Annexure I

# Chaudhary Bansi Lal University, Prem Nagar

(A State University established under Haryana Act No. 25 of 2014)

## Scheme of Examination
## For
## Post Graduate Programme

## M.Sc. PHYSICS

**as per NEP 2020**
**Curriculum and Credit Framework for Undergraduate Programmes**
**(Multiple Entry-Exit, Internships and Choice Based Credit System LOCF)**

**With effect from the session 2025-26 (in phased manner)**


**DEPARTMENT OF PHYSICS**
Chaudhary Bansi Lal University, Prem Nagar-127021
Bhiwani
HARYANA, INDIA

Annexure I

**Programme Learning Outcomes(PLOs) for PG Programmes as per NEP-2020**

| PLOs | Master Degree in Physics |
|---|---|
| | **After the completion of Master degree in Physics the student will be able to:** |
| PLO-1: Knowledge and Understanding | Demonstrate the fundamental and advanced knowledge of the subject and understanding of recent developments and issues, including methods and techniques, related to the Physics. |
| PLO-2: General Skills | Acquire the general skills required for performing and accomplishing the tasks as expected to be done by a skilled professional in the fields of Physics. |
| PLO-3: Technical/ Professional Skills | Demonstrate the learning of advanced cognitive technical/professional skills required for completing the specialized tasks related to the profession and for conducting and analyzing the relevant research tasks indifferent domains of the Physics. |
| PLO-4: Communication Skills | Effectively communicate the attained skills of the Physics in well-structured and productive manner to the society at large. |
| PLO-5: Application of Knowledge and Skills | Apply the acquired knowledge and skills to the problems in the subject area, and to identify and analyze the issues where the attained knowledge and skills can be applied by carrying out research investigations to formulate evidence-based solutions to complex and unpredictable problems associated with the field of Physics or otherwise. |
| PLO-6: Critical thinking and Research Aptitude | Attain the capability of critical thinking in intra/inter-disciplinary areas of the Physics enabling to formulate, synthesize, and articulate issues for designing of research proposals, testing hypotheses, and drawing inferences based on the analysis. |
| PLO-7: Traditional knowledge, Values and Ethics | Demonstrate awareness of traditional astronomical tools and methodologies and compare them with modern instruments. Understand the historical, cultural, and philosophical foundations of Indian science and its global relevance. |
| PLO-8: Capabilities/qualities and mindset | To exercise personal responsibility for the outputs of own work as well as of group/team and for managing complex and challenging work(s)that requires new/strategic approaches. |
| PLO-9: Employability and job-ready skills | Attain the knowledge and skills required for increasing employment potential, adapting to the future work and responding to the rapidly changing demands of the employers/industry/society with time. |

## Chaudhary Bansi Lal University Bhiwani

Scheme of Examination for the Post Graduate Programmes (M.Sc. Physics)
as per NEP 2020 Curriculum and Credit Frame work for Postgraduate Programmes
(Choice Based Credit System LOCF) with effect from the session 2025-26 (in a phased manner)

**2-year PG Programme**

**Semester I**

| **Course Type** | **Course Code** | **Nomenclature of course** | **Theory (T)/ Practical (P)** | **Credits** | | **Contact hours per week L: Lecture P: Practical T: Tutorial** | | | | **Internal Assessment Marks** | **End Term Examination Marks** | **Total Marks** | **Examination hours** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | **Total** | **L** | **T** | **P** | **Total** | | | | |
| CC-1 | 25PN-PHY-101 | Mathematical Physics | T | 4 | | 4 | 0 | 0 | 4 | 30 | 70 | 100 | 3 |
| CC-2 | 25PN-PHY-102 | Classical Mechanics | T | 4 | | 4 | 0 | 0 | 4 | 30 | 70 | 100 | 3 |
| CC-3 | 25PN-PHY-103 | Quantum Mechanics -I | T | 4 | | 4 | 0 | 0 | 4 | 30 | 70 | 100 | 3 |
| DEC-I | 25PN-PHY-105E | Electronic Devices and Circuits- I | T | 4 | 24 | 4 | 0 | 0 | 4 | 30 | 70 | 100 | 3 |
| | 25PN-PHY-105M | Material Science -I | | | | | | | | | | | |
| CC-4 | 25PN-PHY-104 | General Electronics-I | P | 4 | | 0 | 0 | 8 | 8 | 30 | 70 | 100 | 3 |
| PC-1 | 25PN-PHY-106 | Physics Lab- I | P | 4 | | 0 | 0 | 8 | 8 | 30 | 70 | 100 | 3 |

