Semester-I

BSC/PHY/MD/1/DSC/101–Mechanics

Credits: 3 **Max. Marks: 75**
Lectures: 45 **Final Term Exam.: 50**
Duration of Exam.: $2\frac{1}{2}$ Hrs. **Internal Assessment: 25**

Objective: The objective of this course is to teach the students fundamentals of Newtonian Mechanics, rigid body dynamic, concept of inverse square force and the special theory of relativity**.**

Course Outcomes: After successfully completing the course, student will be able to:

CO1: Learn the concept of conservation of energy, momentum, angular momentum and apply them to understand the basic problems in physics.

CO2: Understand the application of rotational dynamics motions in analyzing rolling with slipping. Write the expression for the moment of inertia about the given axis of symmetry for different uniform mass distributions.

CO3: Understand the concept of central force problem, gravitational energy and GPS. Applications of inverse square law.

CO4: Describe special relativistic effects and their effects on the mass and energy of a moving object and appreciate the nuances and important outcomes of Special Theory of Relativity.

Note for the Paper Setter: *The question paper will consist of seven questions in all. The first question will be compulsory and will consist of four short questions of 2 marks each covering the whole syllabus. In addition, six more questions will be set unit-wise comprising of two questions from each of the three units. The candidates are required to attempt three more questions selecting at least one question from each unit.*

Unit-I

Fundamentals of Dynamics: Reference frames, Inertial and non-inertial frames of references, Conservative and non-conservative forces, fictitious forces, Concept of potential energy, Energy diagram. Stable and unstable equilibrium, Elastic potential energy, Force as gradient of potential energy, Work &Potential energy, Impulse, Centre of Mass for a system of particles, Motion of centre of mass (discrete and continuous), Expression for kinetic energy, Linear momentum and angular momentum for a system of particles in terms of centre of mass values.

Collisions: Elastic and inelastic collisions between particles, Centre of Mass and Laboratory frames.

Unit-II

Rotational Dynamics: Equation of motion of a rigid body, Rotational motion of a rigid body in general and that of plane lamina, Rotation of angular momentum vector about a fixed axis, Angular momentum and kinetic energy of a rigid body about principal axis, Torque, Principle of conservation of angular momentum, Moment of Inertia (discrete and continuous), Calculation of moment of

inertia for rectangular, cylindrical and spherical bodies, Kinetic energy of rotation, Motion involving both translation and rotation, elementary Gyroscope.

Unit-III

Inverse Square Law Force: Forces in nature (qualitative), Central forces, Law of gravitation, Gravitational potential energy, Inertial and gravitational mass,

Special Theory of Relativity: Michelson-Morley Experiment and its outcome, Galilean transformation (velocity, acceleration)and its inadequacy, Postulates of Special Theory of Relativity, Lorentz Transformations, simultaneity, Lorentz contraction, Time dilation, Relativistic transformation of velocity, frequency and wave number, Relativistic addition of velocities, Variation of mass with velocity,

Text/Reference Books:

1. Classical Mechanics by H. Goldstein (2^{nd}Edition)
2. Berkeley Physics Course.Vol. 1.Mechanics, E.M. Purcell
3. Concepts of Modern Physics,Arthur Beiser
4. An introduction to Mechanics, D. Kleppner, R.J. Kolenkow, 2007, McGraw-Hill.
5. Mechanics, D.S. Mathur, S. Chand and Company Limited,2012.
6. Introduction to Special Relativity, R. Resnick, 2005, John Wiley andSons.
7. University Physics, F.W. Seers, M. W. Zemansky, H. D. Young, Addison-Wesley Pub. Co.
8. Fundamentals of Physics, Halliday, &Walker, Resnick John Wiley &Sons,Inc.

BSC/PHY/MD/1/DSC/102–Physics Lab-I

Credits: 1 (Practical) **Max. Marks: 25**
Teaching per week: 2 Hrs. **Duration of Exam: 2 Hrs.**

Objective: The objective of this course is to impart practical knowledge through design and performance of experiments.

Course outcomes: After successfully completing the course, student will be able to:

CO1: Hands on experience with different instruments and measurements of different physical quantities and related concepts in Physics.

CO2: Verify some fundamental principles, effects and concepts of physics through experimentation.

CO3: Perform experiments related to mechanics (compound pendulum), rotational dynamics (Flywheel), elastic properties (Young Modulus and Modulus of Rigidity) and fluid dynamics (verification of Stokes law, Searle method) etc.

CO4: Learn to present observations, results and analysis in suitable and presentable form.

List of Experiments:

1. Measurement of Length (or diameter) using Travelling Microscope.
2. Moment of Inertia of a Fly Wheel
3. Moment of Inertia of irregular body using a Torsion Pendulum.
4. Surface Tension by Jaeger's Method.
5. Young Modulus by Bending of Beam.
6. Modulus of rigidity of material of wire by Maxwell's Needle.
7. Elastic constant by Searle's method.
8. Viscosity of water by its flow through a uniform capillary tube.
9. Acceleration due to Gravity 'g' by Bar pendulum.
10. To study the Motion of spring and calculate Spring constant & value of Acceleration due to Gravity.
11. To compare Moment of Inertia of a solid Sphere, Hollow Sphere and solid Disc of same mass with the help of Torsion Pendulum.

References:

1. B.Sc. Practical Physics, C.L. Arora, S. Chand Publisher, New Delhi
2. Advanced Level Practical Physics, M.Nelkon and Ogborn, Henemann Education Books Ltd., New Delhi
3. Practical Physics, S.S. Srivastava and M.K. Gupta, Atma Ram & Sons, Delhi
4. Practical Physics, S.L. Gupta and V. Kumar, PragatiPrakashan Meerut
5. Modern Approach to Practical Physics, R.K.Singla, Modern Publishers, Jalandhar
6. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, Asia Publishing House

BSC/PHY/MD/1/MIC/101–Environmental Physics

Credits: 2 **Max. Marks: 50**
Lectures: 30 **Final Term Exam.: 35**
Duration of Exam.: 2 Hrs. **Internal Assessment: 15**

Objective: To enhance the understanding of energy and its types, thermal aspects of energy generation and radioactivity in detail. This course will provide knowledge about nuclear reactors.

Course outcomes:
CO1: Structure and thermodynamics of the atmosphere develop a keen interest in weather formation and its change (or science behind the nature).

CO2: Students get aware of climate change issues.
CO3: Gain a basic knowledge of energy transformations and heat engines.

OC4: Understand how electricity can be generated from nuclear reactions. Become aware of biological effects of nuclear radiations.

Note for the Paper Setter: *The question paper will consist of five questions in all. The first question will be compulsory and will consist of seven short questions of 1 mark each covering the whole syllabus. In addition, four more questions will be set unit-wise comprising of two questions from each of the two units. The candidates are required to attempt two more questions selecting at least one question from each unit.*

Unit-I

Structure and thermodynamics of the atmosphere; Troposhere, Stratosphere, Mesophere, Ionoshpere, Exosphere; Temperature, pressure and density variations with height; Composition of air. Radiation, radiant energy; Solar and Terrestrial radiation; Rayleigh and Mie scattering; Ultraviolet(UV) radiation, Infrared (IR) radiation, Ozone depletion problem; Green House Effect, Global warming.

Unit-II

Concept of heat, energy and work, Energy transformation, Thermodynamic state of a system, Laws of thermodynamics, Isothermal and adiabatic processes; Carnot cycle, Heat pump and refrigerator; Entropy and disorder. Radioactivity; Characteristics of radioactive radiations; Radioisotopes and application; Units of radiation dose, Biological effects of nuclear radiation and safety measure; Age of earth-radioactive dating; Nuclear energy, Nuclear reactor.

Text/Reference Books:

- Lutgens, F. K., & Tarbuck, E. J. (2018). The atmosphere: An Introduction to Meteorology. London: Pearson.
- Salby, M.L. (1996). Fundamentals of Atmospheric Physics. Cambridge: Academic Press.
- Santra, S. C. (2011). Environmental Science. New Delhi: New Central Book Agency.
- Boeker, E., & Groundelle R. V. (2011). Environmental Physics. New Jersey: John Wiley.
- Manna, A. (2011). Heat and Thermodynamics. Noida: Pearson Education India.
- Ghoshal, S. N. (1994). Nuclear Physics. New Delhi: Sultan Chand & Sons.

CDLU/SEC/1/101–Physics Lab-II

Credits:3 (Practical) **Max. Marks: 75**
Teaching per week: 4 Hrs. **Duration of Exam: 4 Hrs.**

Objective: The objective of this course is to impart practical knowledge through design and performance of experiments.

