**1.1.3 Courses having focus on employability/ entrepreneurship/ skill development offered by the University during the year**

| Color Index | |
|---|---|
| Employability | Yellow |
| Entrepreneurship | Green |
| Skill Development | Pink |

# LINGAYA'S VIDYAPEETH

## SCHEME OF STUDIES

## SESSION: 2021-24

| School: School of Basic and Applied Sciences | Batch: 2021-2024 |
|---|---|
| Department: Physics | Year: 1st |
| Course: B.Sc. Hons. Physics | Semester: 1st |

| SN | Cate-gory | Course Code | Course Name | Periods | | | Credits | Evaluation Scheme | | | | | Subject Total Marks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Theory | | | Practical | | |
| | | | | L | T | P | | ABQ | MSE | ESE | IP | EXP | |
| 1 | PCC | BS-101 | Electricity and Magnetism | 3 | 1 | 0 | 4 | 15 | 25 | 60 | - | - | 100 |
| 2 | PEC | BS-103 | Algebra | 3 | 1 | 0 | 4 | 15 | 25 | 60 | - | - | 100 |
| 3 | PEC | BS-105 | Inorganic Chemistry | 3 | 1 | 0 | 4 | 15 | 25 | 60 | - | - | 100 |
| 4 | PEC | BS-151 | Physics Laboratory-I | 0 | 0 | 3 | 2 | | | | 40 | 60 | 100 |
| 5 | PEC | BS-155 | Chemistry Laboratory-I | 0 | 0 | 3 | 2 | | | | 40 | 60 | 100 |
| 6 | PDP | HSS-107 | English and Communication Skills | 2 | 0 | 0 | 2 | 15 | 25 | 60 | - | - | 100 |
| | | | **Total---->** | **11** | **3** | **6** | **18** | **60** | **100** | **240** | **80** | **120** | **600** |

| School: School of Basic and Applied Sciences | Batch: 2021-2024 |
|---|---|
| Department: Physics | Year: 1st |
| Course: B.Sc. Hons. Physics | Semester: 2nd |

| SN | Cate-gory | Course Code | Course Name | Periods | | | Credits | Evaluation Scheme | | | | | Subject Total Marks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Theory | | | Practical | | |
| | | | | L | T | P | | ABQ | MSE | ESE | IP | EXP | |
| 1 | PCC | BS-102 | Statistical Physics | 3 | 1 | 0 | 4 | 15 | 25 | 60 | - | - | 100 |
| 2 | PEC | BS-104 | Calculus | 3 | 1 | 0 | 4 | 15 | 25 | 60 | - | - | 100 |
| 3 | PEC | BS-106 | Organic Chemistry-I | 3 | 1 | 0 | 4 | 15 | 25 | 60 | - | - | 100 |
| 4 | PCC | BS-152 | Physics Laboratory-II | 0 | 0 | 3 | 2 | | | | 40 | 60 | 100 |
| 5 | PEC | BS-156 | Chemistry Laboratory-II | 0 | 0 | 3 | 2 | | | | 40 | 60 | 100 |
| 6 | PDP | CE-108 | Environmental Science & Ecology | 2 | 0 | 0 | 2 | 15 | 25 | 60 | - | - | 100 |
| | | | **Total---->** | **11** | **3** | **6** | **18** | **60** | **100** | **240** | **80** | **120** | **600** |

| School: School of Basic and Applied Sciences | | | | | | | | | | | | | Batch: 2021-2024 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Department: Physics | | | | | | | | | | | | | Year: 2nd | | | | | | |
| Course: B.Sc. Hons. Physics | | | | | | | | | | | | | Semester: 3rd | | | | | | |

| SN | Cate-gory | Course Code | Course Name | Periods | | | Credits | Evaluation Scheme | | | | | Subject Total Marks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Theory | | | Practical | | |
| | | | | L | T | P | | ABQ | MSE | ESE | IP | EXP | |
| 1 | PCC | BPH-201 | Vibration and Waves | 3 | 1 | 0 | 4 | 15 | 25 | 60 | - | - | 100 |
| 2 | PCC | BPH-203 | Optical Physics | 3 | 1 | 0 | 4 | 15 | 25 | 60 | - | - | 100 |
| 3 | PCC | BPH-205 | Quantum Physics | 3 | 1 | 0 | 4 | 15 | 25 | 60 | - | - | 100 |
| 4 | PCC | BPH-207 | Atomic & Molecular Physics | 3 | 1 | 0 | 4 | 15 | 25 | 60 | - | - | 100 |
| 5 | PCC | BPH-209 | Mathematical Physics-I | 3 | 1 | 0 | 4 | 15 | 25 | 60 | - | - | 100 |
| 6 | PCC | BPH-251 | Physics Laboratory-III | 0 | 0 | 3 | 2 | | | | 40 | 60 | 100 |
| | | | Total----> | 15 | 5 | 3 | 22 | 75 | 125 | 300 | 40 | 60 | 600 |

| School: School of Basic and Applied Sciences | | | | | | | | | | | | | Batch: 2021-2024 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Department: Physics | | | | | | | | | | | | | Year: 2nd | | | | | | |
| Course: B.Sc. Hons. Physics | | | | | | | | | | | | | Semester: 4th | | | | | | |

| SN | Cate-gory | Course Code | Course Name | Periods | | | Credits | Evaluation Scheme | | | | | Subject Total Marks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Theory | | | Practical | | |
| | | | | L | T | P | | ABQ | MSE | ESE | IP | EXP | |
| 1 | PCC | BPH-202 | Mathematical Physics-II | 3 | 1 | 0 | 4 | 15 | 25 | 60 | - | - | 100 |
| 2 | PCC | BPH-204 | Nuclear Physics | 3 | 1 | 0 | 4 | 15 | 25 | 60 | - | - | 100 |
| 3 | PCC | BPH-206 | Solid State Physics | 3 | 1 | 0 | 4 | 15 | 25 | 60 | - | - | 100 |
| 4 | PCC | BPH-208 | Electronics | 3 | 1 | 0 | 4 | 15 | 25 | 60 | - | - | 100 |
| 5 | PCC | BPH-210 | Thermodynamics | 3 | 1 | 0 | 4 | 15 | 25 | 60 | - | - | 100 |
| 6 | PCC | BPH-212 | Classical Mechanics | 3 | 1 | 0 | 4 | 15 | 25 | 60 | - | - | 100 |
| 7 | PCC | BPH-252 | Physics Laboratory-IV | 0 | 0 | 3 | 2 | | | | 40 | 60 | 100 |
| | | | Total----> | 18 | 6 | 3 | 26 | 90 | 150 | 360 | 40 | 60 | 700 |

| School: School of Basic and Applied Sciences | | | | | | | | | | | | | Batch: 2021-2024 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Department: Physics | | | | | | | | | | | | | Year: 3rd |
| Course: B.Sc. Hons. Physics | | | | | | | | | | | | | Semester: 5th |
| S N | Cate - gory | Course Code | Course Name | Periods | | | Credits | Evaluation Scheme | | | | | Subject Total Marks |
| | | | | | | | | Theory | | | Practical | | |
| | | | | L | T | P | | ABQ | MSE | ESE | IP | EXP | |
| 1 | PCC | BPH-301 | Condensed Matter Physics | 3 | 1 | 0 | 4 | 15 | 25 | 60 | - | - | 100 |
| 2 | PCC | BPH-303 | Special Theory of Relativity | 3 | 1 | 0 | 4 | 15 | 25 | 60 | - | - | 100 |
| 3 | PCC | BPH-305 | Electromagnetic Theory-I | 3 | 1 | 0 | 4 | 15 | 25 | 60 | - | - | 100 |
| 4 | PCC | BPH-307 | Elements of Modern Physics | 3 | 1 | 0 | 4 | 15 | 25 | 60 | - | - | 100 |
| 5 | PCC | BPH-309 | Plasma Physics | 3 | 1 | 0 | 4 | 15 | 25 | 60 | - | - | 100 |
| 6 | PCC | BPH-351 | Physics Laboratory-V | 0 | 0 | 3 | 2 | | | | 40 | 60 | 100 |
| | | | Total----> | 15 | 5 | 3 | 22 | 75 | 125 | 300 | 40 | 60 | 600 |

| School: School of Basic and Applied Sciences | | | | | | | | | | | | | Batch: 2021-2024 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Department: Physics | | | | | | | | | | | | | Year: 3rd |
| Course: B.Sc. Hons. Physics | | | | | | | | | | | | | Semester: 6th |
| S N | Cate - gory | Course Code | Course Name | Periods | | | Credits | Evaluation Scheme | | | | | Subject Total Marks |
| | | | | | | | | Theory | | | Practical | | |
| | | | | L | T | P | | ABQ | MSE | ESE | IP | EXP | |
| 1 | PCC | BPH-302 | Fundamentals of Nanotechnology | 3 | 1 | 0 | 4 | 15 | 25 | 60 | - | - | 100 |
| 2 | PCC | BPH-304 | Electromagnetic Theory-II | 3 | 1 | 0 | 4 | 15 | 25 | 60 | - | - | 100 |
| 3 | PCC | BPH-306 | Material Science | 3 | 1 | 0 | 4 | 15 | 25 | 60 | - | - | 100 |
| 4 | PCC | BPH-308 | Laser Physics | 3 | 1 | 0 | 4 | 15 | 25 | 60 | - | - | 100 |
| 5 | PROJ | BPH-352 | Project | 0 | 0 | 22 | 11 | | | | | 100 | 100 |
| | | | Total----> | 12 | 4 | 22 | 27 | 60 | 100 | 240 | - | 100 | 500 |

**Abbreviations:**

| | | | |
|---|---|---|---|
| PCC: | Programme Core Courses | ABQ: | Assignment Based Quiz |
| PEC: | Programme Elective Courses | MSE: | Mid Semester Examination |
| PROJ: | Project | ESE: | End Semester Examination |
| PDP: | Personality Development Programme | IP: | Internal Practical |
| L: | Lecture | EXP: | External Practical |
| T: | Tutorial | | |
| P: | Practical | | |

# SEMESTER-I

| Course Code BS-101 | Subject Name ELECTRICITY AND MAGNETISM (Semester I) | L T P | Cr. |
|---|---|---|---|
| | | 3+1+0 | 4 |

| **OBJECTIVES:** Learn the mathematical methods to solve the problems involving electric potential and fields. |
|---|
| **Course OUTCOMES:**<br>CO1: Master the mathematical tools to find electric potential and fields.<br>CO2: Learning of important theorems as Gauss theorem.<br>CO3: Calculating the electric fields around conductors.<br>CO4: The use of Coulomb's law and Gauss' law for the electrostatic force. |

| Unit | Contents | Lectures |
|---|---|---|
| I | Vector Calculus : Differentiation of vectors, scalar and vector fields, conservative fields and potentials, line integrals, gradient of a scalar field, divergence of a vector field and divergence theorem, curl of a vector field and its physical significance, Stokes' theorem, combination of grad, div and curl. | 8 |
| II | Electric field and electric potential: Electric field: Electric field lines. Electric flux. Gauss' Law with applications to charge distributions with spherical, cylindrical and planar symmetry. Conservative nature of Electrostatic Field. Electrostatic Potential. Laplace's and Poisson equations. The Uniqueness Theorem. Potential and Electric Field of a dipole. Force and Torque on a dipole.<br>Electrostatic energy of system of charges. Electrostatic energy of a charged sphere. Conductors in an electrostatic Field. Surface charge and force on a conductor. Capacitance of a system of charged conductors. Parallel-plate capacitor. Capacitance of an isolated conductor. Method of Images and its application to: (1) Plane Infinite Sheet and (2) Sphere. | 14 |
| III | Dielectric properties of matter: Electric Field in matter. Polarization, Polarization Charges. Electrical Susceptibility and Dielectric Constant. Capacitor (parallel plate, spherical, cylindrical) filled with dielectric. Displacement vector D. Relations between E, P and D. Gauss' Law in dielectrics. | 10 |
| IV | Magnetic field: Magnetic force between current elements and definition of Magnetic FieldB. Biot-Savart's Law and its simple applications: straight wire and circular loop. Current Loop as a Magnetic Dipole and its Dipole Moment (Analogy with Electric Dipole). Ampere's Circuital Law and its application to (1) Solenoid and (2) Toroid. Properties of B: curl and divergence. Vector Potential. Magnetic Force on (1) point charge (2) current carrying wire (3) between current elements. Torque on a current loop in a uniform Magnetic Field. | 10 |
| V | Electromagnetic induction & ballistic galvanometer: Faraday's Law. Lenz's Law. Self Inductance and Mutual Inductance. Energy stored in a Magnetic Field. Behavior of various substances in magnetic fields. Magnetic permeability and susceptibility and their interrelation. Orbital motion of electrons and diamagnetism. Electron spin and paramagnetic. Ferromagnetism. Domain theory of ferromagnetism, magnetization curve, hysterics loss, ferrites. | 10 |

