce important products.<br>References:<br>1. Green Chemistry: Theory and Practice, Anastas, P. T.; Wamer, J. C. Oxford University Press: New York, 1998.<br>2. Renewables-Based Technology: Sustainability Assessment; Dewulf. J.; Langenhove, H. V., Eds.; John Wiley & Sons, Ltd, 2006.<br>3. Green Chemistry and Engineering. Doble, M.; Kruthiventi, A. K.; Elsevier, 2007.<br>4. Handbook of Green Chemistry and Technology, James Clark and Duncan Macquarrie, Blackwell Science, 2002.<br>5. The Chemistry of Waste Minimization, J.H. Clark, Blackie Academic, 1995.<br>6. Multi Component Reactions Jeiping Zhu and Hugues Bienayme (Ed.), Wiley VCH Velag GmbH & Co., 2005.<br>7. Green Chemistry: Environmentally Benign Reactions; Ahluwalia, V. K., CRC Press: Boca Raton, FL, 2008.</td><td>40</td></tr>
</table>

| Evaluation/Assessment Methodology | |
|---|---|
| | **Max. Marks** |
| 1) Class tasks/ Sessional Examination<br>2) Assignments<br>3) ESE | **20**<br>**10**<br>**70** |
| **Total:** | 100 |
| Prerequisites for the course: Post Graduations | |
| **Course Learning Outcomes:**<br>To learns about various concepts of green chemistry and its importance in day to day chemistry and life. | |

# Evaluation Scheme

| Program: Ph.D. in Mathematics<br>Semester: ODD/EVEN | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **S.No.** | **Course Code** | **Course Name** | **Course Category** | **Periods** | | | **Marks** | | | | | **Credit** |
| | | | | | | | **Internal** | | | **External** | **Total** | |
| | | | | **L** | **T** | **P** | **CT** | **TA** | **Total** | | | |
| 1 | PRM-111/121 | Research Methodology | Core | 4 | 0 | 0 | 20 | 10 | 30 | 70 | 100 | 4 |
| 2 | PCM-111/121 | Instrumental tools and Methods | Core | 2 | 0 | 1 | 10 | 5 | 15 | 35 | 50 | 2 |
| 3 | PRE-111/121 | Research & Publication Ethics | Core | 2 | 0 | 0 | 10 | 5 | 15 | 35 | 50 | 2 |
| 4 | PLR-111/121 | Seminar on Literature Review | Core | 2 | 0 | 0 | 50 | - | 50 | 0 | 50 | 2 |
| **Discipline Specific Elective Courses (Any One)** | | | | | | | | | | | | |
| 5 | PCM-112/122 | Partial Differential Equations: Theory and Numeric | Elective-2 | 4 | 0 | 0 | 20 | 10 | 30 | 70 | 100 | 4 |
| 6 | PCM-113/123 | Inventory and Production Management | Elective-3 | | | | | | | | | |
| 7 | PCM-114/124 | Mathematical Programming | Elective-4 | | | | | | | | | |
| 8 | PCM-115/125 | Theory of Reliability | Elective-5 | | | | | | | | | |
| 9 | PCM-116/126 | Software Reliability | Elective-6 | | | | | | | | | |
| 10 | PCM-117/127 | Network Optimization | Elective-7 | | | | | | | | | |
| | | **Total** | | **14** | **0** | **1** | | | | | **350** | **14** |

# Format-3

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: I/ Semester: I**

| | |
|---|---|
| **Programme:** Ph.D. (Mathematics)<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>**Class:** Doctorate | Year: I<br><br>Semester: I |
| **Credits 4**<br>Theory: 4<br>Practical: 0 | **Subject: Mathematics** |
| **Course Code:**<br>**PRM- 111/121** | **Title: Research Methodology** |
| **Course Objectives:** To familiarize the research scholar with the fundamentals of scientific research and to gain familiarity about various data collection tools and techniques, data analysis and interpretation along with the application of computer and statistical software in research. | |
| **Nature of Paper:** Core | |
| **Minimum Passing Marks/Credits:** 40% Marks | |
| L: 4<br>T: 0<br>P: 0 (In Hours/Week)<br>Theory - 4 Hr. = 4 Credit<br>Practical- 0 Hrs.=0 Credit (0Hrs./Week=0Credits) | |

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | **Scientific Research:** meaning and characteristics of scientific research, validity in research, phases/stages in research; types of research- qualitative, quantitative, exponential, exploratory, empirical, descriptive, ex-post facto, case studies, historical studies, philosophical studies, quasi-experimental; ethical problems in research; Review of literature- purpose of the review, sources of the review, preparation of index card for reviewing and abstracting. | 40 |
| II | **Problem Identification and Hypothesis Formation:** problem- meaning and characteristics of a problem, types of problem, generality and specific of problem; hypothesis- meaning and characteristics of a good hypothesis, types of hypotheses, formulating a hypothesis, ways of stating a hypothesis; testing experimental hypothesis- standard error, test of significance, level of significance, degrees of freedom, errors in hypothesis- type I, type II errors. | |
| III | **Sampling and Research Design:** meaning and types of sampling; methods of drawing samples, requisites of a good sampling method, sample size, sampling error; meaning and purpose of research design, criteria of a good research design, basic principles of experimental design. | |
| IV | **Data Collection, Processing and Analysis:** methods of data collection – primary data, secondary data; primary data collection – observation method, interview method, questionnaires, schedules, guideline for constructing questionnaires/schedules, secondary data collection of, selection of appropriate method of data collection; coding, editing and tabulation of data, charts and diagrams used in data analysis, bar and pie diagrams and their significance; measures of central tendency, measures of dispersion; correlation and | |

| | | |
|---|---|---|
| | regression analysis - meaning and uses, methods of calculation of coefficients and their analysis and implication. sampling distribution, sampling schemes and sample sizes, confidence interval for the mean, t-statistic, z-statistic, confidence interval for the population variances, hypothesis testing, test of hypothesis for the population mean, population variance and ratio of two population variances; applications of z-test, t-test, f-test and chi-square test, association of attributes and techniques of testing, ANOVA.<br>**Report Writing:** meaning and significance of report writing, types of report, steps in writing report, layout of the research report, precaution in writing research report, developing thesis report, formatting, inside citations, references and bibliography, knowledge of computer, statistical software and their application. | |

**Reference / Text Books:**


1. Research Methodology: Methods & Techniques by C.R. Kothari, New Age International Publishers.
2. Statistical Methods for Research Workers by Fisher R.A., Cosmo Publications, New Delhi.
3. Design and Analysis of Experiments by Montgomery D.C. (2001), John Wiley.
4. Research Methodology: A step by step for beginners by Ramjet Kumar, Sage Publication.
5. Mathematical Economics by R.G.D. Allen.
6. Mathematics for Economics by Mehta & Madanami.


**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 20 |
| 2) Assignments | 10 |
| 3) ESE | 70 |
| **Total:** | 100 |

Prerequisites for the course: Post Graduations

**Course Learning Outcomes:** On completion of this course, research students will be able to:

- Understand the various methods of fundamental and empirical research.
- Analyze the various sources of data sources used in social science research.
- Evaluate the various statistical tool used in research.

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: I/ Semester: I**

| | |
|---|---|
| **Programme:** Ph.D. (Mathematics)<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>**Class:** Doctorate | Year: I<br><br>Semester: I |
| **Credits: 02**<br>Theory: **02**<br>Practical: | **Subject: Mathematics** |
| **Course Code:**<br>PRE-111/121 | **Title: Research and Publication Ethics** |

**Course Objectives:** On completion of the course research students should be able to:

- Define and explain the process of media research ethics.
- Conduct media research by making use of any of the research ethics.
- To gain a better understanding of the ethics in research
- To enable the student to analyze value of research ethics in conducting research in physical education.
- Demonstrate and apply basic principles of ethics to research movement and implements used in various sports.