Course outcomes: After successfully completing the course, student will be able to:
CO1: Hands on experience with different instruments and appreciate the beauty of different concepts and related experiments in Physics.
CO2: Verify some fundamental principles, effects and concepts of physics through experiments. Gaining knowledge related to LCR circuits, Ballistic galvanometer, magnetic field and inductance of two coils.
CO3: Perform experiments related to A.C. mains, D.C. voltage and current. Learn experimentation with Thevenin, Norton and Superposition theorems.
CO4: Learn to present observations, results and analysis in suitable and presentable form.

List of Experiments

1. To use Multimeter for measuring Resistance, A.C. and D.C. Voltage and Current, checking of electrical fuses.
2. Low resistance by Carey Foster's bridge with calibration.
3. Determination of Impedance of an A.C. circuit and its verification.
4. Frequency of A.C. mains using an electromagnet.
5. Frequency of A.C. mains Electrical vibrator.
6. High resistance by substitution method.
7. To study the characteristics of a series RC Circuit.
8. To determine an unknown Low Resistance using Potentiometer.
9. To determine an unknown Low Resistance using Carey Foster's Bridge
10. To compare capacitances using De'Sauty's bridge.
11. Measurement of field strength B and its variation in a solenoid (determine dB/dx).
12. To determine self-inductance of a coil by Anderson's bridge.
13. To study response curve of a Series LCR circuit and determine its (a) Resonant frequency, (b) Impendence at resonance, (c) Quality factor Q, and (d) Band width.
14. To study the response curve of a parallel LCR circuit and determine its (a) Anti-resonant frequency and (b) Quality factor Q.
15. Measurement of charge and current sensitivity and CDR of Ballistic Galvanometer.
16. Determine a high resistance by leakage method using Ballistic Galvanometer.
17. To determine self-inductance of a coil by Rayleigh's method.

18. To determine the mutual inductance of two coils by Absolute method.

References:

1. B.Sc. Practical Physics, C.L. Arora, 2005-2006, S. Chand Publisher, New Delhi
2. Advanced Level Practical Physics, M.Nelkon and Ogborn, Henemann Education Books Ltd., New Delhi
3. Practical Physics, S.S. Srivastava and M.K. Gupta, Atma Ram & Sons, Delhi
4. Practical Physics, S.L. Gupta and V. Kumar, PragatiPrakashan Meerut
5. Modern Approach to Practical Physics, R.K. Singla, Modern Publishers, Jalandhar
6. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, Asia Publishing House.

Semester-II

BSC/PHY/MD/2/DSC/103– Thermal Physics

Credits: 3 **Max. Marks: 75**
Lectures: 45 **Final Term Exam.: 50**
Duration of Exam.: $2\frac{1}{2}$ Hrs. **Internal Assessment: 25**

Objective: The course on thermal physics is framed with the objective that students are able to understand basic concepts of thermos-dynamical systems. Students will be able to understand heart, work, temperature, entropy and the laws of thermodynamics. Behaviour of real gases as thermos-dynamical systems has also been included.

Course Outcomes: After successfully completing the course, student will be able to:
CO1: Learn about Kinetic interpretation of Temperature, the real gas equations, Van der Waal equation of state and Brownian motion.
CO2: Learn the basic aspects of kinetic theory of gases, Maxwell-Boltzman distribution law, equitation of energies, mean free path of molecular collisions, viscosity, thermal conductivity, diffusion.
CO3: Understand the basic concepts of thermodynamics, the first and the second law of thermodynamics, Joule Thomson effect, Joule-Thomson(Porous plug)experiment, the concept of entropy and the associated theorems, calculations of entropy freversible& irreversible process, T-Sdiagram and Nernstheat law (third law of thermodynamics).
CO4: Derive the Clausius-Clapeyron and Clausiuslatent heat equations and understand their significance. The students will also be able to learn about Maxwell's thermodynamic relations their physical interpretations.

Note for the Paper Setter: *The question paper will consists of seven questions in all. The first question will be compulsory and will consist of four short questions of 2 marks each covering the whole syllabus. In addition, six more questions will be set unit-wise comprising of two questions from each of the three units. The candidates are required to attempt three more questions selecting at least one question from each unit.*

Unit-I

Zeroth and First Law of Thermodynamics: Extensive and intensive thermodynamic variables, Thermodynamic equilibrium, zeroth law and Concept of Temperature, Work and heat, State functions, Firstlawof thermodynamics, Internal energy, Applications of first law, General relation between C_p and C_v, Work done during isothermal and adiabatic processes.

Unit-II

Entropy and Third law of Thermodynamics: Concept of entropy, Clausius theorem, Clausius Inequality, Second Law of Thermodynamics in terms of Entropy, Entropy of a

Perfect Gas and Universe, Entropy Changes in Reversible and Irreversible Processes, Principle of Increase of Entropy, Third Law of The rmodynamics, Unattainability of absolute zero, T-S Diagrams, Phase Change, Classification of Phase Changes.

Unit-III

Thermodynamic Potentials: Extensive and Intensive Thermodynamic Variables; Internal Energy; Definition, importance, properties and applications of Chemical Potential, Enthalpy, Gibbs function and Helmholtz function. **Maxwell's Thermodynamic Relations:** Derivations of Maxwell's Relations and their applications: (1) Clausius- Clapeyronequation(2) Cp-Cvvalue, (3) Energy equations (4) Change of temperature during adiabatic process.Van -der Waal's Equation of State for Real Gases.

Thermo-electricity: Seeback effect, Paltier effect, Thomson effect and their explanations.

Text/Reference Books:

1. A Treatise on Heat: MeghnadSahaand B.N. Srivastava, IndianPress
2. Thermal Physics: S. Garg, R. Bansal and Ghosh, Tata McGraw-Hill
3. Concepts in Thermal Physics: S.J. Blundell and K.M. Blundell, Oxford University Press
4. Heat and Thermodynamics: An Intermediate Textbook by M. W. ZemanskyandR. Dittman, McGraw-Hill.
5. Thermal Physics and Statistical Mechanics, S.K. Roy, New Age International Publishers, New Delhi
6. Thermodynamics and Statistical Physics, J.K.Sharma and K.K. Sarkar, Himalaya Publishing House, Bombay
7. Introduction to Thermodynamics and itsApplications, Stowe Keith,University Press (India) Pvt.Ltd,Hyderabad
8. Introductory Thermodynamics, PierreInfelta, BrownWalkerPress, Boca Ratan, Florida
9. Fundamentalsof Thermodynamics, J. K.Johnson, Universityof Pittsburgh2009
10. Thermodynamics andItsApplications, Jefferson Tester, Michael Modell, 3rd Edition
11. Thermodynamics, Statistical Thermodynamics & Kinetics, Thomas Engel, PhilipReid, 2nd Edition

BSC/PHY/MD/2/DSC/104–Physics Lab-III

Credits: 1 (Practical) **Max. Marks: 25**
Teaching per week: 2 Hrs. **Duration of Exam: 2 Hrs.**

Objective: The objective of this course is to impart practical knowledge through design and performance of experiments.

Course outcomes: After successfully completing the course, student will be able to:
CO1: Hands on experience with different instruments and measurements of related physical quantities.
CO2: Verify some fundamental principles, effects and concepts of physics through experimentation.
CO3: Perform basic experiments in thermal Physics, viz., determinations of Stefan's constant, coefficient of thermal conductivity, temperature coefficient of resistant, variation of thermo-emf of a thermocouple with temperature difference at its two junctions and calibration of a thermocouple.
CO4: Learn to present observations, results and analysis in suitable and presentable form.

List of Experiments

1. Measurement of Planck constant using black body radiation.
2. To determine Stefan's Constant.
3. To determine the coefficient of thermal conductivity of copper by Searle's Apparatus.
4. To determine the thermal conductivity of bad conductor by Lee and Charlton's disc method.
5. To determine the temperature co-efficient of resistance by platinum resistance thermometer.
6. To study the variation of thermoe.m.f. across two junctions of a thermocouple with temperature.
7. To calibrate Resistance Temperature Device (RTD) using Null Method/Off-Balance Bridge.
8. To determine Mechanical Equivalent of Heat by Callender and Barne'scontant flow method.
9. To draw a calibration curve for a thermocouple.
10. To find the specific heat of a solid by a method of mixture
11. To find the specific heat of a liquid (Turpentine oil) by law of cooling.
12. To find coefficient of apparent expansion of glycerine

References:

1. B.Sc. Practical Physics, C.L. Arora, 2005-2006, S. Chand Publisher, New Delhi
2. Advanced Level Practical Physics, M.Nelkon and Ogborn, Henemann Education Books Ltd., New Delhi
3. Practical Physics, S.S. Srivastava and M.K. Gupta, Atma Ram & Sons, Delhi.
4. Practical Physics, S.L. Gupta and V. Kumar, PragatiPrakashan Meerut.
5. Modern Approach to Practical Physics, R.K. Singla, Modern Publishers, Jalandhar.
6. Advanced Practical Physics for students, B.L. Flint and H.T.Worsnop, Asia Publishing House.