**REFERENCE BOOKS:**


1. Mathematical Methods in the Physical Sciences: ML Boas, Wiley, 2002.
2. Introduction to Mathematical Physics: C Harper, Prentice Hall of India, 2004.
3. Electricity and Magnetism (Berkley, Phys. Course 2): EM Purcell, Tata McGraw Hill, 1981
4. Elements of Electromagnetics: MNO Sadiku, Oxford University Press, 2001.
5. Electricity and Magnetism: AS Mahajan, AA Rangwala, Tata McGraw Hill, 1988.

| Course Code BS-103 | Subject Name ALGEBRA (Semester I) | L T P | Cr. |
|---|---|---|---|
| | | 3+1+0 | 4 |

| Unit | Contents | Lectures |
|---|---|---|
| I | Polar representation of complex numbers, nth roots of unity, De Moivre's theorem for rational indices and its applications. | 10 |
| II | Equivalence relations, Functions, Composition of functions, Invertible functions, One to one correspondence and cardinality of a set, Well-ordering property of positive integers, Division algorithm, Divisibility and Euclidean algorithm, Congruence relation between integers, Principles of Mathematical Induction, statement of Fundamental Theorem of Arithmetic. | 11 |
| III | Systems of linear equations, row reduction and echelon forms, vector equations, the matrix equation Ax=b, solution sets of linear systems, applications of linear systems, linear independence. | 11 |
| IV | Introduction to linear transformations, matrix of a linear transformation, inverse of a matrix, characterizations of invertible matrices. | 10 |
| V | Subspaces of Rn, dimension of subspaces of Rn and rank of a matrix, Eigen values, Eigen Vectors and Characteristic Equation of a matrix, special matrices | 10 |

**REFERENCE BOOKS:**

1. Titu Andreescu and Dorin Andrica, Complex Numbers from A to Z, Birkhauser, 2006.
2. Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory, 3rd Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint, 2005.
3. David C. Lay, Linear Algebra and its Applications, 3rd Ed., Pearson Education Asia, Indian Reprint, 2007

| Course Code BS-105 | Subject Name INORGANIC CHEMISTRY (Semester I) | L T P | Cr. |
|---|---|---|---|
| | | 3+1+0 | 4 |

**OBJECTIVES:**
1. To understand the shapes of different orbitals.
2. To understand different principles for filling electrons.
3. To understand how to draw energy diagrams.
4. To understand how to calculate bond order.
5. To understand how to calculate lattice energy through Born Haber Cycle
4. Why any chemical compound behaves totally different on changing their states only

**COURSE OUTCOMES:**

CO1: Student will evaluate the periodic properties of elements.
CO2: To learn and explain electronic structure of atom.
CO3: To learn, understand and relate the quantum numbers and atomic orbitals.
CO4: Illustrate the explanation of atomic structure.

| Unit | Contents | Lecture/ Tutorials/ Tutorials |
|---|---|---|
| I | **Atomic Structure:** Bohr's theory; its limitations and atomic spectrum of hydrogen atom; de Broglie equation, Heisenberg's Uncertainty Principle and its significance, Schrödinger's wave equation, significance of $\psi$ and $\psi$2. Quantum numbers and their significance. Sign of wave functions. Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations. | 9 |
| II | **Periodicity of Elements I:** s, p, d, f block elements, the long form of periodic table; Discussion of following properties with reference to s and p-block elements: Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table. Atomic radii (van der Waals) Ionic and crystal radii; Covalent radii (octahedral and tetrahedral) | 12 |
| III | **Periodicity of Elements II:** Ionization enthalpy; Successive ionization enthalpies and factors affecting ionization energy; Applications of ionization enthalpy; Electron gain enthalpy; trends of electron gain enthalpy. Electro negativity, Pauling's/Mulliken's/Allred Rachow's and Mulliken-Jaffé's electronegativity scales; Variation of electronegativity with bond order, partial charge, hybridization. | 11 |
| IV | **Chemical Bonding and Molecular Structure:** Ionic bond: General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals. Born-Landé equation; Born-Haber cycle and its application, Covalent bond: Lewis structure, Valence Bond theory, Bent's rule, concept of resonance energy, Molecular orbital theory. Molecular orbital diagrams of diatomic and simple polyatomic molecules; VSEPR theory, covalent character in ionic compounds, polarizing power and polarizability. Ionic character; Semiconductors and insulators, defects in solids. | 13 |
| V | **Oxidation-Reduction**: Redox reactions, Standard Electrode Potential and its application to inorganic reactions, Oxidation state, rules for the determination of oxidation states, electrochemical series, applications of electrochemical series. | 7 |

**REFERENCE BOOKS:**

1. Lee, J.D., Concise Inorganic Chemistry, 5th edn, Blackwell Science, London.
2. Douglas, B.E. and McDaniel, D.H., *Concepts & Models of Inorganic Chemistry*,Oxford,1970
3. Atkins, P.W. & Paula, J. *Physical Chemistry*, 10th Ed., Oxford University Press, 2014.
4. J. March and M. B. Smith, March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure, 6th Edition, Wiley, 2007.

| Course Code BS-151 | Subject Name PHYSICS LABORATORY-I (Semester I) | L T P | Cr. |
|---|---|---|---|
| | | 0+0+3 | 2 |

**OBJECTIVES:**
The objective of the course General Physics Laboratory is to expose the students of B.Sc. class to experimental techniques in electronics, so that they can verify some of the things read in theory here or in earlier classes and develop confidence to handle sophisticated equipment.

**COURSE OUTCOMES:**
CO1: Experimental knowledge of Katter's pendulum.
CO2: Understanding of modulus of rigidity.
CO3: Experimental knowledge coefficient of viscosity.
CO4: Knowledge of gravitation force and its value by using bar pendulum.

| S. No. | Practical Description |
|---|---|
| 1. | Use of Vernier calipers, Screw gauge, Spherometer, Barometer, Sphygmomanometer, Light meter, dry and wet thermometer, TDS/conductivity meter and other measuring instruments based on applications of the experiments. Use of Plumb line and Spirit level. |
| 2. | Determination of 'g' by Katter's pendulum. |
| 3. | To study the variation of period with distance between centre of suspension and centre of gravity for a bar pendulum and to determine: (i) Radius of gyration of the bar about an axis through its C.G. and perpendicular to its length. (ii) The value of g in the laboratory. |
| 4. | Determination of modulus of rigidity by (i) dynamic method Maxwell's needle/Torsional pendulum (ii) Forced torsional oscillations excited using electromagnet |
| 5. | Determination of coefficient of viscosity of a given liquid by Stoke's method. Study its temperature dependence. |
| 6. | To study moment of inertia of a flywheel. |
| 7. | Determination of modulus of rigidity by static method |
| 8. | To determine the Young's modulus by (i) bending of beam using traveling microscope/laser, (ii) Flexural vibrations of a bar. |
| 9. | To study one dimensional collision using two hanging spheres of different materials |
| 10. | Determination of height (of inaccessible structure) using sextant. |
| 11. | Measurement of charge and current sensitivity and CDR of Ballistic Galvanometer |
| 12. | Determine a high resistance by leakage method using Ballistic Galvanometer. |
| 13. | To determine self-inductance of a coil by Rayleigh's method. |
| 14. | To determine the mutual inductance of two coils by Absolute method. |
| 15. | To study the Motion of Spring and calculate (a) Spring constant, (b) g and (c) Modulus of rigidity. |
| 16. | To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method). |
| 17. | To determine the value of g using Bar Pendulum. |
| 18. | To determine the height of a building using a Sextant. |

**REFERENCE BOOKS:**

1. A Text Book of Practical Physics: I Prakash, Ramakrishna, Kitab Mahal, 11th ed., 2011.
2. BSc Practical Physics: Geeta Sanon, R. Chand & Co., 1st ed., 2007.
3. BSc Physics Practical – I, II, III: Jain, Sharma, Agarwal, Krishan Prakashan, 2014.
4. B.Sc. Practical Physics: CL Arora, S Chand & Company Ltd., 2010.

| Course Code BS-155 | Subject Name CHEMISTRY LAB-I (Semester I) | L T P | Cr. |
|---|---|---|---|
| | | 0+0+3 | 2 |

**LEARNING OBJECTIVES:**
The objective of the course Chemistry Laboratory is to expose the students of B.Sc. class to experimental techniques in surface tension, viscosity and pH meter; so that they can verify some of the things read in theory here or in earlier classes and develop practical understanding.

| S. No. | Practical Description |
|---|---|
| 1 | **Titrimetric Analysis:**<br>Calibration and use of apparatus<br>Preparation of solutions of different Molarity/Normality of titrants |
| 2 | Estimation of carbonate and hydroxide present together in mixture. |
| 3 | Determination of viscosity of (i) ethanol (ii) amyl alcohol and (iii) aqueous solution of sugar at room temperature |
| 4 | Estimation of free alkali present in different soaps/detergents |
| 5 | Determine the surface tension of given solution using drop number method. |
| 6 | **Preparation and purification through crystallization or distillation and ascertaining their purity through melting or boiling point**:<br>(i) Phenyl benzoate from phenol and benzoyl chloride<br>(ii) M-dinitrobenzene from nitrobenzene (use 1:2 conc. $HNO_3$ - $H_2SO_4$ mixture if fuming $HNO_3$ is not available).<br>(iii) Picric acid<br>(iv) Aspirin from salicylic acid |
| 7 | Crystallization and decolourization of impure naphthalene from ethanol. |

**REFERENCE BOOKS:**


1. O.P. Pandey, D.N. Bajpai& S. Giri, Practical Chemistry, S. Chand & CompanyLtd.
2. B. D. Khosla, V. C. Garg& A. Gulati, *Senior Practical Physical Chemistry*, S. Chand & Co.: New Delhi(2011).

# SEMESTER-II

| Course Code BS-102 | Subject Name STATISTICAL PHYSICS (Semester II) | L T P | Cr. |
|---|---|---|---|
| | | 3+1+0 | 4 |

**OBJECTIVES:**
The main objective of this course is to familiarize students with Statistical Physics that are essential for solving advanced problems in Statistical thermodynamics.

**COURSE OUTCOMES:**

CO1: Understanding of basics of Statistical Physics.

CO2: Use of the Maxwell- Boltzmann statistics.

CO3: Use of the Bose-Einstein and Fermi-Dirac Statistics.

CO4: Understanding the ensembles.

| Unit | Contents | Lectures |
|---|---|---|
| I | Basic Ideas of Statistical Physics: Introduction, Basic ideas of probability and their applications, Macrostates and microstates, Effect of constraints on the system. | 11 |
| II | Distribution of n particles in two compartments, deviation from the state of maximum probability, Equilibrium state of a dynamic system, distribution of N distinguishable particles in unequal compartments, Division into cells, Phase space and its division into cells. | 10 |
| III | Maxwell-Boltzmann Statistics: Phase space and its division into cells. Three kinds of statistics and their basic approach. Maxwell-Boltzmann Statistics for an ideal gas: Volume in phase space, values of α and β. Experimental verification and graphical depiction of Maxwell-Boltzmann distribution of molecular speeds | 11 |
| IV | Isolated System: Micro canonical Ensemble, Closed System : Canonical Ensemble, Open System : Grand Canonical Ensemble Bose-Einstein Statistics : Need for quantum statistics, Bose-Einstein statistics and its application to Black body radiation, photon gas, deductions from Planck's law. | 11 |
| V | Fermi-Dirac Statistics: Fermi-Dirac statistics and its application to electron gas, Fermi energy, comparison of M.B., B.E. and F.D. statistics | 9 |

**REFERENCE BOOKS:**

1. Statistical Physics, Thermodynamics and Kinetic Theory: VS Bhatia, Vishal Pub. Co. Jalandhar, 2003
2. Introduction to Statistical Physics: Kerson Huang Taylor & Francis Inc. 2002
3. An Introduction to Statistical Mechanics and Thermodynamics: Robert H. Swendsen. Oxford University Press Inc. 2012.
4. Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.
5. Statistical Physics, Berkeley Physics Course, F. Reif, 2008, Tata McGraw-Hill.
6. Statistical and Thermal Physics, S. Lokanathan and R.S. Gambhir. 1991, Prentice Hall.

| Course Code BS-104 | Subject Name CALCULUS (Semester II) | L T P | Cr. |
|---|---|---|---|
| | | 3+1+0 | 4 |

**LEARNING OBJECTIVES:**

1. Understand the major problems of differential and integral calculus.
2. Appreciate how calculus allows us to solve important practical problems in an optimal way.