**Nature of Paper:** Core

**Minimum Passing Marks/Credits: 40% Marks**

L:2
T:0
P:0 (In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | **Philosophy and Ethics**<br>Introduction to Philosophy: Definition, Nature and Scope, Concept and Branches,<br>Ethics: Definition, Moral Philosophy<br>Nature of Moral Judgments and Reactions | 8-12 |
| II | **Scientific Conduct**<br>Ethics With Respect to Science and Research Intellectual Honesty and Research Integrity.<br>Scientific Misconduct: Falsification, Fabrication, and Plagiarism Redundant Publication: Duplicate and Overlapping Publications Salami Slicing<br>Selective Reporting and Misrepresentation Of Data. | 8-12 |
| III | **Publication Ethics**<br>Publication Ethics: Definition, Introduction and Importance.<br>Best Practices/ Standard Settings Initiatives and Guidelines: COPE, WAME Etc.<br>Publication Misconducts: Definitions, Concepts, Problem That Lead to Unethical Behavior and Vice-Versa Types.<br>Violation of Publication Ethics, Authorship and Contributions. Identification | 8-12 |

| | | |
|---|---|---|
| | of Publication Misconduct, Complaints and Appeals, Predatory Publishers and Journals. | |
| IV | **PRACTICE:**<br>**Open Access Publishing**<br>Open Access Publications and Initiatives, SHERPA/Romeo Online Resource to Check Publisher Copyright and Self-Archiving Policies. Software Tool to Identify Predatory Publications Developed by SPPU.<br>Journal Finder/Journal Suggestion Tools Viz. JANE, Elsevier Journal Finder and Springer Journal Suggested | 8-12 |
| V | **Publication Misconduct**<br>Group Discussion: Subject Special Ethical Issues, FFP, Authorship, Conflicts of Interest, Complain and Appeals: Examples of Fraud From India and Abroad. Software Tool: Use of Plagiarism Software<br>Like TRINITIN, URKAND and Other Open Source Software Tools | 8-12 |
| VI | **Database and Research Matrices**<br>Database: Indexing Databases, Citation Databases: Web of Science, Scopus Etc.<br>Research Metrics: Impact Factor of Journal As Per Journal Citation Report, SNIP. SJR, IIP, Cite Score. Metrics: H-Index, G-Index, I10 Index, Altimetrics. | 8-12 |

**Reference / Text Books:**


- Bird, A. (2006). Philosophy of Science. Routledge. MacIntyre, Alasdair (1967) A Short History of Ethics. London. P. Chaddah, (2018) Ethics in Competitive Research: Do not get scooped; do not get plagiarized, ISBN:978-9387480865
- National Academy of Sciences, National Academy of Engineering and Institute of Medicine. (2009). On Being a Scientist: A Guide to Responsible Conduct in Research: Third Edition. National Academies Press.
- Resnik, D. B. (2011). What is ethics in research & why is it important. National Institute of Environmental Health Sciences, 1-10. Retrieved from https://www.niehs.nih.gov/research/resources/bioethics/whatis/index.cfm Beall, J. (2012). Predatory publishers are corrupting open access. Nature, 489(7415), 179-179.
- https://doi.org/10.1038/489179a Indian National Science Academy (INSA), Ethics in Science Education, Research and Governance (2019), ISBN:978-81-939482-1-7.
- http://www.insaindia.res.in/pdf/Ethics Book.pdf


**Evaluation/Assessment Methodology**

| | Max. Marks |
|---|---|
| 1) Class tasks/ Seasonal Examination | 5 |
| 2) Presentations /Seminar | |
| 3) Assignments | 5 |
| 4) Research Project Report | 5 |
| Seminar On Research Project Report | |
| 5) ESE | 35 |
| **Total:** | 50 |

Prerequisites for the course: Command over Hindi and English

**Course Learning Outcomes:** On completion of this course, research students will be able to:

- Explain the process of media research ethics.
- Conduct media research by making use of any of the research ethics.
- To gain a better understanding of the ethics in research
- To enable the student to analyze value of research ethics in conducting research in physical education.

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: I/ Semester: I**

| | |
|---|---|
| **Programme:** Ph.D. (Mathematics)<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>**Class:** Doctorate | Year: I<br><br>Semester: I |
| **Credits 2**<br>Theory: 2<br>Practical: | **Subject: Mathematics** |
| **Course Code:**<br>**PLR-111/121** | **Title: SEMINAR ON LITERATURE REVIEW** |
| **Course Objectives:** The main objective of this course is to undertake a thorough review of available literature on the topic selected by the research scholar | |
| **Nature of Paper:** Core | |
| **Minimum Passing Marks/Credits: 40% Marks** | |
| L: 2<br>T: 0<br>P: 0 (In Hours/Week)<br>Theory - = 2 Credit<br>Practical- = Credit (4Hrs./Week=4Credits) | |

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| **I** | The research scholar will review the important studies conducted at the national and international level either by individuals or organizations including government agencies and present the methodology adopted and important findings emerged from these studies. Based on this review of literature the researcher will identify the research gaps existing in the available literature and thus justifying the need for the present study. | **40** |
| **II** | The researcher is supposed to follow the pattern adopted in the standard national and international research journals. However, as an illustration the pattern for reporting review of literature is as under: | |
| **III** | The research scholar has to submit a draft copy of the review of literature duly recommended by his supervisor(s) to the concerned school of the university. The review of literature shall be evaluated by subject expert nominated by the Vice Chancellor who shall submit his assessment/recommendations to the university as to whether the review of literature be accepted or accepted with minor suggestions; referred to the scholar for submission in revised form; or cannot be accepted in the present form and to be resubmitted. If the subject expert recommends the revision or re-submission, the research scholar shall be required to submit the revised draft copy of the review of literature after incorporating the recommendations and suggestions through the research supervisor for the review of DRC whose decision shall be final for grading of the research scholar's performance in the literature review. | |

| Evaluation/Assessment Methodology | |
|---|---|
| | **Max. Marks** |
| 1) Class tasks/ Sessional Examination<br>2) Assignments<br>3) ESE | **50**<br>**0**<br>**0** |
| **Total:** | **50** |
| Prerequisites for the course: Post Graduations | |
| **Course Learning Outcomes:**<br>On completion of this course, research students will be able to learn about literature survey and its presentation skill through power point presentation. | |

**IIMTU-NEP IMPLEMENTATION**
**Year: I/ Semester: I**

<table>
<tr><td colspan="2">Programme: Ph.D. (Mathematics)<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>Class: Doctorate</td><td colspan="2">Year: I<br><br>Semester: I</td></tr>
<tr><td colspan="2">Credits 2<br>Theory: 2<br>Practical:</td><td colspan="2">Subject: Mathematics</td></tr>
<tr><td colspan="2">Course Code:<br>PCM-111/121</td><td colspan="2">Title: Instrumental tools and Methods</td></tr>
<tr><td colspan="4">Course Objectives:<br>1. Understand and apply concepts related to errors in computations, including floating-point representation, significant digits, rounding, and chopping of numbers.<br>2. Solve linear equations using numerical methods, understanding their stability and convergence.<br>3. Interpret and analyze solutions obtained from iterative techniques.</td></tr>
<tr><td colspan="4">Nature of Paper: Core</td></tr>
<tr><td colspan="4">Minimum Passing Marks/Credits: 40% Marks</td></tr>
<tr><td colspan="4">L: 2<br>T: 0<br>P: 0 (In Hours/Week)<br>Theory - = 2 Credit<br>Practical- = Credit (Hrs./Week=Credits)</td></tr>
<tr><td>Unit</td><td colspan="2">Contents</td><td>No. of Lectures Allotted</td></tr>
<tr><td>I</td><td colspan="2">Errors in computation- Floating point representation of numbers, Significant digits, Rounding and chopping a number and error due to these absolute and relative errors, Computation of errors using differentials, Errors in evaluation of some standard functions, Truncation error. Linear equations, Nonlinear Equations-Iterative method, multiple roots, Interpolation-Some operators and their properties, Finite difference table, Error in approximating a function by polynomial, Numerical differentiation and integration, Ordinary differential equations- Initial and boundary value problems, use of software MATLAB, SCILAB, etc</td><td>40</td></tr>
<tr><td colspan="4">Reference / Text Books:<br>1. Radhey S. Gupta, Elements of Numerical Analysis, Macmillan India Ltd. New Delhi (2009).<br>2. M.K. Jain, S.R.K. Iyengar, R.K. Jain, Numerical Methods for Scientific and Engineering Computations, New Age International (P) Ltd. New Delhi (2003).<br>3. James B. Scarborough, Numerical Mathematical Analysis, , Oxford- IBH, India<br>4. Brian Bradie, A Friendly Introduction to Numerical Analysis, Pearson Education, India, 2007.</td></tr>
</table>

| Evaluation/Assessment Methodology | |
|---|---|
| | **Max. Marks** |
| 1) Class tasks/ Sessional Examination<br>2) Assignments<br>3) ESE | **10**<br>**5**<br>**35** |
| **Total:** | 50 |
| Prerequisites for the course: Post Graduations | |

**Course Learning Outcomes:** On completion of this course, research students will be able to:

1) Identify errors in the evaluation of standard functions and quantify their impact.
2) Analyze the stability, convergence, and accuracy of the solutions obtained.
3) Apply techniques to large systems of linear equations using computational tools.
4) Utilize software tools like MATLAB, SCILAB, etc., to solve and visualize ODE solutions.
5) Apply interpolation methods to approximate values between data points.
6) Formulate and solve initial value problems (IVPs) and boundary value problems (BVPs) using numerical techniques.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: I/ Semester: I**