**Semester II**

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CC-5 | 25PN-PHY-201 | Nuclear and Particle Physics | T | 4 | 26 | 4 | 0 | 0 | 4 | 30 | 70 | 100 | 3 |
| CC-6 | 25PN-PHY-202 | Solid State Physics | T | 4 | | 4 | 0 | 0 | 4 | 30 | 70 | 100 | 3 |
| CC-7 | 25PN-PHY-203 | Quantum Mechanics - II | T | 4 | | 4 | 0 | 0 | 4 | 30 | 70 | 100 | 3 |
| DEC-II | 25PN-PHY-205E | Electronic Devices and Circuits-II | T | 4 | | 4 | 0 | 0 | 4 | 30 | 70 | 100 | 3 |
| | 25PN-PHY-205M | Material Science -II | | | | | | | | | | | |
| CC-8 | 25PN-PHY-204 | General Electronics-II | P | 4 | | 0 | 0 | 8 | 8 | 30 | 70 | 100 | 3 |
| PC-2 | 25PN-PHY-206 | Physics Lab-II | P | 4 | | 0 | 0 | 8 | 8 | 30 | 70 | 100 | 3 |
| IKS | 25PN-PHY-IKS201 | India's contribution to science | T | 2 | | 2 | 0 | 0 | 2 | 15 | 35 | 50 | 3 |

An internship course of 4-6 weeks duration during summer vacation after II[nd] semester may be allowed to be completed by student. Internship can be either for enhancing the employability or for developing the research aptitude.

IKS contribution: 4%

| Session: 2025-26 | | | |
|---|---|---|---|
| **PartA - Introduction** | | | |
| Name of Programme | M. Sc. Physics | | |
| Semester | 2nd | | |
| Name of the Course | Nuclear and Particle Physics | | |
| Course Code | 25PN-PHY-201 | | |
| CourseType | CC-5 | | |
| Level of the course | 500-599 | | |
| Pre-requisite for the course (ifany) | -- | | |
| CourseLearningOutcomes (CLOs)<br>After completing this course, the learner will be able to: | **CLO 402.1:** Understand the energy loss processes of different energetic particles in a medium and mechanisms of interaction of gamma photon with matter and Learn about the basic properties and characteristics of Nuclear forces, and their mediating particle.<br>**CLO 402.2:** Know and learn about various type of detectors used in nuclear physics experiments, unique properties of different detectors and their applications in the field of nuclear physics andDifferentiate between different type of nuclear reactions, relevant aspects associated with nuclear reactions and kinematics of such reactions.<br>**CLO 402.3:** Describe certain properties associated with nuclei, models governing different aspects of nuclear behaviour and detailed understanding of deuteron problem and understand the phenomenon of radioactive decays of alpha and beta particles, their detailed formalism.<br>**CLO 402.4:** Know about different elementary particles, their quark content and quark model and Learn about decay of some elementary particles and laws governing such decays. | | |
| Credits | Theory | Practical | Total |
| | 4 | 0 | 4 |
| Teaching Hours per week | 4 | 0 | 4 |
| Internal Assessment Marks | 30 | 0 | 30 |
| End Term Exam Marks | 70 | 0 | 70 |
| Max. Marks | 100 | 0 | 100 |
| Examination Time | 3 hours | | |