CDLU/SEC/2/102–Physics Lab-IV (Basic Instrumentation Skills Lab)

Credits:3 (Practical) **Max. Marks: 75**
Teaching per week: 4 Hrs. **Duration of Exam: 4 Hrs.**

Objective: The objective of this course is to impart practical knowledge through design and performance of experiments.

Course outcomes: After successfully completing the course, student will be able to:
CO1: Hands on experience with different instruments and appreciate the beauty of different concepts and related experiments in Physics.
CO2: Verify some fundamental principles, effects and concepts of physics through experiments. Gaining knowledge related to CRO.
CO3: Perform experiments related to A.C. mains, D.C. voltage and current.
CO4: Learn to present observations, results and analysis in suitable and presentable form.

List of Experiments

1. To use Analog Multimeter for measuring Resistance, A.C. and D.C. Voltage and Current, checking of electrical fuses.
2. To measure frequency of AC signal using CRO.
3. To measure phase shift between AC signals using DSO.
4. To measure the resistance, AC and DC voltage using DSO. .
5. To use digital Multimeter for measuring Resistance, A.C. and D.C. Voltage and Current, checking of electrical fuses.
6. To observe the loading effect of a multimeter while measuring voltageacross a low resistance and high resistance.
7. To observe the limitations of a multimeter formeasuring high frequency voltage and currents.
8. To measure Q of a coil and its dependence onfrequency, using a Q- meter.
9. Measurement of voltage, frequency, time period and phase angleusing CRO.
10. Measurement of time period, frequency, average period using universal counter/frequency counter.
11. Measurement of rise, fall and delay times using a CRO.
12. Measurement ofdistortion of a RF signalgenerator using distortion factor meter.
13. MeasurementofR,L and CusingaLCR bridge/ universal bridge.

Open Ended Experiments: (i). Using a Dual Trace Oscilloscope, ii). Converting the range of agivenmeasuringinstrument (voltmeter, ammeter).

ReferenceBooks:

1. Atext book in Electrical Technology-BLTheraja-S Chand and Co.
2. PerformanceanddesignofAC machines -MG SayELBS Edn.
3. DigitalCircuitsandsystems,Venugopal,2011,TataMcGrawHill.
4. Logiccircuitdesign,ShimonP.Vingron,2012,Springer.

5. DigitalElectronics,SubrataGhoshal,2012,CengageLearning.
6. Electronic Devices and circuits, S. Salivahanan& N. S.Kumar, 3rd Ed., 2012, Tata Mc-GrawHill.
7. Electroniccircuits:Handbookofdesignandapplications,U.Tietze,Ch.Schenk,2008,Springer.
8. ElectronicDevices,7/eThomasL. Floyd,2008,PearsonIndia.

BSC/PHY/MD/2/MIC/102– Physics in Everyday Life

Credits: 2 **Max. Marks: 50**
Lectures: 30 **Final Term Exam.: 35**
Duration of Exam.: 2 Hrs. **Internal Assessment: 15**

Objectives: This course intends to provide knowledge of physics behind everyday phenomena. In addition, it will also enhance knowledge on solar energy.

Course outcomes:
CO1: Will learn about the role of science in human body.
CO2: Get aware of renewable sources of energy.
CO3: Knowledge about laser applications gets enhanced.

CO4 Understand how physics is used in sports.

Note for the Paper Setter: *The question paper will consist of five questions in all. The first question will be compulsory and will consist of seven short questions of 1 marks each covering the whole syllabus. In addition, four more questions will be set unit-wise comprising of two questions from each of the two units. The candidates are required to attempt two more questions selecting at least one question from each unit.*

Unit-I

Human Body: The eyes as an optical instrument, Vision defects; Rayleigh criterion and resolving power of an eye; Sound waves and hearing, Sound intensity, Decibel scale, Physics of the Cardiovascular system (The Cardiac Cycle).Energy: Solar energy; solar cells, its types and applications; Wind energy, Hydroelectric energy, Ocean energy, Geothermal energy, Biomass energy.

Unit-II

Lasers: Laser (characteristics and working), Industry applications (cutting, drilling, welding and material processing), Medical applications. Sports and Technology: The sweet spot, Dynamics of rotating objects, Running, Jumping and pole vaulting, Global Positioning System, Satellite Communication.

Text/Reference Books:

- Spathopoulos, V. M. (2013). An Introduction to the Physics of sports. California: Createspace Independent Publication.
- Singh, P., & Wani, T. A. (2011). Basic Environmental Physics. Meerut: Pragati Prakashan.
- Santra, S. C. (2011). Environmental Science. New Delhi: New Central Book Agency.
- Boeker, E., & Groundelle R. V. (2011). Environmental Physics. New Jersey: John Wiley.
- Silfvast, W. T. (2008). Laser fundamentals. Cambridge: Cambridge University Press.
- Herman, I. P. (1994). Physics of the Human Body. New York: Springer.

Semester-III

BSC/PHY/MD/3/DSC/201: Solid State Physics

Credits: 3 **Max. Marks: 75**
Lectures: 45 **Final Term Exam.: 50**
Duration of Exam.: $2\frac{1}{2}$ Hrs. **Internal Assessment: 25**

Objective: The aim of the course is to familiarize the students with the concepts of crystal structure, reciprocal lattice, bonding in solids, elastic constants and magnetic properties of solids.
Course Outcomes: After completion of this course, students will be able to understand the basics of crystal structure, reciprocal lattice, bonding in solids, elastic constants and magnetic properties of solids. Students get knowledge on
CO1: elements of crystal structure.
CO2: reciprocal lattice and X-ray diffraction methods.
CO3: bonding in solids and elastic constants.
CO4: theory of magnetism, magnetic properties and superconductivity of materials.

Note for the Paper Setter: *The question paper will consist of seven questions in all. The first question will be compulsory and will consist of four short questions of 2 marks each covering the whole syllabus. In addition, six more questions will be set unit-wise comprising of two questions from each of the three units. The candidates are required to attempt three more questions selecting at least one question from each unit.*

UNIT-I

Crystal Structure: Introduction to crystalline & amorphous solids, Crystal lattice and Translation Vectors, Unit cell and basis, Primitive and non-primitive lattices, Symmetry operations, Point groups and space groups, Bravais lattices in 2D and 3D, Lattice planes, Miller Indices, Interplanner spacing, Crystal structures: sc, bcc, fcc and hcp, Examples: NaCl, CsCl, Diamond and ZnS structure.

UNIT-II

Reciprocal lattice: Bragg's law, Fourier analysis of electron density, reciprocal lattice, Diffraction condition in reciprocal space, Laue's equations, Ewald construction, Brillioun zones and Weigner Seitz cell concepts, Brillioun zones construction, Reciprocal lattice (sc, bcc, fcc), Fourier analysis of basis, Atomic scattering factors, Geometrical structure factor, X-ray diffraction method: Laue, Rotating and powder crystal methods.

UNIT – III

Magnetic Properties: Origin of magnetism, Types of magnetism,Dia-, Para-, Ferri-, Ferro and anti- ferromagnetic materials, Langevin's Classical and quantum Theory of Dia– and

Paramagnetic, Curie's law, Weiss's Theory of Ferromagnetism, Superconductivity: Critical temperature, Critical magnetic field, Meissner effect, Type I and type II Superconductors, London's equation and Penetration depth, energy gap, BCS theory, Josephson effect.

ReferenceBooks:

1. Introduction to Solid State Physics, Charles Kittel, 8th Edition, 2004, Wiley India Pvt. Ltd.
2. K.V. Keer, Principles of solid state physics, Wiley - Eastern, 1993.
3. Solid State Physics, N.W. Ashcroft and N.D. Mermin, 1976, Cengage Learning.
4. Solid State Physics, M.A. Wahab, 2011, Narosa Publications.
5. Introduction to Solid State Physics, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill.
6. Solid State Physics: An Introduction to Theory and Experiment by H. Ibach and H. Luth
7. Neil W Ashcroft and N David Mermin, Solid State Physics, Holt Saunders International Edn, 1976.
8. BD Cullity, Introduction to Magnetic Materials, Addison-Wesley, 1

BSC/PHY/MD/3/DSC/202–Physics Lab-V

Credits: 1 (Practical) **Max. Marks: 25**
Teaching per week: 2 Hrs. **Duration of Exam: 2 Hrs.**

Objective: The objective of this course is to impart practical knowledge through design and performance of experiments.