<table>
<tr><td colspan="2">Programme: Ph.D. (Mathematics)<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>Class: Doctorate</td><td colspan="2">Year: I<br><br>Semester: I</td></tr>
<tr><td>Credits 4<br>Theory: 4<br>Practical:</td><td colspan="3">Subject: Mathematics</td></tr>
<tr><td>Course Code:<br>PCM-111/122</td><td colspan="3">Title: Partial Differential Equations: Theory and Numeric</td></tr>
<tr><td colspan="4">Course Objectives:<br>1. To recognize the interdisciplinary nature of PDEs and their applications across different fields.<br>2. To collaborate with students from diverse backgrounds to solve problems and discuss applications.<br>3. To develop theoretical understanding and practical skills related to solving and analyzing partial differential equations.</td></tr>
<tr><td colspan="4">Nature of Paper: Elective-2</td></tr>
<tr><td colspan="4">Minimum Passing Marks/Credits: 40% Marks</td></tr>
<tr><td colspan="4">L: 4<br>T: 0<br>P: 0 (In Hours/Week)<br>Theory - = 2 Credit<br>Practical- = Credit (Hrs./Week=Credits)</td></tr>
</table>

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | **Scientific Research:** meaning and characteristics of scientific research, validity in research, phases/stages in research; types of research- qualitative, quantitative, exponential, exploratory, empirical, descriptive, ex-post facto, case studies, historical studies, philosophical studies, quasi-experimental; ethical problems in research; Review of literature- purpose of the review, sources of the review, preparation of index card for reviewing and abstracting. | **40** |
| II | **Problem Identification and Hypothesis Formation:** problem- meaning and characteristics of a problem, types of problem, generality and specific of problem; hypothesis- meaning and characteristics of a good hypothesis, types of hypotheses, formulating a hypothesis, ways of stating a hypothesis; testing experimental hypothesis- standard error, test of significance, level of significance, degrees of freedom, errors in hypothesis- type I, type II errors. | |
| III | **Sampling and Research Design:** meaning and types of sampling; methods of drawing samples, requisites of a good sampling method, sample size, sampling error; meaning and purpose of research design, criteria of a good research design, basic principles of experimental design. | |
| IV | **Data Collection, Processing and Analysis:** methods of data collection – primary data, secondary data; primary data collection – observation method, interview method, questionnaires, schedules, guideline for constructing questionnaires/schedules, secondary data collection of, selection of appropriate method of data collection; coding, editing and tabulation of data, charts and | |

| | | |
|---|---|---|
| V | diagrams used in data analysis, bar and pie diagrams and their significance; measures of central tendency, measures of dispersion; correlation and regression analysis - meaning and uses, methods of calculation of coefficients and their analysis and implication. sampling distribution, sampling schemes and sample sizes, confidence interval for the mean, t-statistic, z-statistic, confidence interval for the population variances, hypothesis testing, test of hypothesis for the population mean, population variance and ratio of two population variances; applications of z-test, t-test, f-test and chi-square test, association of attributes and techniques of testing, ANOVA.<br>**Report Writing:** meaning and significance of report writing, types of report, steps in writing report, layout of the research report, precaution in writing research report, developing thesis report, formatting, inside citations, references and bibliography, knowledge of computer, statistical software and their application. | |

**Reference / Text Books:**

1. Research Methodology: Methods & Techniques by C.R. Kothari, New Age International Publishers.
2. Statistical Methods for Research Workers by Fisher R.A., Cosmo Publications, New Delhi.
3. Design and Analysis of Experiments by Montgomery D.C. (2001), John Wiley.
4. Research Methodology: A step by step for beginners by Ramjet Kumar, Sage Publication.
5. Mathematical Economics by R.G.D. Allen.
   Mathematics for Economics by Mehta & Madanami.

**Evaluation/Assessment Methodology**

| | Max. Marks |
|---|---|
| 1) Class tasks/ Sessional Examination | **20** |
| 2) Assignments | **10** |
| 3) ESE | **70** |
| **Total:** | 100 |

Prerequisites for the course: Post Graduations

**Course Learning Outcomes:** On completion of this course, research students will be able to:

1) Gain a deep understanding of the maximum principles for second-order linear parabolic, elliptic, and hyperbolic partial differential equations.
2) Understand the concept of weak solutions, their importance in various mathematical and physical contexts, and their connection to classical solutions.
3) Explore the Lax-Milgram theorem and its significance in establishing the existence, uniqueness, and regularity of solutions for second-order linear parabolic, elliptic, and hyperbolic PDEs.
4) Develop skills in analyzing the dispersion and dissipation properties of partial differential equations and their finite difference schemes.
5) Learn strategies to handle and analyze solutions that exhibit jumps or discontinuities, and explore their implications in various applications. Acquire proficiency in designing and implementing finite difference schemes for systems of parabolic and hyperbolic PDEs.

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: I/ Semester: I**

| | |
|---|---|
| **Programme:** Ph.D. (Mathematics)<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>**Class:** Doctorate | Year: I<br><br>Semester: I |
| **Credits 4**<br>Theory: 4<br>Practical: | **Subject: Mathematics** |
| **Course Code:**<br>**PCM-113/123** | **Title: Inventory and Production Management** |

**Course Objectives:**
1. To understanding Deterministic Inventory Models
2. To mastering Deteriorating Items and Stock Dependent Demand
3. To study specialized inventory control scenarios, such as joint replenishment policies and inventory control under inflationary conditions.

**Nature of Paper: Elective-3**

**Minimum Passing Marks/Credits: 40% Marks**

L: 4
T: 0
P: 0 (In Hours/Week)
Theory - = 2 Credit
Practical- = Credit (Hrs./Week=Credits)

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| **I** | Deterministic Inventory Lot-Size Models with Time proportional demand, Deterministic Joint replenishment policy, Inventory Control of deteriorating Items (discrete and continuous), Inventory Control under Inflationary Conditions, Inventory models with stock dependent demand, Interaction of Inventory and trade credit policies, Impact of marketing policies on Inventory decisions, Joint buyer-seller inventory model. The Distribution free newsboy problem and its extensions. Aggregate Production Planning: Fixed and Variable Work Force Model, Inventory Location Model, Production Planning with Time Varying Demand. | **40** |

**Reference / Text Books:**

1. Walters, C.D.J., 2003, Inventory Control & Management, John Wiley. & Sons.
2. Heizer, J. and Render. 2001, Principles of Operations Management, Prentice Hall.
3. Zipkin, P.H., 2000, Foundations of Inventory Management, McGraw-Hill.
2. Bernard, P. 1999. Integrated inventory management (Vol. 9). Wiley.
3. Silver, E., Pyke, D., and Peterson, R. 1998. Inventory Management and Production Planning and Scheduling, John Wiley and Sons, New York.
4. Tony Wild, 1998, Best Practice in Inventory Management, John Wiley & Sons.
5. Bedworth, D. D., & Bailey, J. E. 1999. Integrated production control systems: management, analysis, design. John Wiley & Sons, Inc.
6. Plossl, G. W., 1985, Production and Inventory Control: Principles, and Techniques, Prentice Hall.
7. Relevant research paper

| **Evaluation/Assessment Methodology** | |
|---|---|
| | **Max. Marks** |
| 1) Class tasks/ Sessional Examination<br>2) Assignments<br>3) ESE | **20**<br>**10**<br>**70** |
| **Total:** | 100 |
| Prerequisites for the course: Post Graduations | |

**Course Learning Outcomes:** On completion of this course, research students will be able to:

1) Develop a comprehensive understanding of deterministic inventory lot-size models with time-proportional demand. Study how these models help in optimizing order quantities, minimizing costs, and ensuring efficient inventory management.
2) Gain expertise in inventory control techniques for deteriorating items, both in discrete and continuous settings.
3) Investigate the interaction of inventory management with trade credit policies and marketing decisions.
4) Develop problem-solving skills by delving into joint buyer-seller inventory models.
5) Learn about aggregate production planning models, including fixed and variable workforce models, inventory location models, and production planning with time-varying demand.\
   Explore how inventory models integrate production and inventory decisions to achieve efficient production schedules and meet demand fluctuations.