| PartB-Contentsofthe Course | | |
|---|---|---|
| **Instructions for Paper- Setter:** The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering entire syllabus. The question paper is expected to contain problems to the extent of 20% of total marks. The examinee will be required to attempt 5 questions; selecting one question from each unitand the compulsory question. All questions will carry equal marks. | | |
| **Unit** | **Topics** | **Contact Hours** |
| I | **Radiation Interaction and Nuclear Forces:** Interaction of Charged Particles with Matter: qualitative description of various energy loss mechanisms, their relative contribution in case of heavy ions and electrons, classical stopping power equation for electronic energy-loss (no derivation) with significance of various terms involved, behavior of electronic energy-loss curve as a function of ion velocity, concept of energy straggling and range straggling and their correlation; Interaction of Gamma Radiation with Matter: features of photoelectric, Compton and pair production processes, Nuclear Forces: experimental evidence of charge symmetry and charge independence of nuclear forces, concept of isospin, Meson theory of nuclear forces, relationship between the range of the force and mass of the mediating particle. | 15 |
| II | **Radiation Detectors and Nuclear Reactions:** Gamma Ray Spectrometer: basic principle and working of NaI (Tl) scintillation detector, mechanism of pulse formation, basic idea of pulse processing unit, concept of energy resolution and efficiency of detector and its applications; Semiconductor Detectors: basic principle, construction and working and applications of Si surface barrier detector, high purity germanium detector. Nuclear Reactions: types of nuclear reactions, Q-value of a nuclear reaction and its determination, definition of cross section and its significance, elementary idea of compound nuclear reactions and direct reactions. Concept of neutron detection, Coulomb excitation, nuclear kinematics. | 15 |
| III | **Nuclear Properties and Radioactive Decays:** Basic nuclear properties: size, shape and charge distribution, spin and parity. Binding energy, semi-empirical mass formula, liquid drop model, Deuteron problem; Ground state of deuteron, Magnetic moment and its importance in the determination of exact ground state of deuteron. Radioactive Decays: energetics of alpha decay, tunnel theory of alpha decay, energetics of beta decay, Fermi theory of allowed beta decay, importance of Fermi-Kurie plot, parity non-conserving property of neutrino; | 15 |
| IV | **Particle Physics:** Units in high energy physics; Classification of particles- fermions and bosons, particles and antiparticles; Strange particles, Basic idea of different fundamental types of interactions with suitable examples; Quark flavors and their quantum numbers, Quarks as constituents of Hadrons, Qualitative idea of Quark confinement and asymptotic freedom, necessity of introducing the Color quantum no., Quark model, decay of pion and muon, Gell-Mann Nishijima formula, | 15 |

| | | |
|---|---|---|
| | conservation laws. | |
| | **Total Contact Hours** | 60 |

| | | | |
|---|---|---|---|
| **SuggestedEvaluationMethods** | | | |
| **InternalAssessment: 30** | | **End Term Examination: 70** | |
| ➢ **Theory** | **30** | ➢ **Theory:** | **70** |
| • Class Participation: | 5 | Written Examination | |
| • Seminar/presentation/assignment/quiz/class test etc.: | 10 | | |
| • Mid-Term Exam: | 15 | | |

**PartC-Learning Resources**

**Recommended Books/e-resources/LMS:**

1. Introduction to Experimental Nuclear Physics by R. M. Singru.
2. Elements of Nuclear Physics by W. E. Meyerhof.
3. Nuclear Radiation Detectors by S. S. Kapoor and V. S. Ramamurthy
4. Introduction to High Energy Physics (2nd edition) by D. H. Perkins.
5. Radiation Detection and Measurement by G. F. Knoll.
6. Nuclear Physics Theory and Experiment, by R. R. Roy and B. P. Nigam.

| Session: 2025-26 | | | |
|---|---|---|---|
| **PartA–Introduction** | | | |
| Name of Programme | M. Sc. Physics | | |
| Semester | $2^{nd}$ | | |
| Name of the Course | Solid State Physics | | |
| Course Code | 25PN-PHY-202 | | |
| CourseType | CC-6 | | |
| Level of the course | 500-599 | | |
| Pre-requisite for the course (ifany) | -- | | |
| CourseLearningOutcomes (CLOs)<br>After completing this course, the learner will be able to: | **CLO 202.1:** Analyze the structure of a crystalline solid in terms of lattice, basis and unit cell, and of a non-crystalline solid on the basis of pair-distribution function and deduce the structure of a crystalline solid from the XRD pattern.<br>**CLO 202.2:** Calculate the dispersion of lattice waves for crystals with mono- and diatomic basis, and acquire an understanding of phonon and use it to determine the lattice heat capacity in the Einstein and Debye models.<br>**CLO 202.3:** Learn the Bloch's theorem, solve the KP model & one-electron Schrödinger equation for a periodic potential, classify materials into conductors, semiconductors and insulators, and apply the tight binding & Wigner-Seitz methods for calculation of energy bands.<br>**CLO 202.4:** Grasp main characteristics of superconductors, along with qualitative aspects of the BCS theory, explain flux quantization in a superconducting ring, and the DC& AC Josephson effects. | | |
| Credits | Theory | Practical | Total |
| | 4 | 0 | 4 |
| Teaching Hours per week | 4 | 0 | 4 |
| Internal Assessment Marks | 30 | 0 | 30 |
| End Term Exam Marks | 70 | 0 | 70 |
| Max. Marks | 100 | 0 | 100 |
| Examination Time | 3 hours | | |
| **PartB-Contentsofthe Course** | | | |
| **Instructions for Paper- Setter:** The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering entire syllabus. The question paper is expected to contain problems to the extent of 20% of total marks. The examinee will be required to attempt 5 questions; selecting one question from each unitand the compulsory | | | |