Course outcomes: After successfully completing the course, student will be able to:
CO1: get hands on experience with different instruments and measurements related physical quantities.
CO2: verify some fundamental principles, effects and concepts of physics through experimentation.
CO3:getbasic understanding on instruments, data observation, errors, along with practical's training to use and learn techniques, skills and tools for professional practices.

CO4: learn to present observations, results and analysis in suitable and presentable form.

List of Experiments

1. Study of Franck-Hertz experiment.
2. To study the characteristics of solar cell.
3. Study of Zeeman Effect.
4. Determine wavelength of laser light by using vernier calipers/ engraved metal scale.
5. Distance measurement by triangularization method using laser.
6. To measure the divergence of laser beam.
7. To determine Boltzmann constant.
8. To determine the angular diameter of the Sun with the help of a sextant.
9. To determine the amplitude or the angular elevation of the Sun using a sextant.
10. To find the capacitance of a capacitor using flashing and quenching of a neon lamp.
11. To find the band gap of a semiconductor material.

Reference Books:

1. B.Sc. Practical Physics, C.L. Arora, 2005-2006, S. Chand Publisher, New Delhi
2. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
3. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition reprinted 1985, Heinemann Educational Publishers
4. A Text Book of Practical Physics, I.Prakash& Ramakrishna, 11th Ed., 2011,Kitab Mahal.
5. A Course of Experiments with He-Ne laser, R.S. Sirohi, 2001, New Age International Publication.
6. Experimental Physics, Gyan Prakash, 2012, Studium Press (India) Pvt. Ltd.

BSC/PHY/MD/3/MIC/201: Waves and Optics

Credits: 4 **Max. Marks: 100**
Lectures: 60 **Final Term Exam.: 70**
Duration of Exam.: 3Hrs. **Internal Assessment: 30**

Objective: The objective of this course is to introduce the basics of Waves & Optics and their applications.

Course Outcomes: After successfully completing the course, student will be able to:
CO1: Have understanding of Interference - by Division of Wave front, by Division of Amplitude and Interference due to transmitted light & reflected light.
CO2: Learn about Huygens-Fresnel's theory, diffraction at a straight edge and at a circular aperture, diffraction due to a narrow slit and due to a narrow wire.
CO3: Understand and explain the Fraunhoffer diffraction, dispersive power of grating, Rayleigh's criterion and resolving power of telescope & a grating.
CO4: Understand the theories and laws of polarization along with understanding of the production and detection of (i) Plane polarized light (ii) Circularly polarized light and (iii) Elliptically polarized light.

Note for the Paper Setter: *The question paper will consist of nine questions in all. The first question will be compulsory and will consist of seven short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the three units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

UNIT-I

Interference: Interference by Division of Wave front: Young's double slit experiment, Coherence, Conditions of interference, Fresnel's biprism and its applications to determine the wavelength of sodium light and thickness of amica sheet, phase change on reflection. Interference by Division of Amplitude: Plane parallel thin film, production of colors in thin films, classification of fringes infilms, Interference due to transmitted light and reflected light, wedgeshaped film, Newton's rings.

UNIT-II

Diffraction-I: Huygens-Fresnel's theory, Fresnel's assumptions, rectilinear propagation of light, Fresnel's half period zones, zone plate, diffraction at a straight edge, rectangular slit and diffraction at a circular aperature. Diffraction due to a narrow slit, diffraction due to a narrow wire. Fraunhoffer diffraction: one slit diffraction, two slit diffractions, N-slit diffraction, plane transmission grating spectrum, dispersive power of grating, limit of resolution.

Unit-III

Polarisation by reflection, refraction and scattering, Malus Law, Phenomenon of double refraction, Huygens'swave theory of double refraction (Normal and oblique incidence), Analysis of polarized Light. Nicolprism, Quarter wave plate and half wave plate,

Unit-IV

production and detection of(i) Plane polarized light (ii)Circularly polarized light and(iii)Elliptically polarized light. Optical activity, Fresnel's theory of optical rotation, Specific rotation, Polarimeters (half shade and Biquartz).

Text/Reference Books:

1. Principles of Optics, M. Born and E. Wolf, Pergamaman Press.
2. Fundamentals of Optics, Jenkins and White, McGraw Hill Book Co. Ltd., New Delhi.
3. Optics, K.D. Muller, University Science Books, Millally California.
4. An Introduction to Interferometery, Tolansky, John Wiley & Sons, New Delhi.
5. Polarized Light Production and Use, Shurcliff, Harward University Press, Cambridge, M A (USA)
6. Refresher Course in Physics Vol. II, C.L. Arora, 2005-2006, S Chand and Co, New Delhi.

CDLU/SEC/3/201–Physics Lab-VI

Credits: 3 (Practical) **Max. Marks: 75**
Teaching per week: 4 Hrs. **Duration of Exam: 3 Hrs.**

Objective: The objective of this course is to impart practical knowledge through design and performance of experiments.

Course outcomes: After successfully completing the course, student will be able to:

CO1: get hands on experience with different instruments by measuring related physical quantities.

CO2: verify some fundamental principles, effects and concepts of physics through experimentation.

CO3: basic understanding on instruments, data observation, errors, along with practical's training to use and learn techniques, skills and tools for professional practices.

CO4: learn to present observations, results and analysis in suitable and presentable form.

List of Experiments

1. Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light.
2. To determine the Planck's constant using LEDs of at least 4 different colours.
3. To determine the wavelength of laser source using diffraction of single slit.
4. To determine the wavelength of laser source using diffraction of double slits.
5. Comparing intensity of light sources and verify inverse square law.
6. Study the characteristics of photodiodes.
7. To determine the particle size of lycopodium powder.
8. To find the horizontal distance between two points using a sextant.
9. To compare the capacitances of two capacitors by deflection method.
10. To find the capacitance of a capacitor by discharging it through a voltmeter.
11. To compare the luminous intensities of two light sources using a photo-voltaic cell.
12. To determine the thermionic work function of tungsten using a directly heated diode.

Reference Books:

1. B.Sc. Practical Physics, C.L. Arora, 2005-2006, S. Chand Publisher, New Delhi
2. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
3. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition reprinted 1985, Heinemann Educational Publishers
4. A Text Book of Practical Physics, I.Prakash& Ramakrishna, 11th Ed., 2011,Kitab Mahal
5. A Course of Experiments with He-Ne laser, R.S. Sirohi, 2001, New Age International Publicaiton.
6. Experimental Physics, Gyan Prakash, 2012, Studium Press (India) Pvt. Ltd.

Semester-IV

BSC/PHY/MD/4/DSC/203: Classical and Statistical Physics

Credits: 3 **Max. Marks: 75**
Lectures: 45 **Final Term Exam.: 50**
Duration of Exam.: $2\frac{1}{2}$ Hrs. **Internal Assessment: 25**

Objective: The objective of the course is to provide a basic knowledge of constraints, planetary motion, Langrange's formulation of classical system of particles. The course also includes the basics of classical and quantum statistics.

Course Outcomes: After completion of this course, students will be able to understand the basics of classical and statistical mechanics. They will be having basic knowledge of.

CO1: two-body central force problem and Lagrangian dynamics.
CO2: rigid bodies- kinematics and dynamics.
CO3: introductory topics in statistical physics.
CO4: topics in classical and quantum statistics.

Note for the Paper Setter: *The question paper will consist of seven questions in all. The first question will be compulsory and will consist of four short questions of 2 marks each covering the whole syllabus. In addition, six more questions will be set unit-wise comprising of two questions from each of the three units. The candidates are required to attempt three more questions selecting at least one question from each unit.*

UNIT – I

Two-body central force problem and Lagrangian Dynamics: Constraints & their classification, Generalized coordinates, D'Alembert's principle and Lagrange's equations, Simple applications of the Lagrangian formulation, Hamilton's principle, Derivation of Lagrange's equations from Hamilton's principle, Cyclic coordinates, Conservation theorems and symmetry properties. Two –body central force problem: Reduction to the equivalent one-body problem, Equations of motion and first integrals, Equivalent 1-D problem and classification of orbits.

UNIT –II

Rigid Bodies- Kinematics and Dynamics: Independent coordinates of the rigid bodies, orthogonal transformations, Euler angles and Euler's theorem, Infinitesimal rotation, rate of change of a vector, Coriolis force, angular theorem, infinitesimal rotation, 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 asymmetrical top.