**Course Outcome**

CO1: Calculate limits, derivatives and indefinite integrals of various algebraic and trigonometric functions of a single variable.

CO2: Use the fact that the derivative is the slop of the tangent line to the curve at a given Point.

CO3: Use the properties of limits and the derivative to analyze graphs of various functions of a single variable

CO4: Apply derivative tests in optimization problems appearing in social sciences, physical sciences, life Sciences and a host of other disciplines.

| Unit | Contents | Lectures |
|---|---|---|
| I | Limit & Continuity :The real line and its geometrical representation; e-δ treatment of limit and continuity; Properties of limit and classification of discontinuities; Properties of continuous functions. | 11 |
| II | Differentiability: Successive differentiation; Leibnitz Theorem; Statement of Rolle's Theorem; Mean Value Theorem; Taylor and Maclaurin's Theorems; Indeterminate forms. | 10 |
| III | Applications of Differentiation : Asymptotes; Concavity, convexity and points of inflection; Curvature; Extrema; elementry curves, tangent and normal in parametric form; Polar Coordinates. | 11 |
| IV | Partial Differentiation: Limits and continuity of functions of two variables; Partial derivatives; Taylor’s theorem and Maclaurin’s Theorem for function of two variable; Maxima and minima for function of two variable. | 10 |
| V | Double and triple integrals; Change of order in double integrals. Application of Integration : length of a curve; Arc length as a parameter; Evoute & Envelope; Volumes and surface areas of solids of revolution. | 10 |

**REFERENCE BOOKS:**


1. Gorakh Prasad, Differential Calculus, Pothishala Pvt. Ltd. Allahabad, 2000.
2. Gorakh Prasad, Integral Calculus, Pothishala Pvt. Ltd. Allahabad, 2000.
3. Gabriel Klambauer, Mathematical Analysis, Marcel Dekkar Inc. New York 1975.
4. Shanti Narayan, Elements of Real Analysis, S. Chand & Company, New Delhi.
5. Shanti Narayan, A Text Book of Vector Calculus, S. Chand & Company, New Delhi.
6. G.B. Thomas and R.L. Finney, Calculus, 9th Ed., Pearson Education, Delhi, 2005.
7. M.J. Strauss, G.L. Bradley and K. J. Smith, Calculus, 3rd Ed., Dorling Kindersley (India) Ltd. (Pearson Education), Delhi, 2007.

| Course Code BS-106 | Subject Name ORGANIC CHEMISTRY-I (Semester II) | L T P | Cr. |
|---|---|---|---|
| | | 3+1+0 | 4 |

| **OBJECTIVES:** |
|---|
| 1. Differentiate chiral and achiral molecules.<br>2. Recognize and draw structural isomers (constitutional isomers), stereoisomers including enantiomers and diastereomers, racemic mixture, and meso compounds.<br>3. Identify the stereo centers in a molecule and assign the configuration as R or S. |
| **COURSE OUTCOMES:**<br>1. To learn the involvement of reactive intermediates and understand their structure and reactivity.<br>2. To learn and understand the orbital interactions (Woodward Hoffmann rules) in concerted reactions.<br>3. To calculate optical purity and enantiomer excess, |

| Unit | Contents | Lecture/ Tutorials/ Tutorials |
|---|---|---|
| I | **Basics Of Organic Chemistry-I:** Organic Compounds: Classification, and Nomenclature, Hybridization, Shapes of molecules, Influence of hybridization on bond properties. Electronic Displacements: Inductive, electromeric, resonance and mesomeric effects, hyperconjugation and their applications; Dipole moment; Organic acids and bases; their relative strength. | 13 |
| II | **Basics Of Organic Chemistry-II:** Homolytic and Heterolytic fission with suitable examples. Curly arrow rules, formal charges; Electrophiles and Nucleophiles; Nucleophlicity and basicity; Types, shape and their relative stability of Carbocations, Carbanions, Free radicals and Carbenes.<br>Introduction to types of organic reactions and their mechanism: Addition, Elimination and Substitution reactions. | 10 |
| III | **Stereochemistry:** Fischer Projection, Newmann and Sawhorse Projection formulae and their interconversions; Geometrical isomerism: cis–trans and, syn-anti isomerism E/Z notations with C.I.P rules.<br>Optical Isomerism: Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, Molecules with two or more chiral-centres, Distereoisomers, meso structures, Racemic mixture and resolution. Relative and absolute configuration: D/L and R/S designations. | 13 |
| IV | **Chemistry of Aliphatic Hydrocarbons: (i) Carbon-Carbon sigma bonds:** Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation -relative reactivity and selectivity. | 9 |
| V | **Chemistry of Aliphatic Hydrocarbons (ii) Carbon-Carbon pi bonds:** Mechanism of E1 and E2 reactions. Saytzeff and Hofmann eliminations. Electrophilic additions their mechanisms (Markownikoff/ Anti Markownikoff addition), mechanism of oxymercuration-demercuration, hydroboration-oxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation (oxidation). Diels-Alder reaction. | 9 |

**REFERENCE BOOKS:**


1. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. Pearson Education).
2. Kalsi, P. S. Stereochemistry Conformation and Mechanism; New Age International, 2005

| Course Code BS-152 | Subject Name PHYSICS LABORATORY-II (Semester II) | L T P | Cr. |
|---|---|---|---|
| | | 0+0+3 | 2 |

**OBJECTIVES:**
The objective of the course General Physics Laboratory is to expose the students of B.Sc. class to experimental techniques in electronics, so that they can verify some of the things read in theory here or in earlier classes and develop confidence to handle sophisticated equipment.

**COURSE OUTCOMES:**
CO1: Understanding of resolving power of prism, telescope, and diffraction grating.
CO2: Experimental knowledge of Newton's ring method.
CO3: Experimental knowledge of resolving power.
CO4: Understanding of the electrical and thermal conductivity.

| S. No. | Practical Description |
|---|---|
| 1. | To determine Cauchy's constants and resolving power of a given prism. |
| 2. | To find the refractive index of a given liquid using a prism spectrometer. |
| 3. | To determine the wavelength of sodium light using Newton's rings method. |
| 4. | To find the resolving power and magnification of a telescope. |
| 5. | To find the resolving power and magnification of a diffraction grating. |
| 6. | To study hydrogen/Neon gas discharge tube spectrum using diffraction grating. |
| 7. | To study temperature dependence of refractive index of organic liquid using Abbe's refractometer. |
| 8. | To study the variation of specific rotation of sugar solution with concentration. |
| 9. | To measure power distribution and divergence parameters of He-Ne and Semiconductor Lasers. |
| 10. | Study of G.M. Counter characteristics. Measurements of Background radiation and alpha, beta and gamma rays using natural sources. |
| 11. | To find the first ionization potential of mercury. |
| 12. | To determine the value of Stefan's Constant of radiation |
| 13. | Determination of mechanical equivalent of heat by Calendar and Barne's constant flow method. |
| 14. | To measure the thermal conductivity and thermal diffusivity of a conductor. |
| 15. | To determine thermal conductivity of a bad conductor disc (i) Lees and Chorlton method using steam heating and thermometers (ii) Advance kit involving constant current source for heating and thermocouples for temperature measurements. |
| 16. | Measurement of the electrical and thermal conductivity of copper to determine its Lorentz number. |

**REFERENCE BOOKS:**


1. A Textbook of Practical Physics: I Prakash, Ramakrishna, Kitab Mahal, 11th ed., 2011.
2. BSc Practical Physics: Geeta Sanon, R. Chand & Co., 1st ed., 2007.
3. BSc Physics Practical – I, II, III: Jain, Sharma, Agarwal, Krishan Prakashan, 2014.
4. B.Sc. Practical Physics: CL Arora, S Chand & Company Ltd., 2010.

| Course Code BS-156 | Subject Name CHEMISTRY LABORATORY -II (Semester II) | L T P | Cr. |
|---|---|---|---|
| | | 0+0+3 | 2 |

| **OBJECTIVES:** |
|---|
| The objective of the course is to present a theory of classical electrodynamics. Thus, Maxwell equations and their consequences are considered in detail. It is concerned with principles of the electromagnetic field theory and the description using Maxwell's equations. |
| **COURSE OUTCOMES:** |
| Understanding of motion of charged particles in electromagnetic fields, principles of the special theory of relativity and invariance of Maxwell equations under the Lorentz transformation and their related problems. |

| S. No. | Practical Description |
|---|---|
| 1. | **Preparation of the following inorganic compounds**<br>(I) $VO(acac)_2$<br>(II) Cis-$K[Cr(C_2O_4)_2(H_2O)_2$<br>(III) $Na[Cr(NH_3)_2(SCN)_4]$<br>(IV) $K_3[Fe(C_2O_4)_3]$ |
| 2. | **Quantitative Analysis**<br>(a) Separation and determination of two metal ions Cu-Ni, Ni-Zn, Cu-Fe, Ba-Cu etc. involving volumetric and gravimetric methods. |
| 3. | **Spectrophotometric Determinations**<br>1. Ni by extractive Spectrophotometric method.<br>2. Fe by Job's method of continuous variations<br>3. Fe in vitamin tablets<br>4. Nitrite in water in colorimetric method. |
| 4. | Determination of heat capacity of the calorimeter and enthalpy of neutralization of hydrochloric acid with sodium hydroxide. |
| 5. | Determination of enthalpy of hydration of copper sulphate. |

**REFERENCE BOOKS:**


1. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
2. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).
3. Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003).

# SEMESTER-III

| Course Code BPH-201 | Subject Name VIBRATION AND WAVES (Semester III) | L T P | Cr. |
|---|---|---|---|
| | | 3+1+0 | 4 |

**OBJECTIVES:**
The course aims to introduce the basic concepts required for a mathematical description of oscillations and waves, and to provide expertise for solving the differential equations which arise in simple mathematical models for oscillations and waves.