**IIMTU-NEP IMPLEMENTATION**
**Year: I/ Semester: I**

<table>
<tr><td colspan="2">Programme: Ph.D. (Mathematics)<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>Class: Doctorate</td><td>Year: I<br><br>Semester: I</td></tr>
<tr><td>Credits 4<br>Theory: 4<br>Practical:</td><td colspan="2">Subject: Mathematics</td></tr>
<tr><td>Course Code:<br>PCM-114/124</td><td colspan="2">Title: Mathematical Programming</td></tr>
<tr><td colspan="3">Course Objectives:<br>1. To gain a solid understanding of generalized convexity concepts, focusing on invexity and its generalizations.<br>2. To master the concept of complementarity problems, with a focus on the Linear Complementarity Problem (LCP).<br>3. To formulate and analyze optimization problems involving convexity, invexity, complementarity, bi-level programming, and vector optimization.</td></tr>
<tr><td colspan="3">Nature of Paper: Elective-4</td></tr>
<tr><td colspan="3">Minimum Passing Marks/Credits: 40% Marks</td></tr>
<tr><td colspan="3">L: 4<br>T: 0<br>P: 0 (In Hours/Week)<br>Theory - = 2 Credit<br>Practical- = Credit (Hrs./Week=Credits)</td></tr>
<tr><td>Unit</td><td>Contents</td><td>No. of Lectures Allotted</td></tr>
<tr><td>I</td><td>Generalized Convexity: Invexity and its Generalization, Optimality and Duality under invexity. Complementarity Problem: Linear Complementarity Problem (LCP), Applications of LCP, Complementary Pivot Algorithm and Its variants, Vertical LCP, Horizontal LCP, Generalized Leontief input-output model as vertical LCP. Bi-Level Programming: Linear Bilevel Programming, Existence of Optimal Solutions, Optimality Conditions, Solution Algorithms. Vector Optimization: Pareto Optimality¸ Optimality Conditions, Solution Algorithms, Interactive Approaches, Goal Programming</td><td>40</td></tr>
<tr><td colspan="3">Reference / Text Books:<br>1. S. K. Mishra and G. Giorgi (2008), “Invexity and Optimization”, Nonconvex Optimization and Its Applications, Vol. 88, Springer-Verlag.<br>2. R. W. Cottle, J.-S. Pang and R. E. Stone (2009), “The Linear Complementarity Problem”, Classics in Applied Mathematics, SIAM Edition.<br>3. S. Dempe (2002), “Foundations of Bilevel Programming”, Nonconvex Optimization and Its Applications, Vol. 61, Kluwer Academic Publishers.<br>4. K. Miettinen (1998), “Nonlinear Multiobjective Optimization”, International Series in Operations Research & Management Science, Vol. 12, Springer.<br>5. Relevant Research Papers on the Selected Topics</td></tr>
</table>

| Evaluation/Assessment Methodology | |
|---|---|
| | **Max. Marks** |
| 1) Class tasks/ Sessional Examination<br>2) Assignments<br>3) ESE | **20**<br>**10**<br>**70** |
| **Total:** | 100 |
| Prerequisites for the course: Post Graduations | |

**Course Learning Outcomes:** On completion of this course, research students will be able to:

1) Explore the properties and implications of invex functions, and recognize their significance in optimization problems.
2) Develop the ability to formulate and analyze dual problems, recognizing their role in deriving efficient solutions.
3) Acquire the skills to model real-world situations as LCPs and apply complementary pivot algorithms and their variants to find solutions.
4) Understand how LCPs model practical scenarios and contribute to informed decision-making.
5) Create the theoretical foundations, existence of optimal solutions, and optimality conditions for bi-level problems.
6) Study vector optimization techniques, focusing on Pareto optimality. Learn how to handle multi-objective optimization problems and recognize the trade-offs between conflicting objectives.

**IIMTU-NEP IMPLEMENTATION**
**Year: I/ Semester: I**

<table>
<tr><td colspan="2">Programme: Ph.D. (Mathematics)<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>Class: Doctorate</td><td>Year: I<br><br>Semester: I</td></tr>
<tr><td>Credits 4<br>Theory: 4<br>Practical:</td><td colspan="2">Subject: Mathematics</td></tr>
<tr><td>Course Code:<br>PCM-115/125</td><td colspan="2">Title: Theory of Reliability</td></tr>
<tr><td colspan="3">Course Objectives:<br>1. To develop a solid understanding of the fundamental principles and concepts of reliability theory<br>2. To explore and apply various reliability analysis techniques, such as reliability block diagrams, fault trees, and event trees, to systematically assess and quantify the reliability of complex systems.<br>3. To acquire skills to design and optimize reliable systems by implementing redundancy strategies, selecting appropriate components, and making informed decisions about maintenance schedules to meet desired reliability targets.</td></tr>
<tr><td colspan="3">Nature of Paper: Elective-5</td></tr>
<tr><td colspan="3">Minimum Passing Marks/Credits: 40% Marks</td></tr>
<tr><td colspan="3">L: 4<br>T: 0<br>P: 0 (In Hours/Week)<br>Theory - = 2 Credit<br>Practical- = Credit (Hrs./Week=Credits)</td></tr>
</table>

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | Product Life Cycle, Reliability Planning and Specification. System Reliability and Optimization: System Structure Analysis: Coherent Structures, Structures represented by Paths and Cuts, Pivotal Decomposition, Modules of Coherent Structures, Exact System Reliability, Multistate Coherent Systems. Principles of Importance Measures: Reliability importance measures, Lifetime importance measures, Structure importance measures, State – Space Method for System Reliability Evaluation, Dependent Failures: Modeling of Dependent Failures, Associated Variables, Combinatorial Reliability Optimization: Combinatorial Reliability Optimization Problems of Series Structure and Non-Series Structure, Combinatorial Reliability Optimization with Multiple choice Constraints, Optimal Redundancy Problems. Reliability Testing: Life Testing Models, Burn-in tests, Bogey Testing. Maintenance Models: Random Point Processes in System Replacement, Time-Based System Replacement, System Replacement Based on Cost Limits, Maintenance Models with General Degree of Repair, Inspection of Systems. | 40 |

**Reference / Text Books:**

1. Kuo, W. and Zuo, M.J. (2003). Optimal Reliability Modeling-Principles and Applications. John Wiley & Sons, Inc.
2. Nakagawa, T. (2005). Maintenance Theory of Reliability. Springer Series in Reliability Engineering.
3. Pham, H. (2003). Handbook of Reliability Engineering. Springer-Verlag London Limited.
4. Ushakov, I. (2013). Optimal Resource Allocation. John Wiley & Sons, Inc.
5. Yang, G. (2007). Life Cycle Reliability Engineering. John Wiley & Sons, Inc.
6. Relevant Research Papers.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | **20** |
| 2) Assignments | **10** |
| 3) ESE | **70** |
| **Total:** | **100** |

Prerequisites for the course: Post Graduations

**Course Learning Outcomes:** On completion of this course, research students will be able to:

1) Describe fundamental reliability concepts such as failure rates, mean time between failures (MTBF), availability, and maintainability.
2) Understand the various probability distributions used to model component and system failures, such as exponential, Weibull, and normal distributions.
3) Apply appropriate mathematical methods to calculate the reliability of complex systems using component reliability data and system configurations.
4) Analyze the trade-offs between system reliability, cost, and performance, considering factors such as redundancy levels, maintenance strategies, and component quality.
5) Evaluate the effectiveness of different reliability improvement strategies, such as preventive maintenance, spare parts inventory management, and reliability-centered maintenance (RCM).
6) Design comprehensive reliability assurance plans for complex systems, integrating techniques such as reliability testing, accelerated life testing, and failure mode and effects analysis (FMEA)

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: I/ Semester: I**

| | |
|---|---|
| **Programme:** Ph.D. (Mathematics)<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>**Class:** Doctorate | Year: I<br><br>Semester: I |
| **Credits 4**<br>Theory: 4<br>Practical: | **Subject: Mathematics** |
| **Course Code:**<br>**PCM-116/126** | **Title: Software Reliability** |

**Course Objectives:**

1. To develop a clear understanding of the fundamental concepts of software reliability, including failure rates, fault tolerance, availability, and the impact of software defects on overall system performance.
2. To explore different models and metrics used to quantify and predict software reliability. Study probabilistic models, reliability growth models, and methods to estimate software reliability metrics based on historical data and testing results.
3. To acquire skills in identifying and addressing software faults and defects. Learn how to analyze error reports, diagnose software failures, and implement corrective measures to improve software reliability.