UNIT- III

Introduction to Statistical Physics: Laws of Thermodynamics, Entropy and Disorder, Statistical Definition of Entropy, Macroscopic and Microscopic Systems, Events (dependent,

independent and mutually exclusive), statistical Probability, a-priori probability, probability theorems, Tossing of Coins, Permutations and Combinations, Distribution of N distinguishable and indistinguishable particles in boxes, Macro and Micro states, Thermodynamic potentials and Thermodynamic equilibriums, phase space, Liouville's Theorem, Density Matrix, Fluctuations, Three kinds of Statistics 75.

Reference Books:

1. Classical Mechanics, 3rded.,2002 by H.Goldstein, C. Poole and J. Safko, Pearson Edition
2. Classical Mechanics of Particles and Rigid Bodies by K. C. Gupta, 2008, New Age International.
3. Classical Mechanics, N.C. Rana & P.S. Jaog, 2017, Tata MC Graw Hill, New Delhi.
4. Statistical Mechanics, R.K. Pathria& D. Beale, 2021, Elsevier Publication.
5. Statistical Mechanics, B.K. Agarwal & M. Eisner,2020, New Age International Publication.
6. Introduction to Statistical Mechanics, S.K. Sinha, 2005, Narosa Publication.

BSC/PHY/MD/4/DSC/204–Physics Lab-VII

Credits: 1 (Practical) **Max. Marks: 25**
Teaching per week: 2 Hrs. **Duration of Exam: 2Hrs.**

Objective: The objective of this course is to impart practical knowledge through hands on training of basic instruments.

Course outcomes: After successfully completing the course, student will be able to get:
CO1: exposure with various aspects of instruments and their usage through hands-on mode.
CO2: real work experience of various lab skills on related instruments in the profession.
CO3: basic understanding on instruments data observation, measurements, errors and analysis.
CO4: practical's training to use and learn techniques, skills and tools for professional practices.

List of Experiments:

1. To study the growth and decay of current in a L, R circuit using magnetic core inductor.
2. To determine the magnetic induction field between the pole pieces of an electromagnet with the help of a search coil and a ballistic galvanometer using a mutual inductance for calibration of ballistic galvanometer.
3. To determine the value of e/m for electron by long solenoid (Helical) method.
4. To determine e/m by magnetron method or small solenoid method.
5. To determine the electronic charge by Millikan's Method.
6. To determine the frequency of AC mains using a Sonometer and an electromagnet.
7. To find the value of B_H the Horizontal component of earth's magnetic field in the laboratory using a deflection and vibration magnetometer.
8. To find the value of M in the laboratory using deflection and vibration magnetometer.
9. To study the variation of magnetic field with distance along the axis of a circular coil carrying current by plotting a graph.
10. To study the induced emf as a junction of velocity of the magnet (simple method).
11. To study the induced emf as a junction of velocity of magnet.
12. To obtain the wave form of AC mains supply using a cathode ray oscilloscope.
13. To measure the AC voltage using a CRO and to calculate the deflection sensitivity in mm per rms volt.
14. To measure a dc voltage with the help of a CRO.
15. To demonstrate the phase difference in the case of resistance, inductance and capacitance and to measure their values using a CRO.
16. To measure the phase difference between current & voltage for CR and LR of AC circuit using a CRO.
17. Magnetic field measurement by using Helmholtz coil.

Reference Books:

1. B.Sc. Practical Physics: C.L. Arora, 2005-2006, S.Chand& Co. Ltd.
2. A text book in Electrical Technology - B L Theraja, 2006, S Chand and Co.

3. Performance and design of AC machines - M G Say, 2002, ELBS Edn.
4. Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
5. Logic circuit design, Shimon P. Vingron, 2012, Springer.
6. Digital Electronics, SubrataGhoshal, 2012, Cengage Learning.
7. Electronic Devices and circuits, S. Salivahanan& N. S. Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill.
8. Electronic circuits: Handbook of design and applications, U. Tietze, Ch. Schenk, 2008, Springer.
9. Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India.
10. Experimental Physics, Gyan Prakash, 2012, Studium Press (India) Pvt. Ltd.

BSC/PHY/MD/4/MIC/202: Physics of Semiconductor Devices

Credits: 3 **Max. Marks: 75**
Lectures: 45 **Final Term Exam.: 50**
Duration of Exam.: $2\frac{1}{2}$ Hrs. **Internal Assessment: 25**

Objective: The course enables students to develop an in-depth understanding about the physics of semiconductors through an exposure of various types of semiconductor diodes, transistors, binary number systems and logic gates.

Course Outcomes: After completion of this course, students will be able to understand:

Note for the Paper Setter: *The question paper will consists of seven questions in all. The first question will be compulsory and will consist of four short questions of 2 marks each covering the whole syllabus. In addition,sevent more questions will be set unit-wise comprising of two questions from each of the two units. The candidates are required to attempt three more questions selecting at least one question from each unit.*

UNIT – I

Physics of Semiconductors: The Energy-Band theory of Crystals, Classification of materials, Direct and indirect band gap semiconductors, Intrinsic and extrinsic semiconductors, concept of effective mass, Donor and Acceptor impurities, mass action law, Carrier Concentrations; The Fermi Level, Charge densities in semiconductors, Electrical properties of Ge and Si, Generation and recombination of charges, Carrier diffusion, Continuity equation, Injected minority-carrier charge, The Potential variation within a graded semiconductor.

UNIT – II

Semiconductor Diodes: Open circuit p-n junction, V-I characteristics Semiconductor Photodiode, LED, Diode as circuit element, Load line, Piecewise linear diode model, p-n junction as rectifier(half, full and bridge rectifier), Ripples, Filters (capacitor, inductor and π-filters), Clipping and clamping circuits. Bipolar Junction Transistors (BJT): The junction transistor and its current components, I-V characteristics, Transistor as an amplifier, Type of transistors, Common-Base (CB), Common-Emitter (CE), Common-Collector (CC) configuration

UNIT – IV

Number System and Codes: Decimal, Binary, Hexadecimal and Octal number systems, base conversions, Binary, octal and hexadecimal arithmetic (addition, subtraction by complement method, multiplication), representation of signed and unsigned numbers, Binary Coded Decimal code. Logic Gates and Boolean algebra: Introduction to Boolean Algebra and Boolean operators: DeMorgan's Theorems, Boolean Laws, simplifications of Logic Circuits using Boolean

Algebra,Positive and negative logic, Truth Tables of OR, AND, NOT, construction and symbolicrepresentation of XOR, XNOR, Universal NOR and NAND gates (DTL, TTL gates).

Reference Book:

1. Semiconductor Physics and Devices: Donald A Neaman and Dhrubes Biswas, 4thEdition, McGraw Hill, India
2. Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
3. Basic Electronics and Linear Circuits, N. N. Bhargava et. al., 2ndEdition, McGraw Hill, India
4. Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.
5. Solid State Electronic Devices, B. G. Streetman & S. K. Banerjee, 6thEdn.,2009, PHI Learning

BSC/PHY/MD/4/MIC/203–Physics Lab-VIII

Credits: 1 (Practical) **Max. Marks: 25**
Teaching per week: 2 Hrs. **Duration of Exam: 2 Hrs.**

Objective: The objective of this course is to impart practical knowledge through design and performance of experiments.

Course outcomes: After successfully completing the course, student will be able to:
CO1: Hands-on experience of using various optical instruments and making finer measurements of wavelength of light using Newton Rings experiment
CO2: Understand various optical phenomena, principles, workings and applications of optical instruments through experiments.
CO3: Learn to present observations, results and analysis in suitable and presentable form.
CO4: practical's training to use Fresnel Biprism and optical equipment.

List of Experiments

1 To measure the (a) area of a window (b) height of an inaccessible object using a sextant.
2 To determine Refractive index of the material of a prism using sodium source.
3 To determine the dispersive power and Cauchy constants of the material of a prism using Mercury discharge source.
4 To draw a graph between wavelength and minimum deviation for various lines from a Mercury discharge source.
5 Determination of wave length of sodium light and the number of lines per centimetre using a diffraction grating.
6 Determination of wave length of sodium light using Newton's Rings.
7 Resolving power of a telescope.
8 Comparison of Illuminating Powers by a Photometer.
9 Measurement of (a) Specific rotation (b) concentration of sugar solution using polarimeter.
10 Ordinary and extra ordinary refractive indices for calcite or quartz.
11 To find the equivalent focal length of a lens system by nodal slide assembly.