| question. All questions will carry equal marks. | | |
|---|---|---|
| **Unit** | **Topics** | **Contact Hours** |
| I | **Crystal Structure:** Recapitulation of basic concepts: Bravais lattice and Primitive vectors; Primitive, Conventional and Wigner-Seitz unit cells; Crystal structures of Diamond, Cubic *ZnS* and *NaCl*; Packing Fraction, Packing fraction of *sc, bcc, fcc, hcp* and Diamond structure; Symmetry operations and fundamental types of lattices; Index system for crystal planes. Determination of crystal structure by X-ray diffraction: Reciprocal lattice and Brillouin zones (examples of *sc, bcc* and *fcc* lattices); Bragg and Laue formulations of X-ray diffraction by a crystal and their equivalence; Laue equations; Ewald construction; Brillouin interpretation; Crystal and atomic structure factors; Structure factor of the *bcc* and *fcc* lattices, Examples of *NaCl* and diamond; Experimental methods of structure analysis: Types of probe beam. | 15 |
| II | **Lattice dynamics and thermal properties:** Cohesive energy in solids; Qualitative idea of Ionic bonds, Covalent bonds, Hydrogen bonds, Intermolecular bonds, Dispersion bonds, dipole-dipole bonds and Metallic binding. Classical theory of lattice vibration (in harmonic approximation): Vibrations of crystals with monatomic basis- Dispersion relation, First Brillouin zone, Group velocity; Two atoms per primitive basis- dispersion of acoustical and optical modes. Quantization of lattice waves: Phonons, Phonon momentum, Inelastic scattering of neutrons by phonons. Thermal properties: Lattice (phonon) heat capacity; Normal modes; Density of states in one and three dimensions; Models of Debye and Einstein, Debye $T^3$ law; Basic idea about point imperfection in crystals. | 15 |
| III | **Electronic properties of solids:** Sommerfeld's free electron gas model, Density of states, Fermi sphere, Fermi and ground-state energy; Heat capacity of electronic gas, experimental heat capacity of metals, Thermal Effective Mass, Electrical Conductivity and Ohm's law, Motion in a Magnetic field and Hall effect, Difficulties with the free electron gas model; Band theory of solids; Periodic potential and Bloch's theorem; Kronig-Penney model; Wave equation of electron in a periodic potential, Effective Mass in Crystal and its Physical Significance, Central equation, Crystal momentum of electron, Solution of the central equation, Approximate solution at and near a zone boundary; Periodic, extended and reduced zone schemes of energy band representation; Number of orbital's in a band; Classification into metals, semiconductors and insulators. Calculation of energy bands: Tight binding method and its application to *sc, bcc* and *bcc* structures; Wigner-Seitz method, Cohesive energy; Pseudo-potential methods (qualitative idea). | 15 |
| IV | **Superconductivity:** Experimental survey: Superconductivity and its occurrence, Destruction of superconductivity by magnetic fields, Meissner effect, Type I and type II superconductors, Entropy, Free energy, Heat capacity, Energy gap, Microwave and infrared properties, Isotope effect; Theoretical survey: Thermodynamics of the | 15 |

| | | |
|---|---|---|
| | superconducting transition, London equation, London penetration depth, Coherence length; Microscopic theory: Qualitative features of the BCS theory, BCS ground state wave function; Quantitative predictions of the BCS theory, critical temperature, energy gap, critical field, specific heat; Flux quantization in a superconducting ring, duration of persistent currents; Dc and Ac Josephson effects; Macroscopic long-range quantum interference; High $T_c$ superconductors (introduction only). | |
| | **Total Contact Hours** | 60 |

| **SuggestedEvaluationMethods** | | | |
|---|---|---|---|
| **InternalAssessment: 30** | | **End Term Examination: 70** | |
| ➢ **Theory** | **30** | ➢ **Theory:** | **70** |
| • Class Participation: | 5 | Written Examination | |
| • Seminar/presentation/assignment/quiz/class test etc.: | 10 | | |
| • Mid-Term Exam: | 15 | | |