**Nature of Paper: Elective-6**

**Minimum Passing Marks/Credits: 40% Marks**

L: 4
T: 0
P: 0 (In Hours/Week)
Theory - = 2 Credit
Practical- = Credit (Hrs./Week=Credits)

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| **I** | Introduction to Software Reliability, Software Development Life Cycle, Software Testing (Verification & Validation), Error, failure and faults in Software, Difference between Hardware & Software Reliability Software Reliability Growth Models (SRGMs) based on NHPP, SRGMs with Error Generation/ Imperfect Debugging, Concept of Change Point, SRGMs using Stochastic Differential Equations, Unification scheme for SRGMs, Allocation and Control of Testing Effort Release Time Problems: When to Stop Testing Software under different criteria (cost, reliability, warranty, risk, safety), bi-criterion release policy Modelling Software Up-gradations, testing stop time for multi up-gradations Software Vulnerability Analysis: Problems with Definitions and Assumptions | **40** |

**Reference / Text Books:**

1. P. K Kapur, H Pham, A Gupta, P. C Jha (2011), "Software Reliability Assessment with OR Applications", Springer.
2. H. Pham (2000), "Software Reliability", Springer.
3. P. K Kapur, R. B Garg, S. Kumar (1999), "Contribution to Hardware and Software Reliability" World Scientific, London.
4. Y. K. Malaiya, P Sriman (1990), "Software Reliability Models", IEEE Computers Society Press.
5. Relevant Research Papers.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | **20** |
| 2) Assignments | **10** |
| 3) ESE | **70** |
| **Total:** | 100 |

Prerequisites for the course: Post Graduations

**Course Learning Outcomes:** On completion of this course, research students will be able to:

1) Define key terms related to software reliability, such as failure rates, fault tolerance, and availability, demonstrating a foundational understanding of the subject.
2) Describe different software testing techniques, including unit testing, integration testing, and system testing, and explain their roles in identifying and addressing software defects.
3) Apply software testing methods to practical scenarios, designing and executing test cases to identify and rectify software defects, thus contributing to the improvement of software reliability.
4) Analyze patterns of software failures, identifying common types of defects and their impact on software reliability, and recommend appropriate corrective actions.
5) Assess and evaluate software reliability metrics and models based on real-world data, critically analyzing the effectiveness of different approaches and their implications for software quality.
6) Design strategies to enhance software reliability, including fault tolerance mechanisms, error handling procedures, and software maintenance plans, demonstrating creativity and innovation in addressing reliability challenges.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: I/ Semester: I**

<table>
<tr><td colspan="2">Programme: Ph.D. (Mathematics)<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>Class: Doctorate</td><td colspan="2">Year: I<br><br>Semester: I</td></tr>
<tr><td colspan="2">Credits 4<br>Theory: 4<br>Practical:</td><td colspan="2">Subject: Mathematics</td></tr>
<tr><td colspan="2">Course Code: PCM-117/127</td><td colspan="2">Title: Network Optimization</td></tr>
<tr><td colspan="4">Course Objectives:<br>1. To understand the fundamental concepts of network optimization and their applications in real-world scenarios.<br>2. To analyze optimality and duality in minimum cost flow problems.<br>3. To comprehend the maximum flow problem and its significance in network optimization.<br>4. To understand the network simplex method and its use in solving network optimization problems.<br>5. To apply appropriate techniques to tackle nonlinear cost functions in network optimization.</td></tr>
<tr><td colspan="4">Nature of Paper: Elective-7</td></tr>
<tr><td colspan="4">Minimum Passing Marks/Credits: 40% Marks</td></tr>
<tr><td colspan="4">L: 4<br>T: 0<br>P: 0 (In Hours/Week)<br>Theory - = 2 Credit<br>Practical- = Credit (Hrs./Week=Credits)</td></tr>
<tr><td>Unit</td><td colspan="2">Contents</td><td>No. of Lectures Allotted</td></tr>
<tr><td>I</td><td colspan="2">Constrained Network Problems, Minimum Cost Flows- Optimality and Duality, Maximum Flow Problem, Network Simplex Method, Relaxation Methods for Network Flow Problems, MultiCommodity Network Flow, Minimum Concave Cost Network Flow Problems, Network Flow Problems with General Nonlinear Arc Costs, Decomposition Methods, Optimal Flow in a Network with Gains, Applications-Project Management; Facility Layout and Location Problems</td><td>40</td></tr>
<tr><td colspan="4">Reference / Text Books:<br>1. R. K. Ahuja, T. L. Magnanti and J. B. Orlin (1993), “Network Flows: Theory, Algorithms, and Applications”, Prentice Hall, Inc.<br>2. D. Jungnickel (2013), “Graphs, Networks and Algorithms”, Fourth Edition, Algorithms and Computation in Mathematics, Springer Heidelberg.<br>3. J. Lee (2004), “A First Course in Combinatorial Optimization”, Cambridge Texts in Applied Mathematics, Cambridge University Press.<br>4. C. H. Papadimitriou and K. Steiglitz (1998), “Combinatorial Optimization: Algorithms and Complexity”, Dover Publications Inc., N.Y.<br>5. Relevant Research Papers on the Selected Topics</td></tr>
</table>

| Evaluation/Assessment Methodology | |
|---|---|
| | **Max. Marks** |
| 1) Class tasks/ Sessional Examination<br>2) Assignments<br>3) ESE | **20**<br>**10**<br>**70** |
| **Total:** | 100 |
| Prerequisites for the course: Post Graduations | |

**Course Learning Outcomes:** On completion of this course, research students will be able to:

1) Formulate and model various constrained network problems as optimization challenges.
2) Solve minimum cost flow problems using network optimization techniques.
3) Apply algorithms to find maximum flows in networks.
4) Apply the network simplex method to solve complex network flow problems.
5) Explore relaxation techniques for solving network flow problems.
6) Model and solve network flow problems with concave arc costs.

# Evaluation Scheme

| Program: Ph.D. in Physics<br>Semester: ODD/EVEN | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **S.No.** | **Course Code** | **Course Name** | **Course Category** | **Periods** | | | **Marks** | | | | | **Credit** |
| | | | | | | | **Internal** | | | **External** | **Total** | |
| | | | | **L** | **T** | **P** | **CT** | **TA** | **Total** | | | |
| 1 | PRM-111/121 | Research Methodology | Core | 4 | 0 | 0 | 20 | 10 | 30 | 70 | 100 | 4 |
| 2 | PPC-111/121 | Study of different Properties of materials | Core | 2 | 0 | 0 | 10 | 5 | 15 | 35 | 50 | 2 |
| 3 | PRE-111/121 | Research & Publication Ethics | Core | 2 | 0 | 0 | 10 | 5 | 15 | 35 | 50 | 2 |
| 4 | PLR-111/121 | Seminar on Literature Review | Core | 2 | 0 | 0 | 50 | - | 50 | 0 | 50 | 2 |
| **Discipline Specific Elective Courses (Any One)** | | | | | | | | | | | | |
| 5 | PPH-111/121 | Soft Matter Physics | Elective-1 | 4 | 0 | 0 | 20 | 10 | 30 | 70 | 100 | 4 |
| 6 | PPH-112/122 | Nanoscience & Nanotechnology | Elective-2 | | | | | | | | | |
| | | **Total** | | **13** | **0** | **0** | | | | | **350** | **14** |

# Format-3

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: I / Semester: I**

| | | |
|---|---|---|
| **Programme:** Ph.D. (Physics)<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>**Class:** Doctorate | | Year: I<br><br>Semester: I |
| **Credits 4**<br>Theory: 4<br>Practical: | **Subject: Physics** | |
| **Course Code:**<br>**PRM- 111/121** | **Title: Research Methodology** | |
| **Course Objectives:** To familiarize the research scholar with the fundamentals of scientific research and to gain familiarity about various data collection tools and techniques, data analysis and interpretation along with the application of computer and statistical software in research. | | |
| **Nature of Paper:** Core | | |
| **Minimum Passing Marks/Credits: 40% Marks** | | |
| L: 4<br>T: 0<br>P: 0 (In Hours/Week)<br>Theory - 4 Hr. = 4 Credit<br>Practical- 0 Hrs.=0 Credit (0Hrs./Week=0Credits) | | |

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | **Scientific Research:** meaning and characteristics of scientific research, validity in research, phases/stages in research; types of research- qualitative, quantitative, exponential, exploratory, empirical, descriptive, ex-post facto, case studies, historical studies, philosophical studies, quasi-experimental; ethical problems in research; Review of literature- purpose of the review, sources of the review, preparation of index card for reviewing and abstracting. | 40 |
| II | **Problem Identification and Hypothesis Formation:** problem- meaning and characteristics of a problem, types of problem, generality and specific of problem; hypothesis- meaning and characteristics of a good hypothesis, types of hypotheses, formulating a hypothesis, ways of stating a hypothesis; testing experimental hypothesis- standard error, test of significance, level of significance, degrees of freedom, errors in hypothesis- type I, type II errors. | |
| III | **Sampling and Research Design:** meaning and types of sampling; methods of drawing samples, requisites of a good sampling method, sample size, sampling error; meaning and purpose of research design, criteria of a good research design, basic principles of experimental design. | |
| IV | **Data Collection, Processing and Analysis:** methods of data collection – primary data, secondary data; primary data collection – observation method, interview method, questionnaires, schedules, guideline for constructing questionnaires/schedules, secondary data collection of, selection of appropriate method of data collection; coding, editing and tabulation of data, charts and diagrams used in data analysis, bar and pie diagrams and their significance; measures of central tendency, measures of dispersion; correlation and regression analysis - meaning and uses, methods of calculation of coefficients | |

| | | |
|---|---|---|
| V | and their analysis and implication. sampling distribution, sampling schemes and sample sizes, confidence interval for the mean, t-statistic, z-statistic, confidence interval for the population variances, hypothesis testing, test of hypothesis for the population mean, population variance and ratio of two population variances; applications of z-test, t-test, f-test and chi-square test, association of attributes and techniques of testing, ANOVA.<br>**Report Writing:** meaning and significance of report writing, types of report, steps in writing report, layout of the research report, precaution in writing research report, developing thesis report, formatting, inside citations, references and bibliography, knowledge of computer, statistical software and their application. | |