References:

1. B.Sc. Practical Physics, C.L. Arora, 2005-2006, S. Chand Publisher, New Delhi
2. Advanced Level Practical Physics, M.Nelkon and Ogborn, Henemann Education Books Ltd., New Delhi
3. Practical Physics, S.S. Srivastava and M.K. Gupta, Atma Ram & Sons, Delhi
4. Practical Physics, S.L. Gupta and V. Kumar, Pragati Prakashan Meerut
5. Modern Approach to Practical Physics, R.K. Singla, Modern Publishers, Jalandhar
6. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, Asia Publishing House

Semester-V

BSc/Phy/SM/5//DSC/301: Quantum Mechanics

Credits: 3 **Max. Marks: 75**
Lectures: 45 **Final Term Exam.: 50**
Duration of Exam.: $2\frac{1}{2}$ Hrs. **Internal Assessment: 25**

Objective: The course content covers foundations of quantum mechanics, Schrodinger wave equation and applications to one dimensional problems, Hydrogen Atom and time dependent and independent Schrodinger equation.

Course Outcomes: After completion of this course, students will be able to understand
CO1: with basics of quantum Mechanics.
CO2: Schrodinger wave equation and its applications.
CO3: Hermitian operators and their properties.
CO4: Eigen value and Eigenvectors of operators.

Note for the Paper Setter: *The question paper will consist of seven questions in all. The first question will be compulsory and will consist of four short questions of 2 marks each covering the whole syllabus. In addition, six more questions will be set unit-wise comprising of two questions from each of the three units. The candidates are required to attempt three more questions selecting at least one question from each unit.*

UNIT-I

Linear Vector Space and Matrix Mechanics: Vector spaces, Hilbert spaces, square integrable functions, Operators, Projection operator, Hermitian and Unitary operators, change of basis, Eigen value and Eigenvectors of operators, Infinitesimal and Finite Unitary operators, Dirac's bra and ket notation, commutators, Simultaneous eigenvectors, Parity operators, Matrix Mehanics and Wave Mechanics, Postulates of quantum mechanics, uncertainty relation. Harmonic oscillator in matrix mechanics, Time development of states and operators, Heisenberg and Schroedinger representations, Exchange operator.

UNIT-II

Schrodinger Wave Equation: wave function, Normalization, Probability current density, Expectation values, Eigen values and eigen functions, Time evolution of expectation values, stationary states, Ehrenfest Theorem, Degeneracy and orthogonality, Operator formalism and its algebra, Hermitian operators and their properties, Linearity and Superposition Principles,

Matrix representation of an operator, Momentum and energy operators, Commutator, Wave Packets, Application to spread of Gaussian Wave packet,

UNIT-III

Quantum theory of Hydrogen atom: Schrodinger equation for H-atom, Separation of variables, Quantum numbers, Electron probability density, Radiative transition, Selection rules, Angular momentum operators and their Commutation relations, Schrodinger equation in spherical symmetric potential

Identical particles : Symmetric and anti symmetric wave functions, distinguish ability of identical particles, the exclusion principle, the connection with statistical mechanics, collisions of identical particles.

ReferenceBooks:

1. Quantum Mechanics by J. L. Powell and B.Crasemann.
2. Quantum Mechanics by D.J Griffith, Pearson publication.
3. Quantum Mechanics by A. Ghatak & Loknathan, Mackmilan India Ltd.
4. Quantum Physics by S.Gasiorowicz.

BSC/PHY/MD/5/DSC/302: Physics Lab-IX

Credits: 1(Practical) **Max. Marks: 25**
Teaching per week: 2 Hrs. **Duration of Exam:2 Hrs.**

Objective: The objective of this course is to impart practical knowledge through design and performance of experiments.

Course outcomes: After successfully completing the course, student will be able to:
CO1: Perform experiments related to four Probe Method and microprocessor

CO2: Verify concepts of physics through experimentation.

CO3: Get experienced with different instruments and measurements.
CO4: analyze the observations and result.

List of Experiments:

1. To determine the Hall coefficient of a semiconductor sample.
2. TO Find Resistivity by Four Probe Method
3. Determine the relaxation time (EPR) for a given sample and find the value of 'g'.
4. Determine the wavelength of the microwave output of a given reflex klystron oscillator and also to determine its repeller mode pattern.
5. Calibrate a cooper resistance thermometer and use it to measure temperature from 77 K to room temperature.
6. Calibrate a silicon resistance thermometer and use it to measure temperature from 77 K to room temperature.
7. Determine the specific heat of a given sample at room and liquid nitrogen temperature.
   13. Determine the Curie temperature of a given ferroelectric material.
8. Programming and interfacing with a given microprocessor.
9. Measurement of the critical temperature of a HTc-sample.

Reference Books

1. Optical Properties of Photonic Crystals, K. Sakoda (Springer, 2001)
2. The Rietveld method, R.A.Young (IUCR-Oxford University Press, 1995)
3. Fundamentals of Crystallography, C.Giacovazzo (IUCR-Oxford University Press, 2002)
4. Characterization of nanophase materials, Zhon Ling Wang (Wiley-VCH Verlag GmbH, 2000)
5. Physical Properties of Semiconductors, C. M. Wolfe, J.R.N.Holonyak and G.E.Stillman (Prentice Hall International Inc., London, 1989).
6. Handbook on Semiconductors, Vol. 1-4., T.S. Moss, Ed., by S.P.Keller (NorthHolland, Amsterdam, 1980)

BSC/PHY/MD/5/MIC/301– Atomic and Molecular Spectroscopy

Credits: 2 **Max. Marks: 50**
Lectures: 30 **Final Term Exam.: 35**
Duration of Exam.: 2 Hrs. **Internal Assessment: 15**

Note for the Paper Setter: *The question paper will consists of 5 questions in all. The first question will be compulsory and will consist of 7 short questions of 1 marks covering the whole syllabus. In addition, four more questions will be set unit-wise comprising of two questions from each of the two units. The candidates are required to attempt two more questions selecting at least one question from each unit.*

Unit-I

One electron system: Quantum states of an electron in an atom, Electron Probability density, Space Quantization, Electron Spin, Stern-Gerlach experiment, Spectroscopic terms and selection rules, Spin – orbit interaction energy, Quantum mechanical relativity correction, Hydrogen fine structure, Hyperfine structure, Pauli exclusion principle, Exchange symmetry of wave function.

Unit-II

Vibration-rotational spectra of diatomic molecules: Types of molecules, Diatomic linear symmetric-top, Asymmetric-top and Spherical-top, The diatomic molecule as rigid rotator, Harmonic oscillator, Non rigid rotator, Anharmonic oscillator and vibrating rotator (energy levelsand infrared spectra), Isotopic effect on vibrational-rotational spectra, Intensity of rotation-vibration spectra, Raman spectra of diatomic molecules.

Text/Reference Books:

1. H. E. White: Introduction to Atomic Spectra (McGraw-Hill Inc. US)
2. G. Herzberg : Atomic Spectra and Structure –Vol - I & II (D.Van Nostrand Company Inc. 6^{th}ed.)
3. G. Herzberg : Molecular Spectra and Structure
4. C.N. Banwell : Fundamentals of Molecular Spectroscopy (McGraw-Hill Higher ed.)
5. Raj Kumar : Atomic and Molecular Spectra: Laser (5^{th} ed. Kedar Nath Ram Nath, Merrut, India)
6. K. P. R. Nair : Atom Molecules and Laser (Alpha Science International Ltd. USA)
7. Bransden and Joachain : Physics of Atom & Molecules (2^{nd} ed. Prentice Hall)
8. Huber and Hertzberg : Molecular Spectra and Molecular Structure (Springer)
9. S. N. Ghoshal : Atomic Physics (S-Chand, 1^{st}ed.)
10. G. Aruldhas : Molecular Structure and Spectroscopy (PHI learning

BSC/PHY/MD/5/MIC/302–PHYSICS LAB-X

Credits: 1 (Practical) **Max. Marks: 25**
Teaching per week: 2 Hrs. **Duration of Exam: 2 Hrs.**

Objective: The objective of this course is to impart practical knowledge through design and performance of experiments.

Course outcomes: After successfully completing the course, student will be able to:
CO1: Hands on experience with different instruments and appreciate the beauty of different concepts and related experiments in Physics.
CO2: Verify some fundamental principles, effects and concepts of physics through experiments.
CO3: Perform experiments related to NPN and PNP transistors.
CO4: Learn to present observations, results and analysis in suitable and presentable form.

List of Experiments:

1. Study frequency response of R-C Coupled Amplifier
2. Study characteristics of a Push-Pull Amplifier
3. Study a LC/RC Oscillator using transistors
4. Study of Analog Communication System.
5. Study of NPN transistor as Amplifier.
6. Study of PNP transistor as Amplifier.
7. Study of Tunnel Diode characteristics.
8. Study the G M counter.
9. To determine the frequency and amplitude of phase shift oscillator.
10. To study the variation of magnetic field with distance along the axis of the circular coil carrying current by plotting a graph.
11. Determination of applied magnetic field and resonance frequency (or g-factor) of a given sample using Electron spin resonance spectrometer.