**COURSE OUTCOMES:**
CO1: Understanding the behavior of a damped and driven harmonic oscillator in both time and frequency domains.
CO2: Construct travelling and standing solutions to the wave equation.
CO3: Understanding of the behavior of waves at interfaces and their behavior in dissipative media.
CO4: Understanding of Simple and damped harmonic motion.

| Unit | Contents | Lectures |
|---|---|---|
| I | **Simple Harmonic Free Vibrations :** Simple harmonic motion, energy of a SHO, Compound pendulum, Electrical Oscillations, Plasma Vibrations, Lattice Vibrations, Transverse Vibrations of a mass on a string, composition of two perpendicular SHMs of same period and of periods in ratio 1:2, Anharmonic Oscillations. | 10 |
| II | **Damped Simple Harmonic Vibrations:** Decay of free Vibrations due to damping, types of damping, Determination of damping coefficients – Logarithmic decrement, relaxation time and Q-factor. Electromagnetic damping, collision damping – Ionosphere and metals. | 10 |
| III | **Forced Vibrations and Resonance:** A forced oscillator, Transient and Steady State Oscillations, velocity versus driving force frequency, Resonance, power supplied to forced oscillator by the driving force. Q-factor of a forced oscillator, Electrical, nuclear and nuclear-magnetic resonances. Coupled Oscillations: Stiffness coupled oscillators, Normal coordinates and modes of vibrations. Normal frequencies, Forced vibrations and resonance for coupled oscillators, Masses on string-coupled oscillators | 11 |
| IV | **Waves in Physical Media:** Wave motion in one dimension, Transverse and longitudinal waves, progressive harmonic waves and their energy, Transverse waves on a string, longitudinal waves on a rod, Electrical transmission lines, characteristic impedance of a string and a transmission line, waves in an absorbing medium, spherical waves. | 11 |
| V | **Reflection and Transmission:** Reflection and transmission of transverse waves on a string at the discontinuity, Energy considerations of reflected and transmitted waves, Impedance matching, Eigen frequencies and Eigen functions for stationary waves on a string. Normal modes in three dimensions, transmission of non-monochromatic waves, Bandwidth Theorem. | 10 |

**REFERENCE BOOKS:**

1. The Physics of Vibrations and Waves by H.J.Pain John Wiley and Sons.
2. Fundamentals of Vibration and Waves, S.P.Puri, Tata Mc-Graw Hill Company, New Delhi.
3. Waves, Berkeley Physics course Vol. III, Frank S. Crawford Jr., Mc-Graw Hill Book Company.
4. Vibrations and Waves, I.J. Main, Cambridge University Press.

| Course Code BPH-203 | Subject Name OPTICAL PHYSICS (Semester III) | L T P | Cr. |
|---|---|---|---|
| | | 3+1+0 | 4 |

**OBJECTIVES:**
The main objective of this course is to familiarize students with optical phenomena and associated applications.

**COURSE OUTCOMES:**
CO1: Student will identify and apply formulas of optics and wave physics using course literature.
CO2: Identify and illustrate physical concepts and terminology used in optics and to be able to explain them in appropriate detail.
CO3: Able to make approximate judgments about optical and other wave phenomena when necessary.
CO4: Acquire skills allowing the student to organize and plan simpler laboratory course experiments and to prepare an associated oral and written report.

| Unit | Contents | Lectures |
|---|---|---|
| I | **Theories of light:** Corpuscular theory, Wave theory: Huygen's principle, explanation of laws of reflection & refraction.(plane wave front at plane surface ) Group velocity & wave velocity - relation between them. Quantum nature, concept of Photon | 10 |
| II | **Interference:** Coherent sources interference by division of wave front, Young's double slit-theory and experiment, Fresnel's Bi – prism –theory and experiment Lloyd's mirror interference by division of amplitude, thin film of uniform thickness (both reflected and transmitted ) and wedge-shaped film, Newton's ring – theory and experiment. Experimental determination of refractive index of liquid. Michelson Interferometer. | 11 |
| III | **Diffraction:** Concepts of Fresnel and Fraunhofer diffraction. Rectilinear propagation of light, theory of Zone plate, comparison between zone plate and converging lens. Fresnel's diffraction at straight edge and wire. Fraunhofer diffraction at a single slit, derivation of intensity expression double slit with theory. Transmission grating theory and experiment (determination of wavelength of light) dispersion and resolution of grating. | 10 |
| IV | **Polarization:** Double refraction in uni-axial crystals. Huygen's theory, positive & negative crystals. Principle refractive indices Huygen's construction of 'O' & 'E' wave in uni-axial crystal for plane wave front (all cases) Quarter wave & half wave plate. | 11 |
| V | Production and detection of plane, circularly and elliptically polarized light, Babinet compensator, optical activity, Fresnel's theory. Laurent's half shade polarimeter. | 10 |

**REFERENCE BOOKS:**

1. An Introduction to Modern Optics, Ajay K Ghatak, Tata Mc-Graw Hill Co., New Delhi .
2. Advanced Engineering Mathematics, Kreyszig.
3. A Textbook of Light, D.N. Vasudeva, Atma Ram and Sons, New Delhi.
4. Optics, Born and Wolf.
5. Optics, K.D. Moltev, Oxford University Press.

| Course Code BPH-205 | Subject Name QUANTUM PHYSICS (Semester II) | L T P | Cr. |
|---|---|---|---|
| | | 3+1+0 | 4 |

**OBJECTIVES:**
This course develops concepts in quantum mechanics such that the behavior of the physical universe can be understood from a fundamental point of view. It provides a basis for further study of quantum mechanics.

**COURSE OUTCOMES:**

CO1: Understand and explain the differences between classical and quantum mechanics.

CO2: Understand the idea of wave function.

CO3: Understand the uncertainty relations.

CO4: Solve Schrodinger equation for simple potentials.

| Unit | Contents | Lectures |
|---|---|---|
| I | **Time dependent Schrodinger equation:** Time dependent Schrodinger equation and dynamical evolution of a quantum state; Properties of Wave Function. Interpretation of Wave Function Probability and probability current densities in three dimensions; Conditions for Physical Acceptability of Wave Functions. Normalization. Linearity and Superposition Principles. Eigenvalues and Eigenfunctions. Position, momentum, and Energy operators; commutator of position and momentum operators; Expectation values of position and momentum. Wave Function of a Free Particle | 11 |
| II | **Time independent Schrodinger equation:** Hamiltonian, stationary states, and energy eigenvalues; expansion of an arbitrary wavefunction as a linear combination of energy eigenfunctions; General solution of the time dependent Schrodinger equation in terms of linear combinations of stationary states; Application to spread of Gaussian wave-packet for a free particle in one dimension; wave packets, Fourier transforms and momentum space wavefunction; Position-momentum uncertainty principle. | 10 |
| III | **General discussion of bound states in an arbitrary potential:** Continuity of wave function, boundary condition and emergence of discrete energy levels; application to one dimensional problem-square well potential; Quantum mechanics of simple harmonic oscillator-energy levels and energy eigenfunctions using Frobenius method; Hermite polynomials; ground state, zero-point energy & uncertainty principle. | 11 |
| IV | **Quantum theory of hydrogen-like atoms:** Time independent Schrodinger equation in spherical polar coordinates; separation of variables for second order partial differential equation; angular momentum operator & quantum numbers; Radial wavefunctions from Frobenius method; shapes of the probability densities for ground & first excited states; Orbital angular momentum quantum numbers l and m; s, p, d, shells; Many electron atoms: Pauli's Exclusion Principle. Symmetric &Antisymmetric Wave Functions. Periodic table. Fine structure. Spin orbit coupling. Spectral Notations for Atomic States. Total angular momentum. Vector Model. Spin-orbit coupling in atoms L-S and J-J couplings. Hund's Rule. Term symbols. Spectra of Hydrogen and Alkali Atoms (Na etc.). | 10 |
| V | **Atoms in electric & magnetic fields:**<br>Electron angular momentum. Space quantization. Electron Spin and Spin Angular Momentum. Larmor's Theorem. Spin Magnetic Moment. Stern-Gerlach Experiment. Zeeman Effect: Electron Magnetic Moment and<br>Magnetic Energy, Gyromagnetic Ratio and Bohr Magneton; Atoms in External Magnetic Fields: Normal and Anomalous Zeeman Effect. Paschen Back and Stark Effect (Qualitative Discussion only) | 10 |

**REFERENCE BOOKS:**
1. Relativistic Quantum Mechanics – J. D. Bjorken and S. D. Drell, McGraw-Hill, New York(1964).
2. Quantum Field Theory - Lewis H Ryder, Cambridge University Press (1985)
3. Quantum Field Theory - Claude Itzyksen and Jean-Bernard Zuber, McGraw Book Co. (1985)
4. Quantum Field Theory in a nutshell - A. Zee, Princeton University Press (2003).
5. A First Book of Quantum Field Theory – A. Lahiri and P. B. Pal, Narosa Publishing House (2001).
6. An Introduction to Quantum Field Theory by M. E. Peskin and D. V. Schroeder (Perseus Books).

| Course Code BPH-207 | Subject Name ATOMIC AND MOLECULAR PHYSICS (Semester III) | L T P | Cr. |
|---|---|---|---|
| | | 3+1+0 | 4 |

**OBJECTIVES:**
Atomic and Molecular physics is of fundamental importance in in an education in physics. To start with it most direct, concrete application of quantum mechanics.

**COURSE OUTCOMES:**
CO1: Understanding of fundamentals of atomic and molecular structure.
CO2: Understanding of alkali spectra Zeeman effect.
CO3: Understanding of LS coupling and JJ coupling and difference between them.
CO4: Knowledge of electronic spectra.

| Unit | Contents | Lectures |
|---|---|---|
| I | **Hydrogen and Hydrogen-like ions:** Series in hydrogen, circular motion, nuclear mass effect, elliptical orbits, energy levels. Fine structure: basic facts and Sommerfeld theory, electron spin and spin-orbit coupling, relativistic correction and Lamb shift. | 10 |
| II | **Alkali Spectra:** General features, doublet structure, Larmor's theorem and magnetic levels, elementary theory of weak and strong magnetic fields, Zeeman Effect in doublet spectra: anomalous Zeeman Effect and the anomalous g-value. | 10 |
| III | **Pauli's principle and shell structure:** Systems with several electrons and spin functions. Complex Spectra: LS-Coupling scheme, normal triplets, basic assumptions of the theory, identification of terms, selection rules, jj- coupling. | 11 |
| IV | **Infrared and Raman Spectra:** Rigid rotator, energy levels, spectrum, Harmonic oscillator: energy levels, eigenfunctions, spectrum, comparison with observed spectrum, Raman Effect, Quantum theory of Raman Effect, Rotational and Vibrational Ramanspectrum. Anharmonic oscillator: energy levels, Infrared and Raman Spectrum, Vibrational frequency and force constants. Non-rigid rotator: energy levels, spectrum, Vibrating-rotator energy levels, Infrared and Raman spectrum (no derivation of Dunham coefficients), Symmetry properties of rotational levels, influence of nuclear spin. | 11 |
| V | **Electronic Spectra:** Electronic energy and potential curves, resolution of total energy, Vibrational Structure of Electronic transitions. General formulae, Deslandre's table, absorption sequences and Vibrational analysis, Rotational Structure of Electronic bands: General relations, branches of a band, band-head formation, Intensity distribution in a vibrational band system. Franck-Condon Principle and its wave mechanical formulation. Classification of electronic states: Orbital angular momentum, Spin, total angular momentum of electrons, Symmetry properties of electronic eigen-functions | 10 |

**REFERENCE BOOKS:**

1. Atomic Spectra: H Kuhn, Longman Green, 1969.
2. Molecular Spectra and Molecular Structure: G Herzberg, Van-Nostrand Rein-hold, 1950.
3. Atomic Spectra: HE White, McGraw Hill, 1934.
4. Fundamentals of Molecular spectroscopy: Banwell, McCash, Tata McGraw Hill, 1994.
5. Molecular Spectroscopy: S Chandra, Narosa, 2009.
4. Atomic, Molecular and Photons: Wolfgang Damtrodes, Springer, 2010.

| Course Code BPH-209 | Subject Name MATHEMATICAL PHYSICS-I (Semester III) | L T P | Cr. |
|---|---|---|---|
| | | 3+1+0 | 4 |

| OBJECTIVES: |
|---|
| To demonstrate knowledge and understanding of the following fundamental concepts in: Vector analysis, differential equations, other mathematical formulations. |
| **COURSE OUTCOMES:**<br>CO1: Understanding of vector and calculus analysis.<br>CO2: Use of basic mathematics tools to understand physics.<br>CO3: Understand integral and differential calculus along with statistical and probability distributions.<br>CO4: Understanding of Differential equation. |

| Unit | Contents | Lectures |
|---|---|---|
| I | Properties of vectors under rotations. Scalar product and its invariance under rotations. Vector product, Scalar triple product and their interpretation in terms of area and volume respectively. Scalar and Vector fields. | 10 |
| II | Vector Differentiation: Directional derivatives and normal derivatives. Gradient of a scalar field and its geometrical interpretation. Divergence and curl of a vector field. Del and Laplacian operators. Vector identities, Gradient, divergence, curl and Laplacian in spherical and cylindrical coordinates. | 11 |
| III | Determinants and Matrices: Determinants for linear algebraic equations, Laplace development, Cramer's rule, antisymmetric, Gauss elimination. Matrices – basic definitions and operations, orthogonal matrices, Hermitian matrices, unitary matrices, diagonalization of matrices, normal matrices. Infinite Series: Fundamental concepts, convergence tests, alternating series, algebra of series, power series, Taylor series. | 11 |
| IV | Differential Equations: Review of differential equations, self-adjoint differential equations, eigenfunctions, eigenvalues, boundary conditions, Hermitian operators, and their properties. | 11 |
| V | Multiple Integrals: Double and triple integrals, application of multiple integrals, change of variables in integrals, general properties of Jacobians, surface, and volume integrals. | 9 |