**Reference / Text Books:**

1. Research Methodology: Methods & Techniques by C.R. Kothari, New Age International Publishers.
2. Statistical Methods for Research Workers by Fisher R.A., Cosmo Publications, New Delhi.
3. Design and Analysis of Experiments by Montgomery D.C. (2001), John Wiley.
4. Research Methodology: A step by step for beginners by Ramjet Kumar, Sage Publication.
5. Mathematical Economics by R.G.D. Allen.
6. Mathematics for Economics by Mehta & Madanami.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | 20 |
| 2) Assignments | 10 |
| 3) ESE | 70 |
| **Total:** | 100 |

Prerequisites for the course: Post Graduations

**Course Learning Outcomes:**

1. Understand the meaning, characteristics, and phases of scientific research, and recognize the ethical considerations associated with research practices.
2. Identify research problems, distinguish between general and specific problems, and formulate testable hypotheses. Evaluate and classify different types of hypotheses and recognize errors in hypothesis testing.
3. Comprehend various methods of sampling, assess their requisites, and determine appropriate sample sizes. Apply the principles of research design, including criteria for its effectiveness and the basics of experimental design.
4. Differentiate between primary and secondary data collection methods, and construct effective questionnaires and schedules. Process, code, edit, and tabulate data, and perform statistical analysis, including measures of central tendency, dispersion, correlation, regression, and hypothesis testing.
5. Recognize the significance of report writing, select appropriate report types, and follow the steps to create a well-structured research report. Apply proper formatting, citations, and references, and demonstrate proficiency in utilizing computer tools and statistical software for data analysis and report generation.
6. Apply the acquired knowledge and skills to practical research scenarios, demonstrating an ability to conduct methodologically sound research, analyze data, and communicate findings effectively through a comprehensive research report.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: I / Semester: I**

| | |
|---|---|
| **Programme:** Ph.D. (Physics)<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>**Class:** Doctorate | Year: I<br><br>Semester: I |
| **Credits: 02**<br>Theory: **02**<br>Practical: | **Subject: Physics** |
| **Course Code:**<br>PRE-111/121 | **Title:** Research and Publication Ethics |

**Course Objectives:**
On completion of the course research students should be able to:
- Define and explain the process of media research ethics.
- Conduct media research by making use of any of the research ethics.
- To gain a better understanding of the ethics in research
- To enable the student to analyze value of research ethics in conducting research in physical education.
- Demonstrate and apply basic principles of ethics to research movement and implementsused in various sports.

**Nature of Paper:** Core

**Minimum Passing Marks/Credits: 40% Marks**

L:2
T:0
P:0 (In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | **Philosophy and Ethics**<br>Introduction to Philosophy: Definition, Nature and Scope, Concept and Branches,<br>Ethics: Definition, Moral Philosophy Nature of Moral Judgments and Reactions | 8-12 |
| II | **Scientific Conduct**<br>Ethics With Respect to Science and Research Intellectual Honesty and Research Integrity.<br>Scientific Misconduct: Falsification, Fabrication, and Plagiarism Redundant Publication: Duplicate and Overlapping Publications Salami Slicing Selective Reporting and Misrepresentation Of Data. | 8-12 |
| III | **Publication Ethics**<br>Publication Ethics: Definition, Introduction and Importance.<br>Best Practices/ Standard Settings Initiatives and Guidelines: COPE, WAME Etc.<br>Publication Misconducts: Definitions, Concepts, Problem That Lead to Unethical Behavior and Vice-Versa Types.<br>Violation of Publication Ethics, Authorship and Contributions. Identification | 8-12 |

| | | |
|---|---|---|
| | of Publication Misconduct, Complaints and Appeals, Predatory Publishers and Journals. | |
| IV | **PRACTICE:**<br>**Open Access Publishing**<br>Open Access Publications and Initiatives, SHERPA/Romeo Online Resource to Check Publisher Copyright and Self-Archiving Policies. Software Tool to Identify Predatory Publications Developed by SPPU.<br>Journal Finder/Journal Suggestion Tools Viz. JANE, Elsevier Journal Finder and Springer Journal Suggested | 8-12 |
| V | **Publication Misconduct**<br>Group Discussion: Subject Special Ethical Issues, FFP, Authorship, Conflicts of Interest, Complain and Appeals: Examples of Fraud From India and Abroad. Software Tool: Use of Plagiarism Software<br>Like TRINITIN, URKAND and Other Open Source Software Tools | 8-12 |
| VI | **Database and Research Matrices**<br>Database: Indexing Databases, Citation Databases: Web of Science, Scopus Etc. Research Metrics: Impact Factor of Journal As Per Journal Citation Report, SNIP. SJR, IIP, Cite Score. Metrics: H-Index, G-Index, I10 Index, Altimetrics. | 8-12 |

**Reference / Text Books:**


- Bird, A. (2006). Philosophy of Science. Routledge. MacIntyre, Alasdair (1967) A Short History of Ethics. London. P. Chaddah, (2018) Ethics in Competitive Research: Do not get scooped; do not get plagiarized, ISBN:978-9387480865
- National Academy of Sciences, National Academy of Engineering and Institute of Medicine. (2009). On Being a Scientist: A Guide to Responsible Conduct in Research: Third Edition. National Academies Press.
- Resnik, D. B. (2011). What is ethics in research & why is it important. National Institute of Environmental Health Sciences, 1-10. Retrieved from https://www.niehs.nih.gov/research/resources/bioethics/whatis/index.cfm Beall, J. (2012). Predatory publishers are corrupting open access. Nature, 489(7415), 179-179.
- https://doi.org/10.1038/489179a Indian National Science Academy (INSA), Ethics in Science Education, Research and Governance (2019), ISBN:978-81-939482-1-7.
- http://www.insaindia.res.in/pdf/Ethics Book.pdf


**Evaluation/Assessment Methodology**

| | Max. Marks |
|---|---|
| 1) Class tasks/ Seasonal Examination | 5 |
| 2) Presentations /Seminar | |
| 3) Assignments | 5 |
| 4) Research Project Report | 5 |
| Seminar On Research Project Report | |
| 5) ESE | 35 |
| **Total:** | 50 |

Prerequisites for the course: Command over Hindi and English

**Course Learning Outcomes:** On completion of this course, research students will be able to:

- Explain the process of media research ethics.
- Conduct media research by making use of any of the research ethics.
- To gain a better understanding of the ethics in research
- To enable the student to analyze value of research ethics in conducting research in physical education.

**IIMTU-NEP IMPLEMENTATION**
**Year: I/ Semester: I**

<table>
<tr><td colspan="2">Programme: Ph.D. (Physics)<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>Class: Doctorate</td><td colspan="2">Year: I<br><br>Semester: I</td></tr>
<tr><td>Credits 2<br>Theory: 2<br>Practical:</td><td colspan="3">Subject: Physics</td></tr>
<tr><td>Course Code:<br>PLR-111/121</td><td colspan="3">Title: SEMINAR ON LITERATURE REVIEW</td></tr>
<tr><td colspan="4">Course Objectives: This course aims to equip research scholars with the skills and knowledge necessary for conducting a thorough literature review in alignment with the standards of national and international research journals. Through theoretical concepts and practical examples, students will learn how to critically analyze and synthesize existing studies, identify research gaps, and justify the significance of their own research. The course will guide scholars through the process of drafting and revising a comprehensive literature review while adhering to academic standards.</td></tr>
<tr><td colspan="4">Nature of Paper: Core</td></tr>
<tr><td colspan="4">Minimum Passing Marks/Credits: 40% Marks</td></tr>
<tr><td colspan="4">L: 2<br>T: 0<br>P: 0 (In Hours/Week)<br>Theory - = 2 Credit<br>Practical- = Credit (4Hrs./Week=4Credits)</td></tr>
<tr><td>Unit</td><td colspan="2">Contents</td><td>No. of Lectures Allotted</td></tr>
<tr><td>I<br><br><br><br><br><br>II<br><br><br>III</td><td colspan="2">The research scholar will review the important studies conducted at the national and international level either by individuals or organizations including government agencies and present the methodology adopted and important findings emerged from these studies. Based on this review of literature the researcher will identify the research gaps existing in the available literature and thus justifying the need for the present study.<br>The researcher is supposed to follow the pattern adopted in the standard national and international research journals. However, as an illustration the pattern for reporting review of literature is as under:<br>The research scholar has to submit a draft copy of the review of literature duly recommended by his supervisor(s) to the concerned school of the university. The review of literature shall be evaluated by subject expert nominated by the Vice Chancellor who shall submit his assessment/recommendations to the university as to whether the review of literature be accepted or accepted with minor suggestions; referred to the scholar for submission in revised form; or cannot be accepted in the present form and to be resubmitted. If the subject expert recommends the revision or re-submission, the research scholar shall be required to submit the revised draft copy of the review of literature after incorporating the recommendations and suggestions through the research supervisor for the review of DRC whose decision shall be final for grading of</td><td>40</td></tr>
</table>

| | | |
|---|---|---|
| | the research scholar's performance in the literature review. | |
| | **Scientific Research:** | 9 |