ReferenceBooks:

1. Basic Electronics: Atext lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller,1994, Mc-GrawHill.
2. Modern DigitalElectronics,R.P.Jain,4thEdition,2010,TataMcGrawHill.

Internship- BSC/PHY/MD/5/SEC/301

Credits-04 Maximum Marks:100

Semester-VI

BSC/PHY/MD/6/DSC/303: Nuclear Physics

Credits: 3
Lectures: 45
Duration of Exam.: $2\frac{1}{2}$ Hrs.

Max. Marks: 75
Final Term Exam.: 50
Internal Assessment: 25

Objective: The objective of this course is to teach the students fundamentals of nuclear properties, nuclear forces and nuclear models.

Course Outcomes: After successfully completing the course, student will be able to:
CO1: Understand the basics nucleus and nuclear forces.
CO2: Understand the concepts of liquid drop model and shell model.
CO3: know about the types of nuclear reactions

CO4: understand the classification of elementary particles.

Note for the Paper Setter: *The question paper will consist of seven questions in all. The first question will be compulsory and will consist of four short questions of 2 marks each covering the whole syllabus. In addition, six more questions will be set unit-wise comprising of two questions from each of the three units. The candidates are required to attempt three more questions selecting at least one question from each unit.*

Unit-I

Introductory concepts and nuclear forces: Basic nuclear properties: size, shape, charge distribution, spin and parity, moments and statistics, binding energy, Fundamental forces of nature, charge independence and charge symmetry of nuclear forces, Isospin, deuteron problem: ground state of deuteron, magnetic dipole and electric quadruple moments of the deuteron.

Unit-II

Nuclear models: Weizsacher's semi-empirical mass formula, liquid drop model of the nucleous, mass parabolas: prediction of stability against β-decay for members of an isobaric family. Shell model of the nucleus: evidences that led to the shell model, assumptions of the single particle shell model,

Nuclear decay and reactions: Disintegration energy of spontaneous α-decay, Alpha decay paradox- barrier penetration, Fermi's theory of β-decay, Selection rules for β-decay, Parity non-conservation in α β-decay, γ-ray emission- selection rules, Internal conversion, Types of nuclear reactions, Balance of mass and energy in

nuclear reactions, Q-value equation and its solution.

Unit-III

High energy physics: Classification of elementary particles, Conservation laws & symmetries: conservation of baryon and lepton numbers, concept of isospin, isospin multiplets, isospin & strangeness conservation and violation in different types of interactions, Gell–Mann–Nishijima formula, Baryons octet ($1/2^+$) and decuplet ($3/2^+$), Quark structure of hadrons and quark flavours,

Introductory concept of colour quantum number and gluons, Charge conjugation (C) and parity (P) operators, C & P non-conserving property of neutrino, CPT theorem.

ReferenceBooks:

1. Physics of Atomic Nuclei, Vladimir Zelevinsky, Wiley-VCH,2017
2. The Atomic Nucleus, J.M. Reid, Penguin Books,1972
3. Kenneth S. Krane, Introductory Nuclear Physics,Wiley,NewYork,1988
4. R. R. Royand B. P. Nigam, Nuclear Physics,Wiley-Eastern Ltd.,1983
5. NuclearPhysics,S.B.Patel,NewAgepublication
6. Basic Ideas and Concepts in Nuclear Physics: K. Heyde, (Overseas Press India) (2005).
7. Nuclear Physics: Experimental and Theoretical: H. S. Hans, (New Academic Science Ltd., Second Revised edition) (2010).

BSC/PHY/MD/6/DSC/304–Physics Lab-XI

Credits: 1 (Practical) **Max. Marks: 25**
Teaching per week: 2 Hrs. **Duration of Exam: 2 Hrs.**

Objective: The objective of this course is to impart practical knowledge through design and performance of experiments.

Course outcomes: After successfully completing the course, student will be able to:
CO1: Hands on experience with different instruments and measurements of related physical quantities.
CO2: Verify some fundamental principles, effects and concepts of physics through experimentation.
CO3: Perform basic experiments in thermal Physics, viz., determinations of Stefan's constant, coefficient of thermal conductivity, temperature coefficient of resistant, variation of thermo-emf of a thermocouple with temperature difference at its two junctions and calibration of a thermocouple.
CO4: Learn to present observations, results and analysis in suitable and presentable form.

List of Experiments

13. Measurement of Planck constant using black body radiation.
14. To determine Stefan's Constant.
15. To determine the coefficient of thermal conductivity of copper by Searle's Apparatus.
16. To determine the thermal conductivity of bad conductor by Lee and Charlton's disc method.
17. To determine the temperature co-efficient of resistance by platinum resistance thermometer.
18. To study the variation of thermo e.m.f. across two junctions of a thermocouple with temperature.
19. To calibrate Resistance Temperature Device (RTD) using Null Method/Off-Balance Bridge.
20. To determine Mechanical Equivalent of Heat by Callender and Barne'scontant flow method.
21. To draw a calibration curve for a thermocouple.
22. To find the specific heat of a solid by a method of mixture
23. To find the specific heat of a liquid (Turpentine oil) by law of cooling.
24. To find coefficient of apparent expansion of glycerine

References:

7. B.Sc. Practical Physics, C.L. Arora, 2005-2006, S. Chand Publisher, New Delhi
8. Advanced Level Practical Physics, M.Nelkon and Ogborn, Henemann Education Books Ltd., New Delhi
9. Practical Physics, S.S. Srivastava and M.K. Gupta, Atma Ram & Sons, Delhi.
10. Practical Physics, S.L. Gupta and V. Kumar, PragatiPrakashan Meerut.
11. Modern Approach to Practical Physics, R.K. Singla, Modern Publishers, Jalandhar.

12. Advanced Practical Physics for students, B.L. Flint and H.T.Worsnop, Asia Publishing House.

BSC/PHY/MD/6/MIC/303: Basics of Lasers

Credits: 3 **Max. Marks: 75**
Lectures: 45 **Final Term Exam.: 50**
Duration of Exam.: $2\frac{1}{2}$ Hrs. **Internal Assessment: 25**

Objective: The objective of the course on Lasers is to familiarize the students to the basic aspects of Laser Physics.

Course Outcomes: After taking the course, students should be able:
CO1: to explain central concepts, laws and models in Laser physics.
CO2: Understand different types of lasers.
CO3: explain properties of lasers.
CO4: understand applications of laser in medicine and industry.

Note for the Paper Setter: *The question paper will consist of seven questions in all. The first question will be compulsory and will consist of four short questions of 2 marks each covering the whole syllabus. In addition, six more questions will be set unit-wise comprising of two questions from each of the three units. The candidates are required to attempt three more questions selecting at least one question from each unit.*

Unit-I

Review of some basic concepts and principle of laser, Introduction to LASERS: Interaction of radiation with matter – induced absorption, spontaneous emission, stimulated emission. Einstein's co-efficient (derivation). Active material. Population inversion – concept and discussion about different techniques. Resonant cavity. Properties – coherency, intensity, directionality, monochromaticity and focussibility.

Unit-II

Properties of LASERS Gain mechanism, threshold condition for population inversion (derivation), emission broadening – line width, derivation of FWHM natural emission line width as deduced by quantum mechanics – additional broadening process: collision broadening, broadening due to dephasing collision, amorphous crystal broadening, Doppler broadening in laser and broadening in gases due to isotope shifts.

Unit-III

Types of LASERS (Solid, Liquid and Gas states): principle, construction, working and application: (i) Ruby LASER – (ii) Neodymium (Nd) LASERS. (iii) He-Ne LASER
Applications: Fiber optic communication, Holography, LASERS in industry: Drilling, cutting and welding. Lasers in medicine: Dermatology, cardiology, dentistry and ophthalmology.

References:

1. William T Silfvast, “Laser Fundamentals”, Cambridge University Press, UK (2003).
2. B B Laud, “Lasers and Non linear Optics”, New Age International (P) Ltd., New Delhi.
3. Andrews, “An Introduction to Laser Spectroscopy (2e)”, Ane Books India (Distributors).
4. K R Nambiar, “Lasers: Principles, Types and Applications”, New Age International (P) Ltd., New Delhi.
5. T Suhara, “Semiconductor Laser Fundamentals”, Marcel Dekker (2004).