**PartC-Learning Resources**

**Recommended Books/e-resources/LMS:**

1. Introduction to Solid State Physics (7th edition) by Charles Kittel
2. Solid State Physics by Neil W. Ashcroft and N. David Mermin
3. Solid State Physics: An Introduction to Theory and Experiment by H. Ibach and H. Luth
4. Principles of the Theory of Solids (2nd edition) by J. M. Ziman
5. Condensed Matter Physics by Michael P. Marder
6. Applied Solid State Physics by Rajnikant

| **Session: 2025-26** | | | |
|---|---|---|---|
| **PartA - Introduction** | | | |
| Name of Programme | M. Sc. Physics | | |
| Semester | 2nd | | |
| Name of the Course | Quantum Mechanics-II | | |
| Course Code | 25PN-PHY-203 | | |
| CourseType | CC-7 | | |
| Level of the course | 500-599 | | |
| Pre-requisite for the course (ifany) | -- | | |
| CourseLearningOutcomes (CLOs)<br>After completing this course, the learner will be able to: | **CLO 203.1:** Formulate perturbation, variational & WKB methods for obtaining approximate solutions of the Schrödinger equation, and comprehend simple physical effects: Zeeman & Stark effects&alpha decay.<br>**CLO 203.2:** Apply the time-dependent perturbation theory to deal with atom-em radiation interaction and calculate explicitly the transition probability for induced absorption and emission.<br>**CLO 203.3:** Explicate electronic structure of many-electron atoms in central-field approximation, estimate the central potential using the Thomas-Fermi &Hartree methods, and have an understanding of molecular energy levels.<br>**CLO 203.4:** Grasp the basics of quantum scattering theory, learn the partial waves and Green's function methods for deriving scattering cross-sections, and calculate these for finite square well, hard sphere & screened Coulomb potentials. | | |
| Credits | Theory | Practical | Total |
| | 4 | 0 | 4 |
| Teaching Hours per week | 4 | 0 | 4 |
| Internal Assessment Marks | 30 | 0 | 30 |
| End Term Exam Marks | 70 | 0 | 70 |
| Max. Marks | 100 | 0 | 100 |
| Examination Time | 3 hours | | |
| **PartB-Contentsofthe Course** | | | |
| **Instructions for Paper- Setter:** The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering entire syllabus. The question paper is expected to contain problems to the extent of 20% of total marks. The examinee will be required to attempt 5 questions; selecting one question from each unitand the compulsory question. All questions will carry equal marks. | | | |