**Reference / Text Books:**

1. Doing a Literature Review: Releasing the Social Science Research Imagination"** by Christopher Hart
2. The Literature Review: Six Steps to Success"** by Lawrence A. Machi and Brenda T. McEvoy
3. Systematic Approaches to a Successful Literature Review"** by Andrew Booth, Anthea Sutton, and Diana Papaioannou
4. The Literature Review: A Step-by-Step Guide for Students"** by Diana Ridley
5. Writing Literature Reviews: A Guide for Students of the Social and Behavioral Sciences"** by Jose L. Galvan and Melisa C. Galvan

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | **50** |
| 2) Assignments | **0** |
| 3) ESE | **0** |
| **Total:** | **50** |

Prerequisites for the course: Post Graduations

**Course Learning Outcomes:**

1. Apply systematic methods to review and analyze relevant studies conducted at both national and international levels, considering contributions from individuals, organizations, and government agencies.
2. Assess and present the methodologies employed in reviewed studies, highlighting their strengths and weaknesses, and identifying common research approaches.
3. Summarize the important findings and outcomes from reviewed literature, emphasizing their significance and relevance to the research field.
4. Identify gaps in the existing literature through a comprehensive analysis, demonstrating a clear understanding of areas where further research is needed.
5. Draft a well-structured and academically rigorous literature review following the pattern adopted in standard national and international research journals.
6. Revise the literature review based on feedback and suggestions from subject experts and research supervisors, ensuring the incorporation of valuable insights and improvements.

Format-3

**IIMTU-NEP IMPLEMENTATION**
**Year: I/ Semester: I**

| | |
|---|---|
| **Programme:** Ph.D. (Physics)<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>**Class:** Doctorate | Year: I<br><br>Semester: I |
| **Credits 2**<br>Theory: 2<br>Practical: | **Subject: Physics** |
| **Course Code:**<br>**PPC-111/121** | **Title: Study of different Properties of materials** |
| **Course Objectives:** This course aims to provide students with a comprehensive understanding of electromagnetism and its modern applications. Through theoretical concepts and practical examples, students will explore the principles of magnetostatics, fields in matter, bonding in crystals, quantum states of electrons, atomic spectra, and laser technology. The course also introduces X-ray and photo electronic spectroscopy techniques, enabling students to analyze materials at the atomic and molecular levels. | |
| **Nature of Paper:** Core | |
| **Minimum Passing Marks/Credits: 40% Marks** | |
| L: 2<br>T: 0<br>P: 0 (In Hours/Week)<br>Theory - = 2 Credit<br>Practical- = Credit (Hrs./Week=Credits) | |

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | **MAGNETOSTATICS AND FIELDS IN MATTER**<br>The divergence and curl of B, Ampere's law, Magnetic vector potential, Boundary conditions and multipole Expansion, Magnetisation-Dia, para and ferromagnets, Effect of Magnetic field in atomic orbits, Bound currents and their interpretation, Magnetic field inside matter, Ampere's law in magnetised materials, Linear and nonlinear media. | 40 |
| II | Ionic bonding, Evaluation of Madelung constant, covalent crystals, Exchange energy calculation, Molecular bonding and Vander-Waals interaction. Point defects, Line defects and planer faults, The role of dislocations in plastic deformation and crystal growth, X-ray and electron microscopy techniques for observation of imperfections in crystals. | |
| III | Quantum states of an electron atoms, Atomic orbitals, Pauli's principle, Different series in alkali spectra, Term values and quantum defect, Ritz combination principle, Penetrating and non-penetrating orbits, Spin orbit interaction, Spectra of alkali and alkaline elements, Energy state of helium atom, Spectra of helium and mercury, Characteristics of X-ray spectra, Fine structure of X-ray levels, Spin relativity doublets, Flourescence yield and Auger effect. | |
| IV | Spontaneous and stimulated emission, Temporal and spatial coherences, Pumping process, Types of Laser: Solid state Laser (Ruby), Gas Lasers | |

| | | |
|---|---|---|
| V | (Helium-Neon and Carbon dioxide) and Semiconductor laser (Ga- As), Population inversion, Properties of Laser beams, Laser Applications: Distance measurement, Laser interferometery, Holography.<br>Introduction of X-ray and photo electronic spectroscopy, Principles, basic instrumentation and applications of DSC (differential scanning calorimetry) and XRD (X-ray diffraction). | |
| | **Scientific Research:** | 9 |

**Reference / Text Books:**

1. Solid state physics – SO Pilai
2. Introduction to Electrodynamics - Griffith D.J
3. Classical Electrodynamics -Bittencourt
4. Electricity & Magnetism - A. Kip, McGraw Hill
5. Laser spectroscopy & Instrumentation – Demtroder
6. Lasers- B.B. Laud
7. Principles of Lasers- O. Svelto
8. Laser Applications - Sirohi

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | **10** |
| 2) Assignments | **5** |
| 3) ESE | **35** |
| **Total:** | 50 |

Prerequisites for the course: Post Graduations

**Course Learning Outcomes:**

1. Apply Ampere's law, understand the divergence and curl of magnetic fields, and compute the magnetic vector potential. Analyze boundary conditions, multipole expansion, and the behavior of magnetic fields inside different materials.
2. Explain ionic and covalent bonding, evaluate Madelung constants, and analyze molecular bonding. Describe different types of crystal defects, including point defects, line defects, and planar faults, and understand their role in plastic deformation and crystal growth.
3. Describe atomic orbitals, Pauli's principle, and quantum states of electrons in atoms. Interpret alkali spectra, term values, and quantum defects. Explore spin-orbit interactions and their impact on atomic spectra.
4. Differentiate between spontaneous and stimulated emission, explain population inversion, and analyze the pumping process. Identify various types of lasers, such as solid-state, gas, and semiconductor lasers, and discuss their properties and applications.
5. Understand the principles and applications of X-ray and photo electronic spectroscopy. Explore the basics of differential scanning calorimetry (DSC) and X-ray diffraction (XRD) techniques for material analysis.
6. 6.Apply the knowledge gained to real-world scenarios, such as distance measurement, laser interferometry, and holography, showcasing the practical significance of electromagnetism and modern physics concepts.

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: I/ Semester: I**

| | |
|---|---|
| **Programme:** Ph.D. (Physics)<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>**Class:** Doctorate | Year: I<br><br>Semester: I |
| **Credits 4**<br>Theory: 4<br>Practical: | **Subject: Physics** |
| **Course Code:**<br>**PPH-111/121** | **Title: Soft Matter Physics** |
| **Course Objectives:** This course aims to provide students with a comprehensive understanding of liquid crystals and their applications, along with an introduction to the characterization techniques used to study these materials. Through theoretical concepts and practical examples, students will explore the diverse phases, properties, and behaviors of liquid crystals, including their response to electric and magnetic fields. Additionally, the course will cover the alignment techniques crucial for liquid crystal displays and devices, as well as the incorporation of nanomaterials for enhanced functionality. | |
| **Nature of Paper: Elective-1** | |
| **Minimum Passing Marks/Credits: 40% Marks** | |
| L: 4<br>T: 0<br>P: 0 (In Hours/Week)<br>Theory - = 4 Credit<br>Practical- = Credit (Hrs./Week=Credits) | |

| Unit | Contents | No. of Lectures Allotted |
|---|---|---|
| I | **Introduction**: Historical overview of liquid crystals, Different types of liquid crystals; Symmetry, textures, classification of liquid crystals, Different phases of liquid crystals, Parameters determining liquid crystalline structure. Electric and Magnetic field effects on liquid crystals, Liquid crystal alignments for displays, Different techniques for liquid crystal alignments, Applications of nano materials for liquid crystal display and devices. | **40** |
| II | **Properties**: Morphological properties of different types of liquid crystals like nematic smectic and cholesteric liquid crystal, Electrical and dielectric properties of liquid crystal, Chiral liquid crystals, Ferroelectric liquid crystals, Electro-optic and magneto-optic effect of liquid crystals, display and memory devices, and surface anchoring properties of liquid crystals. | |
| III | **Characterization Techniques**: Introduction to Polarized Optical Microscopy (POM), Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Atomic Force Microscopy (AFM), X-Ray Diffraction (XRD), Differential scanning Calorimetry (DSC) and their principle, construction, working, and applications. | |

**Reference / Text Books:**

1. Dielectric properties amd molecular behavior by N.E.-Hill and W.E. Vughan, Van Nostrand Londan.
2. Molecular structures and properties of liquid crystals by G.W. Gray, Academic press, New York.
3. Molecular crystals and liquis crystals by Virendra Bhadur, Gordon and Breach Science Publishers New York.
4. Liquid crystal displayed by Ernst Lueder John Willey & sons Ltd, New York.
5. The physics of liquid crystal II edition by De Gennes & J. Prost Oxford Press.