BSC/PHY/MD/6/MIC/304: – Physics Lab–XII

Credits: 1 (Practical) **Max. Marks: 25**
Teaching per week: 2 Hrs. **Duration of Exam: 2 Hrs.**

Objective: Gain practical experience about laser beam parameters, spectroscopy methods and applications in various fields.The major objective of this course is to expose practically about laser and optics through standard set of experiments and motivate the students to apply these concepts in real physical world.

Course Outcomes: Provides practical experience about various experimental laser based techniques to characterize laser beams and material properties. Laser spectroscopy methods to explore optical properties of various materials for their potential use in technology.

CO1: Calibration of experimental setups and evaluate physical Parameters using experimental observations.

CO2: Design and develop various types of experimental systems to analyze properties of materials and optical fibers.

CO3: Develop problem solving ability especially in optics, material science, engineering and related technology.

CO4: Analyze the characteristics of spectrometers, solar cells, LED's, lasers and optical fiber.

List of Experiments:

1. To determine the wavelength of Diode/He-Ne laser
   (a) using transmission grating.
   (b) using reflection grating.
   (c) with a mesh.
2. To determine the size of tiny particle/lycopodium powder
   (a) using cw laser beam.
   (b) using laser diffraction method.
3. To determine distance of an object by triangularization method using He-Ne/diode laser.
4. To determine refractive index of a given sample
   (a) using Abbe refractometer.
   (b) using He-Ne/diode laser.

5. To determine the diameter of human hair/thin wire
   (a) using a He-Ne/diode laser.
   (b) using engraved metal mm-scale/vernier calipers.
6. To calculate the efficiency and fill factors of a variety of solar cells.
7. To study the various optoelectronic devices.
8. Study of laser power attenuation in optical fibers.
9. To determine wavelength of light source (mercury prominent line) using spectrometer diffraction grating.
10. To study bending of light.
11. To find wavelength of laser light using Michelson interferometer.
12. To determine the numerical aperture and acceptance angle of a given optical fiber.
13. Laser beam divergence and spot size determination.
14. Brewster's angle determination.
15. Determine wavelength of a momochromatic source of light or any other experiment using Fresnel biprism.

Text/Reference Books:

- Nagabhushana, S., & Sathyanarayana N. (2013). Lasers and optical instrumentation. New Delhi: I.K. International.
- Ghatak, A. (2017). Optics. New Delhi: Mc-Graw Hill Education India.
- Davis, C. C. (2014). Lasers and Electro-optics. Cambridge: Cambridge University Press.
- Singh, S. P. (2017). Advanced Practical Physics Vol.I. Meerut: Pragati Parkashan.
- Singh, S. P. (2019). Advanced Practical Physics Vol.II. Meerut: Pragati Parkashan.
- Prakash, G. (2012). Experimental Physics. New Delhi: Studium Press India.
- Sirohi, R.S. (1991). A Course of Experiments with He -Ne Laser. New Delhi: New Age International.
- Sirohi, R.S. (2001). Wave Optics and Its Applications. Hyderabad: Orient Longman.

BSC/PHY/MD/6/MIC/305: Computational Physics: Fortan Programming

Credits: 2 **Max. Marks: 50**
Lectures: 30 **Final Term Exam.: 35**
Duration of Exam.: 2 Hrs. **Internal Assessment: 15**

Course Objectives: In this course, students will learn important concepts of Computational Physics.
Course Outcomes: After successful completion of the course student will be benefited as:

CO1: Students would be able to recognize the various interpolation formulae, best fit curve, nature of a specific numerical problem.

CO2: would develop the acumen for choosing an appropriate numerical technique to find its solution.

CO3: Students would acquire a vision for use of computer to solve various algebraic and ordinary differential equations of first and second order and play important role in research prospective.

CO4: After completing this course, students would be able to learn the numerical differentiation and integration by various methods and can understand different type of errors, their propagation, and to minimize errors while writing a program.

Note for the Paper Setter: *The question paper will consists of five questions in all. The first question will be compulsory and will consist of seven short questions of 1 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the two units. The candidates are required to attempt two more questions selecting at least one question from each unit.*

Unit-I

Introduction: Importance of computers in Physics, paradigm for solving physics problems for solution. Usage of linux as an Editor. Algorithms and Flowcharts: Algorithm: Definition, properties and development. Flowchart: Concept of flowchart, symbols, guidelines, types. Examples: Cartesian to Spherical Polar Coordinates, Rootsof Quadratic Equation, Sum of two matrices, Sum and Product of a finite series,calculation of sin (x) as a series,

Unit –II

Scientific Programming: Some fundamental Linux Commands (Internal and External commands). Development of FORTRAN, Basic elements of FORTRAN: Character Set,Constants and their types, Variables and their types, Keywords, Variable Declaration and concept of instruction and

program. Operators: Arithmetic, Relational, Logical and Assignment Operators. Expressions: Arithmetic, Relational, Logical, Character and Assignment Expressions. Fortran Statements: I/O Statements (unformatted/formatted), Executable and Non-Executable Statements, Layout of Fortran Program,

Reference Books:

• Introduction to Numerical Analysis, S.S. Sastry, 5th Edn., 2012, PHI Learning Pvt. Ltd.

• Computer Programming in Fortran 77". V. Rajaraman (Publisher:PHI).

• LaTeX–A Document Preparation System", Leslie Lamport (Second Edition, Addison-Wesley, 1994).

• Gnuplot in action: understanding data with graphs, Philip K Janert, (Manning 2010)

• Schaum's Outline of Theory and Problems of Programming with Fortran, S Lipsdutz and A Poe, 1986Mc-Graw Hill Book Co.

• Computational Physics: An Introduction, R. C. Verma, et al. New Age International Publishers, New Delhi(1999)

• A first course in Numerical Methods, U.M. Ascher and C. Greif, 2012, PHI Learning

• Elementary Numerical Analysis, K.E. Atkinson, 3 r d Edn., 2007, Wiley India Edition.

BSC/PHY/MD/6/MIC/306: Physics Lab-XIII

Credits: 2 (Practical) **Max. Marks: 50**
Teaching per week: 4 Hrs. **Duration of Exam: 3 Hrs.**

Course Objective: There are some topics in physics whose analytical solutions are very complex and suffer accuracy. Such phenomena can be described by various mathematical models and can be solved by various numerical methods. The course will enable the student to solve numerical computationally and to be aware about various types of errors in numerical computation.

Course Outcomes: After successful completion of the course student will be able to:

CO1: Fit a given data set with a best fit curve using principle of least square fitting,

CO2: Solve numerical problems involving interpolation and/or extrapolation using different methods.

CO3: Solve a set of simultaneous linear algebraic and ordinary differential equations numerically.

Find roots of algebraic equations and ordinary differential equations using various iterative methods.

CO4: Find numerically the eigen values and eigenvectors of matrices using polynomial and power Methods. Such techniques enhances computational skills in context of higher studies in Physics,

List of Experiments:

1. Numerical integration using (a) Simpson1/3 and (b) Gauss quadrature methods for one and twodimensional integrals.
2. Least square fitting (Linear).
3. To find eigen values and eigen vectors of asquare matrix using power method.
4. Solution of second order differential equation using Runge–Kutta method.
   Application: Eigen values and eigen functions of a linear harmonic oscillator using Runge –Kutta method.
5. Solution of simultaneous linear algebraic equations by Gauss Jordan elimination method. Application: Illustration of Kirchoff's laws for simple electric circuits.
6. Interpolation and Extrapolation by using Lagrangian method and Newton Forward Interpolation formula.

7. To find the area of a circle by Monte–Carlo technique.
8. Simulation of nuclear radioactivity by Monte-Carlo technique.
9. Simulation of Brownian motion using Monte-Carlo technique.
10. To solve simultaneous linear equations using Gauss–Elimination method.
11. Study of frequency response curve for LCR Circuits.
12. Dynamics of damped driven pendulum.

Reference Books:

1. Introduction to Numerical Analysis, S.S. Sastry, 5th Edn., 2012, PHI Learning Pvt. Ltd.
2. Computer Programming in Fortran 77". V. Rajaraman (Publisher:PHI).
3. LaTeX–A Document Preparation System", Leslie Lamport (Second Edition, Addison-Wesley, 1994).
4. Gnuplot in action: understanding data with graphs, Philip K Janert, (Manning 2010)
5. Schaum's Outline of Theory and Problems of Programming with Fortran, S Lipsdutz and A Poe, 1986Mc-Graw Hill Book Co.
6. Computational Physics: An Introduction, R. C. Verma, et al. New Age International Publishers, New Delhi(1999)
7. A first course in Numerical Methods, U.M. Ascher and C. Greif, 2012, PHI Learning
8. Elementary Numerical Analysis, K.E. Atkinson, 3 r d Edn., 2007, Wiley India Edition.