**REFERENCE BOOKS:**

1. Mathematical Methods for Physicists: G Arfken, HJ Weber, Academic Press, San Diego, 7th ed., 2012.
2. Mathematical Methods in the Physical Sciences: ML Boas, Wiley, 2002.
3. Applied Mathematics for Engineers and Physicists: LA Pipes, LR Harvill, McGraw- Hill, 1971.
4. Mathematical Methods for Physics and Engineering: KF Riley, MP Hobson, SJ Bence, Cambridge University Press, 1998.

| Course Code BPH-251 | Subject Name PHYSICS LABORATORY-III | L T P | Cr. |
|---|---|---|---|
| | | 0+0+3 | 2 |

| **OBJECTIVES:** |
|---|
| The objective of the course Physics Laboratory-III is to expose the students to experimental techniques in electronics, so that they can verify some of the things read in theory here or in earlier classes and develop confidence to handle sophisticated equipment. |
| **COURSE OUTCOME:**<br>CO1: Experimental knowledge of half wave and full wave rectifier.<br>CO2: Experimental knowledge of various transistors.<br>CO3: Understanding of energy band gap of a given semiconductor.<br>CO4: knowledge of high resistance by leakage method. |

| Practical | Practical Description |
|---|---|
| **1.** | To study Moire's fringe patterns and applications to measure small distance and angle. |
| **2.** | To draw the characteristics of a given triode and to determine the tube parameters. |
| **3.** | To determine energy band gap of a given semiconductor. |
| **4.** | Calibration of a Si diode, a thermistor and thermocouple for temperature measurements. |
| **5.** | To measure low resistance by Kelvin's double bridge/ Carey Foster's bridge. |
| **6.** | To study voltage regulation and ripple factor for a half-wave and a full-wave rectifier without and with different filters. Use of Zener diode and IC regulators. |
| **7.** | To study common emitter characteristics of a given transistor and to determine various parameters. |
| **8.** | To study common base characteristics of a given transistor and to determine various parameters. |
| **9.** | To measure high resistance by leakage method. |
| **10.** | To study the induced emf as a function of the velocity of magnet and to study the phenomenon of electromagnetic damping. |
| **11.** | To study the variation of magnetic field with distance along axis of a circular coil – realization of Helmholtz's coils |
| **12.** | Measurement of thermal relaxation time constant of a serial light bulb. |
| **13.** | To determine charge to mass ratio (e/m) of an electron by helical method using CRT. |

**REFERENCE BOOKS:**


1. A Textbook of Practical Physics: I Prakash, Ramakrishna, Kitab Mahal, 11th ed., 2011.
2. B.Sc. Practical Physics: Geeta Sanon, R. Chand & Co., 1st ed., 2007.
3. B.Sc. Physics Practical – I, II, III: Jain, Sharma, Agarwal, Krishan Prakashan, 2014.
4. B.Sc. Practical Physics: CL Arora, S Chand & Company Ltd., 2010.

# SEMESTER-IV

| Course Code BPH-202 | Subject Name MATHEMATICAL PHYSICS-II (Semester IV) | L T P | Cr. |
|---|---|---|---|
| | | 3+1+0 | 4 |

**OBJECTIVES:**
The main objective of this course is to familiarize students with a range of mathematical methods that are essential for solving advanced problems in theoretical Physics.

**COURSE OUTCOMES:**

CO1: Use complex analysis in solving physical problems.

CO2: Use of the differential equations.

CO3: Use of the special functions and solve related problems.

CO4: Use of numerical techniques.

| Unit | Contents | Lectures |
|---|---|---|
| I | Complex analysis: Brief Revision of Complex Numbers and their Graphical Representation. Euler's formula, De Moivre's theorem, Roots of Complex Numbers. Functions of Complex Variables. | 11 |
| II | Integration of a function of a complex variable. Cauchy's Inequality. Cauchy's Integral formula. Simply and multiply connected region. Laurent and Taylor's expansion. Residues and Residue Theorem. Application in solving Definite Integrals. | 10 |
| III | Fourier Transforms: Fourier Integral theorem. Fourier Transform. Examples. Fourier transform of trigonometric, Gaussian, finite wave train & other functions. Representation of Dirac delta function as a Fourier Integral. Fourier transforms of derivatives. Inverse Fourier transform, Convolution theorem. | 11 |
| IV | Laplace Transforms: Laplace Transform (LT) of Elementary functions. Properties of LTs: Change of Scale Theorem, Shifting Theorem. LTs of 1st and 2nd order Derivatives and Integrals of Functions, Derivatives, and Integrals of LTs. LT of Unit Step function, Dirac Delta function, Periodic Functions. Convolution Theorem. Inverse LT. | 10 |
| V | Statistics and Probability: Statistical distributions, second moments and standard deviations, definition of probability, fundamental laws of probability, discrete probability distributions, combinations and permutations, continuous distributions – expectation, moments and standard deviation, Binomial, Poisson and Gaussian distributions, applications to experimental measurement. | 10 |

**REFERENCE BOOKS:**

1.Complex Variables, A.S.Fokas & M.J.Ablowitz, 8th Ed., 2011, Cambridge Univ. Press
2.Mathematical Methods for Physicists: G Arfken, HJ Weber, Academic Press, San Diego, 7th ed., 2012.
3.Mathematical Physics: PK Chattopadhyay, Wiley Eastern, New Delhi, 2004.
4.Mathematical Physics: AK Ghatak, IC Goyal, SJ Chua, MacMillan, India, Delhi,1986.
Mathematical Methods in the Physical Sciences: M Boas , Wiley, New York, 3rd ed., 2007.

| Course Code BPH-204 | Subject Name NUCLEAR PHYSICS (Semester IV) | L T P | Cr. |
|---|---|---|---|
| | | 3+1+0 | 4 |

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|---|
| **OBJECTIVES:** Provide students with opportunities to develop basic knowledge and understanding of scientific phenomena, facts, laws, definitions, concepts, theories, scientific vocabulary, terminology, conventions, scientific quantities, and their determination. |
| **COURSE OUTCOMES:** C**O1:** Demonstrate comprehension of physical reality through estimation, approximation, and mathematical modeling, and understand how a small number of fundamental physical principles underlie a huge variety of interconnected natural phenomena.<br>CO21: Understand the fundamental principles and concepts governing classical nuclear and particle physics and have a working knowledge of their application to real-life problems.<br>CO3: Demonstrate knowledge and understanding of scientific phenomena, facts, laws, definitions, concepts, theories, scientific vocabulary, terminology, conventions.<br>CO4: Students will understand scientific quantities and their determination, order-of-magnitude estimates, scientific and technological applications as well as their social, economic, and environmental implications. |

| Unit | Contents | Lectures |
|---|---|---|
| **I** | **Nuclear properties:** Constituents of nucleus, non-existence of electrons in nucleus, nuclear mass, and binding energy, features of binding energy versus mass number curve, nuclear radius, angular momentum and parity, qualitative discussion of two-body nuclear forces, nuclear moments, magnetic dipole moment and electric quadrupole moment. | 10 |
| **II** | **Radioactive decays:** Modes of decay of radioactive nuclides and decay Laws, chart of nuclides and domain of instabilities, radioactive dating, constituents of Cosmic rays. Beta decays: β-, β+ and electron capture decays, allowed and forbidden transitions (selection rules), parity violation in β-decay. | 10 |
| **III** | **Alpha decay:** Stability of heavy nuclei against break up, Geiger-Nuttal law, barrier penetration as applied to alpha decay, reduced widths, deducing nuclear energy levels. Gamma transitions: Excited levels, isomeric levels, gamma transitions, multipole moments, selection rules, transition probabilities, internal conversion (IC), determination of multipolrity from γγ-correlation and IC measurements. | 11 |
| **IV** | **Nuclear reactions:** Types of nuclear reactions, reactions cross section, conservation laws, Kinematics of nuclear reaction, Q-value and its physical significance, compound nucleus. | 11 |
| **V** | **Nuclear Models :** Liquid drop model, semi-empirical mass formula, condition of stability, Fermi gas model, evidence for nuclear magic numbers, Shell model, energy level scheme, angular momenta of nuclear ground states. | 10 |

**REFERENCE BOOKS:**


1. Basic ideas and Concepts in Nuclear Physics: K Hyde, Institute of Physics, 2004.
2. Introduction to Nuclear Physics: HA Enge, Addison-Wesley, 1971.
3. Nuclear Physics: I Kaplan, Narosa, 2002.
4. Nuclei and Particles: E Segre, W.A. Benjamin Inc, 1965.
5. Concepts of Modern Physics by Arthur Beiser (McGraw-Hill Book Company, 1987)
6. Concepts of nuclear physics by Bernard L.Cohen.(New Delhi: Tata Mcgraw Hill, 1998).
7. Introduction to the physics of nuclei and particles by R.A. Dunlap.(Singapore: Thomson Asia, 2004

| Course Code BPH-206 | Subject Name SOLID STATE PHYSICS (Semester IV) | L T P | Cr. |
|---|---|---|---|
| | | 3+1+0 | 4 |

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|---|
| **OBJECTIVES:**<br>The aim of this course is to give you an extended knowledge of the principles and techniques of solid-state physics. |
| **COURSE OUTCOMES:**<br>CO1: Be able to account for interatomic forces and bonds and have a basic knowledge of crystal systems and spatial symmetries.<br>CO2: Be able to account for how crystalline materials are studied using diffraction and be able to perform structure determination of simple structures.<br>CO3: Understand the concept of reciprocal space and be able to use it as a tool.<br>CO4: Knowledge of the significance of Brillouin zones. |

| Unit | Contents | Lectures |
|---|---|---|
| I | **Crystal structure**: Solids, Amorphous and Crystalline Materials. Lattice Translation Vectors. Lattice with a Basis, Central and Non-Central Elements. Unit Cell. Miller Indices. Reciprocal Lattice. Types of Lattices. Brillouin zones. Diffraction of X-rays by Crystals. Bragg's Law. Atomic and Geometrical Factor. | 9 |
| II | **Elementary lattice dynamics**: Lattice Vibrations and Phonons: Linear Monoatomic and Diatomic Chains. Acoustical and Optical Phonons. Qualitative Description of the 34 Phonon Spectrum in Solids. Dulong and Petit's Law, Einstein and Debye theories of specific heat of solids. T3 law. | 10 |
| III | **Properties of matter:** Magnetic Properties: Dia-, Para-, Ferri- and Ferromagnetic Materials. Classical Langevin Theory of dia– and Paramagnetic Domains. Curie's law, Weiss's Theory of Ferromagnetism and Ferromagnetic Domains. Discussion of B-H Curve. Hysteresis and Energy Loss.; Dielectric Properties: Polarization. Local Electric Field at an Atom. Depolarization Field. Electric Susceptibility. Polarizability. Clausius Mosotti Equation. Classical Theory of Electric Polarizability. Normal and Anomalous Dispersion. Cauchy and Sellmeir relations. Langevin-Debye equation. Ferroelectric Properties: Structural phase transition, Classification of crystals, Piezoelectric effect, Pyroelectric effect, Ferroelectric effect, Electro strictive effect, Ferroelectric domains, PE hysteresis loop. | 13 |
| IV | **Elementary band theory:** Kronig Penny model. Band Gap. Conductor, Semiconductor (P and N type) and insulator. Conductivity of Semiconductor, mobility, Hall Effect. Measurement of conductivity (04 probe method) & Hall coefficient. | 10 |
| V | **Superconductivity:** Experimental Results. Critical Temperature. Critical magnetic field. Meissner effect. Type I and type II Superconductors, London's Equation and Penetration Depth. Isotope effect. Idea of BCS theory (No derivation) | 10 |