**Evaluation/Assessment Methodology**

| | **Max. Marks** |
|---|---|
| 1) Class tasks/ Sessional Examination | **20** |
| 2) Assignments | **10** |
| 3) ESE | **70** |
| **Total:** | 100 |

Prerequisites for the course: Post Graduations

**Course Learning Outcomes:**

1. Trace the historical evolution of liquid crystals and describe their significance in modern technology.
2. Classify and explain the different types of liquid crystals, recognize their symmetries, textures, and phases, and determine the parameters that influence their liquid crystalline structure.
3. Analyze the effects of electric and magnetic fields on liquid crystals and predict their responses in various configurations.
4. Assess and compare different techniques for aligning liquid crystals in displays, devices, and applications, while understanding the importance of surface anchoring properties.
5. Discuss and evaluate the applications of nano materials in liquid crystal displays and devices, exploring the ways in which nanomaterials enhance their properties and performance.
6. Demonstrate an understanding of advanced characterization techniques, including POM, SEM, TEM, AFM, XRD, and DSC, by explaining their principles, operation, and applications in studying liquid crystals and nanostructured materials.

**Format-3**

**IIMTU-NEP IMPLEMENTATION**
**Year: I/ Semester: I**

<table>
<tr><td colspan="2">Programme: Ph.D. (Physics)<br>Certificate/Diploma/Degree/<br>UG(R)/PG/Ph.D.<br>Class: Doctorate</td><td colspan="2">Year: I<br><br>Semester: I</td></tr>
<tr><td colspan="2">Credits 4<br>Theory: 4<br>Practical:</td><td colspan="2">Subject: Physics</td></tr>
<tr><td colspan="2">Course Code:<br>PPH-112/122</td><td colspan="2">Title: Nano science & Nano technology<br>Practical</td></tr>
<tr><td colspan="4">Course Objectives:<br>This course aims to provide students with a comprehensive understanding of nano materials, their synthesis, properties, and applications. Students will explore various nanostructures, including one-dimensional, two-dimensional, and three-dimensional materials, focusing on their unique properties and diverse applications in fields such as electronics, catalysis, biomedicine, and environmental science. Through theoretical concepts and practical techniques, students will gain insights into the world of nanotechnology and its impact on modern science and technology.</td></tr>
<tr><td colspan="4">Nature of Paper: Elective-2</td></tr>
<tr><td colspan="4">Minimum Passing Marks/Credits: 40% Marks</td></tr>
<tr><td colspan="4">L: 4<br>T: 0<br>P: 0 (In Hours/Week)<br>Theory - = 4 Credit<br>Practical- = Credit (Hrs./Week=Credits)</td></tr>
<tr><td>Unit</td><td colspan="2">Contents</td><td>No. of Lectures Allotted</td></tr>
<tr><td>I<br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br>II</td><td colspan="2">Nanomaterials-I:<br>Definition, Types of nanostructures, Properties and Applications: One dimensional, Two dimensional and Three dimensional nanostructured materials, Quantum Dots shell structures, metal oxides, semiconductors, composites, mechanical-physical-chemical properties, application as ferroelectric materials, coating, molecular electronics and nanoelectronics, biological and environmental, membrane based application, polymer based application, nan-catalysis, basic principle. Synthesis and preparation of Nanomaterials and<br>Synthetic Techniques: Synthesis of bulk nanostructured materials - Sol Gel processing- bulk and nano composite materials - Grinding - high energy ball milling – injection moulding - extrusion - melt quenching and annealing, Self assembly-Self Assembled Monolayers (SAM) - Vapour Liquid Solid (VLS) approach - Chemical Vapour Deposition (CVD) - Langmuir- Blodgett (LB) films - Spin coating - Template self-assembly Electrochemical approaches: Thin films -Epitaxy -Lithography.<br>Nanomaterials-II:<br>Carbon nanostructures: Synthesis, separation and characterization of Fullerene</td><td>40</td></tr>
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|---|---|---|
| | and its derivatives, applications, toxicity. Carbon nanotube (CNT), structure, synthesis and functionalization of CNT, electronic, vibrational, mechanical and optical properties of CNT, applications. Graphene, structure, synthesis and functionalization of Graphene, Graphene composites, electronic applications of Graphene, Graphene Oxide. The environmental effects of carbon based nanomaterials. Nanosensors: Introduction to sensors. Characteristics and terminology - static and dynamic characteristics. Micro and nano-sensors, Fundamentals of sensors, micro fluids, Packaging and characterization of sensors, Sensors for aerospace and defense, Organic and inorganic nanosensors, Biosensors: Magnetic Nanoparticles for Imaging and Therapy, Clinical diagnostics, generation of biosensors, Nanomaterial based biosensors, Biosensors based on nucleotides and DNA, Electron transfer of biomolecules, Photodetectors, Nanophotonics, Nanoelectronic Devices, Biosensors | |

**Reference / Text Books:**

1. Chemistry of nanomaterials: Synthesis, properties and applications - CNR Rao et.al.
2. Nanoparticles: From theory to applications, Wiley Weinheim, 2004 - G. Schmidt.
3. Processing & properties of structural naonmaterials - Leon L. Shaw
4. Environmental Chemistry for a Sustainable World, Volume 1: Nanotechnology and Health Risk Editors: Lichtfouse, Schwarz Bauer, Robert
5. Advances in Nanotechnology and the Environment, CRC Press, Taylor and Francis Group- Juyoung Kim
6. Chemical Sensors and Biosensors, Wiley; New York, Chichester, 2002 - Brian R Eggins.
7. Biosensors: A Practical Approach, Oxford University Press, 2004 - J. Cooper & C. Tass,
8. Nanomaterials for Biosensors, Wiley - VCH, 2007 - Cs. Kumar
9. Nanostructures and Nanomaterials: Synthesis, properties and applications, Imperial College Press, 2004 - G.Cao
10. Handbook of Nanoscience, Engg. and Technology, CRC Press, 2002 - W. Gaddand, D. Brenner, S. Lysherski and G. J. Infrate (Eds)
11. Carbon Nanotubes: Properties and Applications- Michael J. O'Connell
12. Nanotubes and Nanowires, RCS Publishing - CNR Rao and A Govindaraj
13. Nanoscale materials -Liz Marzan and Kamat
14. Carbon Nanomaterials for Environmental and Biological Applications, Bergmann and Machado. Springe.

**Evaluation/Assessment Methodology**

| | |
|---|---|
| | **Max. Marks** |
| 1) Class tasks/ Sessional Examination | **20** |
| 2) Assignments | **10** |
| 3) ESE | **70** |
| **Total:** | 100 |

Prerequisites for the course: Post Graduations

**Course Learning Outcomes:**

- Classify and differentiate between various types of nanostructures, including one-dimensional, two-dimensional, and three-dimensional materials, as well as carbon-based nanostructures like graphene and carbon nanotubes.
- Analyze the mechanical, physical, and chemical properties of nanomaterials, and relate these properties to their unique structures at the nanoscale.
- Understand and apply different synthetic techniques, such as sol-gel processing, high-energy ball milling, chemical vapor deposition, and self-assembly, to prepare nanomaterials with specific properties.

- Evaluate the diverse applications of nanomaterials, including their use in ferroelectric materials, electronics, catalysis, biosensors, and environmental applications.
- Describe the synthesis, functionalization, and characterization of carbon nanostructures like carbon nanotubes and graphene, and assess their electronic, mechanical, and optical properties.
- Design and discuss the principles of nano sensors, including their applications in microfluidics, biosensing, and nanoelectronics, with a focus on their contributions to fields such as clinical diagnostics and environmental monitoring.