**REFERENCE BOOKS:**


1. Introduction to Solid State Physics, Charles Kittel, 8th Edition, 2004, Wiley India Pvt. Ltd.
2. Elements of Solid State Physics, J.P. Srivastava, 4th Edition, 2015, Prentice-Hall of India
3. Introduction to Solids, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill
4. Solid State Physics, N.W. Ashcroft and N.D. Mermin, 1976, Cengage Learning
5. Solid-state Physics, H. Ibach and H. Luth, 2009, Springer • Solid State Physics, Rita John, 2014, McGraw Hill
6. Elementary Solid State Physics, 1/e M. Ali Omar, 1999, Pearson India
7. Solid State Physics, M.A. Wahab, 2011, Narosa P

| Course Code BPH-208 | Subject Name ELECTRONICS (Semester-IV) | L T P | Cr. |
|---|---|---|---|
| | | 3+1+0 | 4 |

| OBJECTIVES: |
|---|
| The aim of the course is to provide students with a fundamental knowledge of digital system and logic gates, flip-flop circuits. |
| **COURSE OUTCOMES:**<br>CO1: Student will learn about the basic electronics (digital and analog).<br>CO2: Design CMOS inverters, logic gates and transmission gates to specifications. a, c, e.<br>CO3: Understand the mechanism of sense amplifier and address decoder.<br>CO4: Analyze the effects of ideal feedback network on gain sensitivity, noise, distortion, bandwidth, and impedance. |

| Unit | Contents | Lectures |
|---|---|---|
| I | **Digital Fundamentals**: Binary, Octal and Hexadecimal number systems and their inter conversion, Binary arithmetic (addition, subtraction, multiplication, and division 1's and 2's complements).<br>**Basic logic gates:** OR, AND, NOT, NAND, NOR, XOR, XNOR, positive and negative logic, Boolean algebra theorems, De Morgan's Theorem examples of IC gates. code (straight Binary code, BCD code, gray code) Error detection, correction and Hamming codes. | 10 |
| II | **Basic Idea** about fundamental Products and derivation of through sum of product methods, sum of product equation. Minterms and Maxterms, Karnaugh mapping, k-map representation of logical functions for 2-4 variables.<br>Simplification of Boolean Equation with the help of k-map, Various minimization techniques, Quinne's Methods and quinnel Mc- Cluskey method, Difference between combinational & sequential ckts, Half adder, Full adder, Half subtractor, Full subtractor, Serial and parallel Binary adder. | 13 |
| III | **Flip Flop circuits:** Various kind of Flip Flops, clocked RS flip, Flop, Edge Triggered, D Flip Flop, Flip Flop, twitching time, JK Flip Flop, JK Master slave. Flip Flop. | 8 |
| IV | **Counters:** Clock waveforms, 555 timers as a stable multivibrator, shift registers: Serial out, parallel in, parallel out; synchronous counters, Alynchronous counters, Ring counters. | 8 |
| V | **Converter Circuits:** D/A converters, A/D Counters, clipping and Clamping, a stable, Monostable and bistable multivibrators using transistors.<br>**Logic Families:** Introduction and performance criteria for logic families, Various logic families: DCTL, RTL, DTL, TTL & ECL, working and characteristics in priew, Saturated and non-saturated , fan in and fan out, MOS gates and CMOS gate, comparison of various logic families. | 11 |

**REFERENCE BOOKS:**


1. Malvino and Leach, Digital Principle, and application
2. Taub and Schilling, Digital Integrated Electronics
3. Samuel C Lee, Digital Circuits and Logic Design
4. Pulse, Digital and Switching Waveforms, Millman and Taub.
5. Lionel Warnes, Macmillan Press Limited Analogue and Digital Electronics, London, 1998.

| Course Code BPH-210 | Subject Name THERMODYNAMICS (Semester IV) | L T P | Cr. |
|---|---|---|---|
| | | 3+1+0 | 4 |

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|---|
| **OBJECTIVES:**<br>The objective of this course is to develop a working knowledge of the laws and methods of thermodynamics and to use this knowledge to explore various applications. Many of these applications will relate to topics in materials science and the physics of condensed matter. |
| **COURSE OUTCOMES:**<br>CO1: Identify and describe the statistical nature of concepts and laws in thermodynamics, in particular: entropy, temperature, chemical potential, Free energies, partition functions.<br>CO2: Use the statistical physics methods, such as Boltzmann distribution, Gibbs distribution, Fermi-Dirac, and Bose-Einstein distributions to solve problems in some physical systems.<br>CO3: Apply the concepts and principles of black-body radiation to analyze radiation phenomena in thermodynamic systems.<br>CO4: Apply the concepts and laws of thermodynamics to solve problems in thermodynamic systems such as gases, heat engines and refrigerators etc. |

| Unit | Contents | Lectures |
|---|---|---|
| I | **Introduction to thermodynamics:** Zeroth and First Law of Thermodynamics: Extensive and intensive Thermodynamic Variables, Thermodynamic Equilibrium, Zeroth Law of Thermodynamics & Concept of Temperature, Concept of Work & Heat, State Functions, First Law of Thermodynamics and its differential form, Internal Energy, First Law & various processes, Applications of First Law: General Relation between $C_P$ and $C_V$, Work Done during Isothermal and Adiabatic Processes. | 10 |
| II | **Second law of thermodynamics:** Reversible and Irreversible process with examples. Conversion of Work into Heat and Heat into Work. Heat Engines. Carnot's Cycle, Carnot engine & efficiency. Refrigerator & coefficient of performance, 2nd Law of Thermodynamics: Kelvin Planck and Clausius Statements and their Equivalence. Carnot's Theorem. Applications of Second Law of Thermodynamics: Thermodynamic Scale of Temperature and its Equivalence to Perfect Gas Scale. | 11 |
| III | **Entropy:** Concept of Entropy, Clausius Theorem. Clausius Inequality, Second Law of Thermodynamics in terms of Entropy. Entropy of a perfect gas. Principle of Increase of Entropy. Entropy Changes in Reversible and Irreversible processes with examples. Entropy of the Universe. Entropy Changes in Reversible and Irreversible Processes. Principle of Increase of Entropy. Temperature–Entropy diagrams for Carnot's Cycle. | 11 |
| IV | **Maxwell's thermodynamic relations:** Perfect differentials, Extensive and intensive thermodynamic variables, Maxwell thermodynamic relation: derivation and application, specific heat of substance, relation between $C_P$ and $C_V$, Clausius Clapeyron equation, energy equation, Joule Thomson effect and coefficient, Temperature inversion, Ratio of Adiabatic and Isothermal Elasticities. | 10 |
| V | **Thermodynamic Potentials and their applications:** Thermodynamics veriables, thermodynamic potentials U, H, F and G, relations of thermodynamic potentials and varibles, Tds equations, streching of wire, cooling due to adiabatic demagnetization, Clausius Clapeyron Latent heat equation using Carnot's Cycle, Triple point, Basic idea about Phase transitions, Appoaches to Absolute zero. | 10 |

**REFERENCE BOOKS:**

1. Heat and Thermodynamics, M.W. Zemansky, Richard Dittman, 1981, McGraw-Hill.
2. A Treatise on Heat, Meghnad Saha, and B.N.Srivastava, 1958, Indian Press
3. Thermal Physics, S. Garg, R. Bansal and Ghosh, 2nd Edition, 1993, Tata McGraw-Hill
4. Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer.
5. Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Sears & Salinger. 1988, Narosa.
6. Concepts in Thermal Physics, S.J. Blundell and K.M. Blundell, 2nd Ed., 2012, Oxford University Press
7. Thermal Physics, A. Kumar and S.P. Taneja, 2014, R. Chand Publications

| Course Code BPH-212 | Subject Name CLASSICAL MECHANICS (Semester IV) | L T P | Cr. |
|---|---|---|---|
| | | 3+1+0 | 4 |

**LEARNING OBJECTIVES:**
To demonstrate knowledge and understanding of the following fundamental concepts in: the dynamics of system of particles, motion of rigid body, Lagrangian and Hamiltonian formulation of mechanics, To develop math skills as applied to physics.

**LEARNING OUTCOMES:**
CO1: Understand basic mechanical concepts related to discrete and continuous systems.
CO2: Understand the vibrations of discrete and continuous mechanical systems.
CO3: Understanding of Hamilton's principles and equation.
CO4: Understand planar and spatial motion of a rigid body.

| Unit | Contents | Lectures |
|---|---|---|
| I | Lagrangian formulation: Mechanics of a system of particles; constraints of motion, generalized coordinates, D'Alembert's Principle and Lagrange's velocity - dependent forces and the dissipation function, Applications of Lagrangian formulation. | 8 |
| II | Hamilton's principles: Calculus of variations, Hamilton's principle, Lagrange's equation from Hamilton's principle, extension to nonholonomic systems, advantages of variational principal formulation, symmetry properties of space and time and conservation theorems. | 14 |
| III | Hamilton's equations: Legendre Transformation, Hamilton's equations of motion, Cyclic co-ordinates, Hamilton's equations from variational principle, Principle of least action. | 10 |
| IV | Canonical transformation and Hamilton-Jacobi theory: Canonical transformation and its examples, Poisson's brackets, Equations of motion, Angular momentum, Poisson's Bracket relations, infinitesimal canonical transformation, Conservation Theorems. Hamilton Jacobi equations for principal and characteristic functions, Action-angle variables for systems with one-degree of freedom. | 10 |
| V | Rigid body motion and small oscillations: Independent co-ordinates of rigid body, orthogonal transformations, Eulerian Angles and Euler's theorem, infinitesimal rotation, Rate of change of a vector, Coriolis force, angular momentum and kinetic energy of a rigid body, the inertia tensor, principal axis transformation, Euler equations of motion, Torque free motion of rigid body, motion of a symmetrical top. Eigenvalue equation, Free vibrations, Normal Coordinates, Vibrations of a triatomic molecule. | 10 |

**REFERENCE BOOKS:**

1. Classical Mechanics: H. Goldstein, C. Poole and J. Safko (Pearson Education Asia, New Delhi), 3rd ed 2002.
2. Classical Mechanics of Particles and Rigid Bodies: K.C. Gupta (Wiley Eastern, New Delhi), 1988.

| Course Code BPH-252 | Subject Name PHYSICS LABORATORY-IV (Semester IV) | L T P | Cr. |
|---|---|---|---|
| | | 0+0+3 | 2 |

| OBJECTIVES: |
|---|
| The objective of the course Physics Laboratory-IV is to expose the students to experimental techniques in electronics, so that they can verify some of the things read in theory here or in earlier classes and develop confidence to handle sophisticated equipment. |
| **COURSE OUTCOMES:**<br>CO1: Experimental knowledge of LCR circuit.<br>CO2: Understanding of characteristics of given voltage doubler and tripler.<br>CO3: Understanding of clipping and clamping circuits.<br>CO4: Experimental knowledge of conductivity of semiconductor. |

| Practical | Practical Description |
|---|---|
| 1. | Design of a (i) regulated power supply and (ii) constant current supply. Study its load regulation. |
| 2. | To study the dependence of energy transfer on the mass ratio of the colliding bodies, using air track. |
| 3. | To verify the law of conservation of linear momentum in collision with initial momentum zero, using air track. |
| 4. | To measure the coupling factor between two pendulums and study its dependence on coupling mass and distance of coupling threads from axes of oscillation. |
| 5. | To study the dependence of frequency of normal modes and their difference in a coupled oscillator on coupling mass. |
| 6. | To study the series and parallel L.C.R. circuit and find its Q factor for different resistances. |
| 7. | To study the characteristics of given voltage doubler and tripler. |
| 8. | To study the clipping and clamping circuits. |
| 9. | To study the frequency response of given RC coupled transistor amplifier and determine its band width. |
| 10. | To determine the distributed capacity of given inductance coil. |
| 11. | To determine the given capacitance using flashing and quenching of a neon bulb. |
| 12. | To determine the operating plateau and dead time of a given G.M. Counter. |
| 13. | To determine the Hall coefficient and mobility of given semiconductors. |
| 14. | To study transmission line modeled as LC ladder and find out its propagation constant. |
| 15. | To measure magnetic volume susceptibility of liquid - FeCl2/MnSo4 solution by Quincke's method. |
| 16. | To find conductivity of given semiconductor crystal using four probe method. 18. To measure dielectric constant of a non-polar liquid and its applications. |

**REFERENCE BOOKS:**


1. A Textbook of Practical Physics: I Prakash, Ramakrishna, Kitab Mahal, 11th ed., 2011.
2. BSc Practical Physics: Geeta Sanon, R. Chand & Co., 1st ed., 2007.
3. BSc Physics Practical – I, II, III: Jain, Sharma, Agarwal, Krishan Prakashan, 2014.
4. B.Sc. Practical Physics: CL Arora, S Chand & Company Ltd., 2010.

# SEMESTER-V

| Course Code BPH-301 | Subject Name CONDENSED MATTER PHYSICS (Semester V) | L T P | Cr. |
|---|---|---|---|
| | | 3+1+0 | 4 |

**OBJECTIVES:**
The main objective of this course is to familiarize students with crystals, their structure and various phenomena associated within them.

**COURSE OUTCOMES:**
CO1: Explain mechanical properties of solid matter and connect these to bond type.
CO2: Explain how diffraction of electromagnetic waves on solid matter can be used to obtain lattice structure.
CO3: Knowledge of the concept of `phonons.
CO4: Knowledge the dispersion relationship appears for different lattice structures.

| Unit | Contents | Lectures |
|---|---|---|
| I | Solids and Crystal Structure: General definitions of Lattice, basis and primitive cell, Symmetry operations, Bravais lattices in two and three dimensions, Index system for crystal planes, resume of common lattice types (sc, fcc, bcc, hcp, diamond, NaCl, CsCl & Zns structures), fcc & hcp structures as stacking, Structures of insulators and metals, radius ratio rules and Pauling's principles. | 11 |
| I | Reciprocal Lattice and X-ray Diffraction: Reciprocal Lattice, Miller indices, Brillouin zone of sc, fcc and bcc lattices, Experimental diffraction methods, Bragg diffraction, scattered wave amplitude: atomic form factor, structure factor of simple structures (sc, fcc, bcc, hcp, diamond, NaCl, CsCl & ZnS), Neutron and electron diffraction methods, Temperature dependence of reflection lines. | 11 |
| II | Crystal Binding: Cohesive energy and bulk modulus in inert gas and ionic crystal, Binding in metallic, covalent, and H-bonded crystals (basic ideas only). Lattice Vibrations: Dynamics of monatomic and diatomic linear chains, optical and acoustic modes, concept of phonons, inelastic scattering of photons and neutrons by phonons, density of states (one & three dimensions), Einstein and Debye models of heat capacity, thermal expansion. | 11 |
| III | Free Electron Fermi Gas: Review of statistical mechanics of Fermi Gas of non-interacting electrons, heat capacity of electron gas, electrical conductivity, Ohm's Law, Hall Effect, thermal conductivity, and Pauli Paramagnetism. | 10 |
| IV | Band Theory: Bloch functions, Kronig-Penney model, Qualitative ideas of bands in metals, semi-metals, semiconductors and insulators, Fermi surface-basic idea with square lattice as an example. | 9 |

**REFERENCE BOOKS:**


1. Introduction to Solid State Physics: C Kittel, Wiley, 8th ed., 2005.
2. Introduction to Solids: LV Azaroff, Tata McGraw Hill, 1990.
3. Solid State Physics: AJ Dekker, Prentice-Hall of India.
4. Elements of Materials Science and Engineering: LH Van Vlack, Addison-Wesley, 1998.

| Course Code BPH-303 | Subject Name SPECIAL THEORY OF RELATIVITY (Semester V) | L T P | Cr. |
|---|---|---|---|
| | | 3+1+0 | 4 |

**OBJECTIVES:**
The main objective of this course is to familiarize students with special theory of relativity and gain knowledge and proficiency in solving problems on relativity.

**COURSE OUTCOMES:**
CO1: Demonstrate knowledge and broad understanding of Special Relativity.
CO2: Explain the meaning and significance of the postulate of Special Relativity.
CO3: Explain true nature of Lorentz transformation and Doppler effect.
CO4: Recall the setup and significance of Michelson-Morley experiment.

| Unit | Contents | Lectures |
|---|---|---|
| **I** | Frames of reference: Inertial frame, non inertial frames, Galilean principle of relativity, fictitious force, Rotating frame of reference, concept of Coriolis forces, Center of mass, motion of Center of mass, Center of mass as a frame reference. | **11** |
| **II** | Galilean transformation equations: Transformation of position, distance, velocity and acceleration. Conservation of Momentum and Energy. | **9** |
| **III** | Michelson Morley experiment. Postulates of special theory of relativity – Lorentz transformation equation – Length contraction and time dilation – Relativity of simultaneity concept of proper frame, proper length, proper time – relativistic velocity transformation equations – Variation of mass with velocity. Einstein's mass energy relation – (with derivation) Energy momentum relationship – concept of four vectors – Minkowisky space. | **12** |
| **IV** | Free Electron Fermi Gas: Review of statistical mechanics of Fermi Gas of non-interacting electrons, heat capacity of electron gas, electrical conductivity, Ohm's Law, Hall Effect, thermal conductivity and Pauli Paramagnetism. | **10** |
| **V** | Principle of equivalence, principle of general covariance, criteria for gravitational field equations, Einstein field equations, gravity as a geometric Phenomenon. The energy momentum tensor, the field equations and their classical limits | **10** |

**REFERENCE BOOKS:**


1. Rindler W. Special Relativity, 1966 .
2. Resnick, R., Introduction to special relativity, Wiley-Eastern, 1990.
3. Special Theory of Relativity, Anshan Publishers-2009.

| Course Code BPH-305 | Subject Name ELECTROMAGNETIC THEORY-I (Semester V) | L T P | Cr. |
|---|---|---|---|
| | | 3+1+0 | 4 |

| **OBJECTIVES:** |
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| The main objective of this course is to make students understand various phenomena involved with electromagnetic waves. |
| **COURSE OUTCOMES:**<br>CO1: Understanding Maxwell's equations.<br>CO2: Study various phenomena involved with E.M waves.<br>CO3: Understanding the formation of fringes from light interference and diffraction<br>CO4: Study Fresnel and fraunhauffer diffraction |

| Unit | Contents | Lectures |
|---|---|---|
| I | **Electromagnetic Waves:** Maxwell's equations, wave equation, e.m. waves in a medium with finite ε and μ, Plane waves, Energy flux due to a plane e.m. wave, Wave-impedance of a medium to e.m. waves, e.m. waves in a conducting medium – skin depth and impedance of a conductor. Reflection and Transmission of E.M. waves at the boundary of two dielectric media - impedance and refractive index, E.M. theory of dispersion. | 12 |
| II | **Polarization:** Polarization of plane harmonic waves, linear, circular and elliptical polarization, natural light, production of polarized light, Malus' law, polarization by scattering, Birefringence, quarter wave and half-wave plates. Double refraction, Nicol prism, analysis of circularly and elliptically polarized light. | 10 |
| III | **Interference:** Light vector, coherence, theory of interference. Young's double slit experiment, Fresnel's Biprism, displacement of fringes, fringes with white light, Stoke's law, interference in thin films, non-reflecting films, Newton's rings, and applications. | 10 |
| IV | **Michelson's interferometer**— principle, theory and applications, Fabry-Perot interferometer and etalon, Interference filters. | 9 |
| V | **Diffraction:** Introduction: Helmholtz Kirchhoff's integral, scalar diffraction theory, Fraunhofer diffraction: single slit, circular aperture, diffraction grating, Rayleigh's criterion for resolution, resolving power of a diffraction grating, a telescope and a microscope, Fresnel diffraction at a single slit and circular aperture, Fresnel's half period zones, zone plate. Explanation of rectilinear propagation. | 11 |

**REFERENCE BOOKS:**


1. Text Book of Vibrations and Waves: SP Puri, Macmillan India, 2004.
2. The Physics of Vibrations and Waves: HJ Pain, Wiley and ELBS, 1976.
3. Fundamentals of Optics: FA Jenkins, HE White, McGraw Hill, 1981.

| Course Code BPH-307 | Subject Name ELEMENTS OF MODERN PHYSICS (Semester V) | L T P | Cr. |
|---|---|---|---|
| | | 3+1+0 | 4 |

**OBJECTIVES:**
The main objective of this course is to familiarize students with various atomic models and their behavior.

**COURSE OUTCOMES:**

CO1: Knowledge of the atomic structure and development.
CO2: Understanding of various atomic models.
CO3: Knowledge of the Bohr atom model.
CO4: Understanding of the series of spectra.

| Unit | Contents | Lectures |
|---|---|---|
| I | Particle-like properties of electromagnetic radiation: Electromagnetic spectrum, electromagnetic waves, blackbody radiation, the photoelectric effect, the Compton effect, Bremsstrahlung and X-ray production. | 9 |
| II | Models of the atom: Thompson model, Rutherford model, line spectra, Bohr model, Franck-Hertz experiment, the correspondence principle, deficiencies of Bohr atomic model, vector model, intrinsic spin. | 8 |
| III | Atomic Spectra and Models Atomic spectra, Line spectra of hydrogen atom, , Alpha Particle Scattering, Rutherford Scattering Formula, Rutherford Model of atom and its limitations. | 8 |
| IV | Atomic Model: Bohr's Model of Hydrogen atom, explanation of atomic spec- tra, correction for finite mass of the nucleus, Bohr correspondence principle, limitations of Bohr model, discrete energy exchange by atom, Frank Hertz Experiment, Sommer fields modification of Bohr's Theory. | 9 |
| V | Nuclear Physics- I: Size and structure of atomic nucleus and its relationship with atomic weight, Impossibility of an electron being in the nucleus as a con- sequence of the uncertainty principle, Nature of the nuclear force, NZ graph, Liquid Drop model: semi empirical mass formula and binding energy, Nuclear Shell Model, and magic numbers. Radioactivity, stability of the nucleus, Law of radioactive decay, Mean life and Half-life Alpha decay, Beta decay-energy released. | 12 |

**REFERENCE BOOKS:**


1. Krane, K. S., *Modern Physics*, (John Wiley & Sons, 1983)
2. Bernstein, J., Fishbane, P. M. and Gasiorowicz, S. G., *Modern Physics*, 1st edition, (Prentice-Hall, 2000).

| Course Code BPH-309 | Subject Name PLASMA PHYSICS (Semester V) | L T P | Cr. |
|---|---|---|---|
| | | 3+1+0 | 4 |

| **OBJECTIVES:** |
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| The main objective of this course is to understand the basics and mathematical formulations of plasma physics. |
| **COURSE OUTCOMES:**<br>CO1: Knowledge of formulating and modifying the basic dynamic fluid equations off plasma.<br>CO2: Knowledge the dynamics of plasma media at different levels.<br>CO3: Understanding the propagation of waves in plasmas.<br>CO4: Understanding the dispersion relation for these waves. |

| Unit | Contents | Lectures |
|---|---|---|
| I | Plasma State: Ionized gas, Saha's ionization equation; Collective degrees of freedom, Definition of Plasma, Concept of Plasma temperature, Debye shielding, Quasi-neutrality, Plasma parameters, Plasma approximation, Natural existence of Plasma. Single-particle motion: Dynamics of charged particles in electro-magnetic fields. | 10 |
| II | Particle drifts, EXB drifts, Grad-B drift, Curvature drift, Polarization drift, Adiabatic invariants, and their technological applications. | 10 |
| III | Kinetic theory of Plasma: Vlasov equations, Solution of linearized Vlasov equation, Langmuir waves, Ion-sound waves, Wave-particle interaction and Landau damping, Plasma instabilities and classification, Two-stream, and gravitational instabilities. | 11 |
| IV | Fluid theory of Plasma: Plasma oscillations, Electron-acoustic waves, Ion-acoustic waves, Electrostatic ion-waves perpendicular to magnetic field. | 9 |
| V | Application of Plasma Physics: Thermonuclear fusion- present status and problems, Requirements for fusion plasmas- confinement, beta, power and particle exhaust, Tokamak fusion reactors. Dusty plasma in laboratory and space, Dust charging processes, Waves in dusty plasma, Dust crystal. Laser plasma interaction, Inertial confinement, High-harmonic generation, Laser Wakefield electron accelerator, X-ray laser. Plasma engineering, Industrial applications of plasma. | 12 |

**REFERENCE BOOKS:**

1. Chen, F. F., Introduction to Plasma Physics and Controlled Fusion, 2nd edition, (Plenum, New, York, 1984).
2. Hutchinson, I. H., Principles of Plasma Diagnostics, 2nd edition, (Cambridge University Press, 2002)Solid State Physics: AJ Dekker, Prentice-Hall of India.
3. Vinod, K., Astrophysical Plasmas and Fluids (Springer, New Delhi, 1998)

| Course Code BPH-351 | Subject Name PHYSICS LABORATORY-V (Semester V) | L T P | Cr. |
|---|---|---|---|
| | | 3+1+0 | 4 |

**OBJECTIVES:**
The main objective of this course is to familiarize students with a range of experiments.

**COURSE OUTCOMES:**

CO1: Understand the regulated and constant power supply system.

CO2: Understand the conservation of linear momentum.

CO3: Understand the use of capacitance and inductance.

CO4: Understand the use of transistor and amplifier.

| Practical | Practical Description |
|---|---|
| **1.** | Design of a (i) regulated power supply and (ii) constant current supply. Study its load regulation. |
| **2.** | To study the dependence of energy transfer on the mass ratio of the colliding bodies, using air track. |
| **3.** | To verify the law of conservation of linear momentum in collision with initial momentum zero, using air track. |
| **4.** | To measure the coupling factor between two pendulums and study its dependence on coupling mass and distance of coupling threads from axes of oscillation. |
| **5.** | To study the dependence of frequency of normal modes and their difference in a coupled oscillator on coupling mass. |
| **6.** | To study the characteristics of given voltage doubler and tripler. |
| **7.** | To study the clipping and clamping circuits. |
| **8.** | To study the frequency response of given RC coupled transistor amplifier and determine its band width. |
| **9.** | To determine the distributed capacity of given inductance coil. |
| **10.** | To determine the given capacitance using flashing and quenching of a neon bulb. |

**REFERENCE BOOKS:**


1. A Textbook of Practical Physics: I Prakash, Ramakrishna, Kitab Mahal, 11th ed., 2011.
2. BSc Practical Physics: Geeta Sanon, R. Chand & Co., 1st ed., 2007.
3. BSc Physics Practical – I, II, III: Jain, Sharma, Agarwal, Krishan Prakashan, 2014.
4. B.Sc. Practical Physics: CL Arora, S Chand & Company Ltd., 2010.

# SEMESTER-VI

| Course Code BPH-302 | Subject Name FUNDAMENTALS OF NANOTECHNOLOGY (Semester VI) | L T P | Cr. |
|---|---|---|---|
| | | 3+1+0 | 4 |

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| **OBJECTIVES:**<br>The course aims to introduce the basic concepts of Nanotechnology and its applications. To recognize the methods and different characteristics to develop the new nano materials. |
| **COURSE OUTCOMES:**<br>CO1: Learn the background of nanotechnology.<br>CO2: Understand the impact of nanomaterials in our daily life.<br>CO3: Understand the need of nanotechnology.<br>CO4: Understand the synthesis process and different characterization techniques of nanomaterials and its applications. |

| Unit | Contents | Lectures |
|---|---|---|
| I | **Nanoscale systems:** Introduction of nanotechnology, use of nanotechnology, Length scales, 1D, 2D and 3D nanostructures (nanodots, nanowires, nanorods, thin films,), Band structure and density of states of materials at nanoscale, Size effects in nano systems, Quantum confinement. | 10 |
| II | **Synthesis of nanostructured materials**: Top-down and bottom-up approach, Photolithography. Ball milling. Gas phase condensation. Vacuum deposition. Physical vapor deposition (PVD): Thermal evaporation, E-beam evaporation, Pulsed Laser deposition. Chemical vapor deposition (CVD). Solid state method, Sol-Gel method, Electro deposition. Spray pyrolysis. Hydrothermal synthesis. Co-precipitation method. | 12 |
| III | **Characterization:** X-Ray Diffraction, Optical Microscopy, Scanning Electron Microscopy, Transmission Electron Microscopy, Atomic Force Microscopy, Scanning Tunnelling Microscopy, FTIR, UV spectroscopy. | 11 |
| IV | **Properties of nanomaterials:** Piezoelectric, pyroelectric, ferroelectric properties. Dielectric constant for nanostructures. semiconductor nanocrystals, absorption, emission, and luminescence. Optical properties of heterostructures and nanostructures. Defects and impurities. Mechanical and thermal properties of nanomaterials. | 10 |
| V | **Applications:** Applications of nanoparticles, quantum dots, nanowires and thin films for photonic devices (LED, solar cells). Single electron devices. CNT based transistors. Micro Electromechanical Systems (MEMS), Nano Electromechanical Systems (NEMS) | 9 |

**REFERENCE BOOKS:**


1. An Introduction to Modern Optics, Ajay K Ghatak, Tata Mc-Graw Hill Co., New Delhi .
2. Advanced Engineering Mathematics, Kreyszig.
3. A Textbook of Light, D.N. Vasudeva, Atma Ram and Sons, New Delhi.
4. Optics, Born and Wolf.
5. Optics, K.D. Moltev, Oxford University

| Course Code BPH-304 | Subject Name ELECTROMAGNETIC THEORY-II (Semester VI) | L T P | Cr. |
|---|---|---|---|
| | | 3+1+0 | 4 |

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| **OBJECTIVES:**<br>The main objective of this course is to further understand the complex behavior of electromagnetic waves. |
| **COURSE OUTCOMES:**<br>CO1: Understand the retarded and Lienard- Wiechart potentials.<br>CO2: Understand the electric and magnetic potentials.<br>CO3: To understand the cherenkovv radiation.<br>CO4: Calculate the lagrangian of electromagnetic fields |

| Unit | Contents | Lectures |
|---|---|---|
| I | Radiation: Retarded potentials, Hertzian dipole, antennas and arrays, half-wave dipole, Loop current element, Lenard-Wiechert potentials and electromagnetic fields of a moving point charge. | 12 |
| II | Electric and magnetic dipole radiations, power radiated by a moving point charge, motion of charged particles in electromagnetic fields, | 10 |
| III | Cherenkov radiation, transmission lines, impedance of line, scattering and diffraction. | 10 |
| IV | Four vectors, relativistic electrodynamics, field tensor, energy-momentum tensor, interdependence of electric and magnetic fields, transformation of electromagnetic fields under Lorentz transformation, invariance of Maxwell’s equations | 11 |
| V | Lagrangian for electromagnetic fields, Maxwell’s equations from least action principle. | 9 |

**REFERENCE BOOKS:**


1. Jordan, E. K. and Balmain, K. G., Electromagnetic waves and Radiating systems,
2. Nasar, S. A., 2000 Solved Problems in Electromagnetics, Schaum's series, (McGraw-Hill, 1992.
3. Griffiths, D. J., Introduction to Electrodynamics, (Prentice Hall of India, 2009)
4. Jackson, J. D., Classical Electrodynamics, 3rd edition, (Wiley Eastern Ltd, 1998)

| Course Code BPH-306 | Subject Name MATERIAL SCIENCE | L T P | Cr. |
|---|---|---|---|
| | | 3+1+0 | 4 |

| **OBJECTIVES:** |
|---|
| The main objective of this course is to make students understand the behavior of materials. |
| **COURSE OUTCOMES:**<br>CO1: Understanding the crystal structure and symmetry.<br>CO2: Understanding crystal imperfections.<br>CO3: Understanding phase diagrams of crystals.<br>CO4: Understanding the elastic and fracture behavior of materials. |

| Unit | Contents | Lectures |
|---|---|---|
| I | Internal Structure of Materials: Atomic basis of structure – ionic bonding, covalent bonding, Metallic bonding, Secondary bonding. Crystalline and non-crystalline states, Crystal symmetry, Metal Structures, Ionic and Covalent Structures, Silica and silicates, Polymers, Fullerenes, Experimental methods for structural determination: x-ray and neutron diffraction. | 11 |
| II | Crystal Imperfections: Point, line, surface and volume imperfections, dislocations and their geometry, Disorder in polymers and non-crystalline materials. | 10 |
| III | Phase Diagrams: Phase rule, Single component systems, Binary phase diagrams, Lever rule, phases in polymers, non-crystalline and crystalline phases. Non-equilibrium in phase diagrams, Cu-Zn system, Fe- C alloys, Ceramic Systems, Other applications of phase diagrams. Phase Transformations: Time scale for phase changes, Nucleation kinetics, Growth of nuclei and solidification of alloys, Transformations in steel, Precipitation processes, Glass Transition; Recovery, recrystallization, and grain growth. | 13 |
| IV | Elastic Properties: Elastic behavior and its atomic model, Rubber like elasticity, Anelastic behavior, Relaxation processes, Viscoelastic behavior, spring dash pot model, Plastic deformation | 9 |
| V | Fracture: Ductile fracture, Brittle fracture, Fracture toughness, Ductile-brittle transition, Protection against fracture, Fatigue fracture. | 9 |

**REFERENCE BOOKS:**


1. Introduction to Solid State Physics: C Kittel, Wiley, 8th ed., 2005.
2. Introduction to Solids: LV Azaroff, Tata McGraw Hill, 1990.
3. Solid State Physics, AJ Dekker, Prentice-Hall of India.
4. Essentials of Materials Science: AG Guy, McGraw Hill, 1976.

| Course Code BPH-308 | Subject Name LASER PHYSICS (Semester VI) | L T P | Cr. |
|---|---|---|---|
| | | 3+1+0 | 4 |

**OBJECTIVES:**
The main objective of this course is to know and understand the basics of laser physics.

**COURSE OUTCOMES:**

CO1: Understand the basics and formation of lasers.

CO2: Know the details of laser pumping and resonators.

CO3: Knowledge of different lasers.

CO4: Know the applications of lasers.

| Unit | Contents | Lectures |
|---|---|---|
| **I** | Introduction: Introduction, monochromaticity, temporal and spatial coherence, Einstein's coefficients, momentum transfer, possibility of light amplification, kinetics of optical absorption, shape and width of spectral lines, line broadening mechanism, natural, collision and Doppler broadening. | **12** |
| **II** | Laser Pumping and Resonators: Resonators, modes of a resonator, number of modes per unit volume, open resonators, confocal resonator (qualitative), quality factor, losses inside the cavity, threshold condition, quantum yield. | **10** |
| **III** | Dynamics of the Laser Processes: Rate equations for two, three and four level systems, production of a giant pulse – Q switching, giant pulse dynamics, laser amplifiers, mode-locking, hole burning, distributed feedback lasers. | **10** |
| **IV** | Types of Lasers: He-Ne laser, Nitrogen Laser, CO2 laser, Ruby laser, features of semiconductor lasers, intrinsic semiconductor lasers, doped semiconductors, condition for laser action, Advances in semiconductor lasers, injection lasers, dye lasers. | **10** |
| **V** | Applications: Holography, non-linear optics: harmonic generation, second harmonic generation, phase matching and optical mixing, brief qualitative description of some experiments of fundamental importance. | **10** |

**REFERENCE BOOKS:**


1. Lasers and Non-linear Optics: BB Laud, Wiley Eastern, 1991.
2. Principles of Lasers: O Svelto, Plenum Press, 4th ed., 1998.
3. An Introduction to Lasers and their applications: DC O'Shea, W Russell, WT Rhodes, Addition –Wesley, 1977.
4. Laser Theory and Applications: Thyagarajan, A Ghatak, Plenum reprint: MacMillan, 1981.

| Course Code BPH-352 | Subject Name PROJECT (Semester VI) | L T P | Cr. |
|---|---|---|---|
| | | 0+0+22 | 11 |

| Description |
|---|
| Students are required to work on the allotted topic and must make a presentation in front of advisory committee and B.Sc. Students. Students are expected to provide latest facts and updated information by consulting latest editions of textbooks, reference books, monographs, and peer-reviewed national & international research journals. |

| S.No. | Course details |
|---|---|
| 1. | Research work |
| 2. | Seminar |
| 3. | Evaluation by Research committee |
| 4. | Research work by taking 52 credit hours |