| Unit | Topics | Contact Hours |
|---|---|---|
| I | **Approximate methods for bound states-I:** Stationary perturbation theory: Non-degenerate case- First-order and second-order corrections to energy eigenvalues and eigenfunctions, Perturbation of an oscillator (harmonic and anharmonic ($ax^3 + bx^4$) perturbations), Ground state of Helium atom; Degenerate case- Removal of degeneracy in first and second order, Zeeman effect without electron spin, First-order Stark effect in $n$=2 state of Hydrogen, Fine structure of hydrogen atom (Relativistic and spin-orbit coupling corrections); Rayleigh-Ritz variational method: Ground and excited states, Application to ground state of Helium, Van der Waals interaction using perturbation and variational methods. | 15 |
| II | **Approximate methods for bound states-II:** The WKB approximation: Classical limit, Approximate solutions, Asymptotic nature of the solutions, Solution near a turning point, Linear turning point, Connection at the turning point, Asymptotic connection formulae, Application to energy levels of a quantum well, tunneling through a potential barrier and alpha decay; First-order time-dependent perturbation theory, Transition probability for constant and harmonic perturbations, Transition to a group of final states- The Fermi golden rule, Applications: Ionization of a hydrogen atom, Ionization probability, Interaction of an atom with *em* radiation (semi-classical treatment), Transition probability for induced absorption and emission, perturbation theory in scattering problems. | 15 |
| III | **Selected applications of Quantum Mechanics:** Atomic structure of many-electron atoms: Central-field approximation, Periodic system of elements, Thomas-Fermi statistical model, Evaluation of the potential, Hartree's self-consistent fields and connection with the variational method, Corrections to the central-field approximation, L-S and j-j couplings; Molecular structure: Classification of energy levels, Wave equation; The Hydrogen molecule: Potential energy function, The Morse potential, Rotation and vibration of diatomic molecules, Energy levels. | 15 |
| IV | **Quantum theory of scattering:** Scattering experiments and cross-sections, The laboratory and center-of-mass systems, Scattering amplitude and cross-section; The method of partial waves: Phase shift, Differential and total cross-sections, Relation between phase shift and scattering potential, Convergence of the partial-wave series, Scattering by a finite square well, Resonances- Breit-Wigner formula, Scattering by a hard-sphere potential; Green's function method: Lippmann-Schwinger equation, The Born series, The first Born approximation, Scattering of an electron by a screened Coulomb potential in Born approximation and validity criterion; Scattering of two identical spinless bosons, and spin-1/2 fermions. | 15 |
| | **Total Contact Hours** | 60 |
| | **Suggested Evaluation Methods** | |

| InternalAssessment: 30 | | End Term Examination: 70 | |
|---|---|---|---|
| ➢ **Theory** | **30** | ➢ **Theory:** | **70** |
| • Class Participation: | 5 | Written Examination | |
| • Seminar/presentation/assignment/quiz/class test etc.: | 10 | | |
| • Mid-Term Exam: | 15 | | |

**PartC-Learning Resources**

**Recommended Books/e-resources/LMS:**

1. Quantum Mechanics ($3^{rd}$ edition) by L. I. Schiff
2. Quantum Mechanics ($2^{nd}$ edition) by B. H. Bransden and Joachain
3. Introduction to Quantum Mechanics ($2^{nd}$ edition) by David J. Griffiths
4. Quantum Mechanics by A. K. Ghatak and S. Loknathan
5. A Textbook of Quantum Mechanics by P. M. Mathews and K. Venkatesan
6. Quantum Mechanics by John L. Powell and B. Crasemann
7. Quantum Mechanics: Concepts and Applications ($2^{nd}$ edition) by N. Zettili

| Session: 2025-26 | | | |
|---|---|---|---|
| **PartA - Introduction** | | | |
| Name of Programme | M.Sc. Physics | | |
| Semester | 2nd | | |
| Name of the Course | Electronic Devices and Circuits-II | | |
| Course Code | 25PN-PHY-204E | | |
| Course Type | CC-8 | | |
| Level of the course | 500-599 | | |
| Pre-requisite for the course (ifany) | -- | | |
| CourseLearningOutcomes (CLO)<br>After completing this course, the learner will be able to: | **CLO 204.1:** Well acquainted with the basic structures, operations, characteristics and biasing schemes of various field effect transistors. Understand the operations of different multivibrator circuits.<br>**CLO 204.2:** Develop a clear understanding of the basics of OPAMPS, its operating modes, internal structure and its vital design parameters. Become familiar with the basic structure, operation, characteristics and important applications of negative resistance devices.<br>**CLO 204.3:** Design and describe the operations of various families of logic gates. Simplify involved Boolean expressions with the help of Boolean algebra and K-map.<br>**CLO 204.4:** Explain the construction, operation, characteristics and important technological applications of various photonic devices. Explain the construction, operation, characteristics and important technological applications of different temperature sensitive devices. | | |
| Credits | Theory | Practical | Total |
| | 4 | 0 | 4 |
| Teaching Hours per week | 4 | 0 | 4 |
| Internal Assessment Marks | 30 | 0 | 30 |
| End Term Exam Marks | 70 | 0 | 70 |
| Max. Marks | 100 | 0 | 100 |
| Examination Time | 3 hours | | |
| **PartB-Contentsofthe Course** | | | |

**Instructions for Paper- Setter:** The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering entire syllabus. The question paper is expected to contain problems to the extent of 20% of total marks. The examinee will be required to attempt 5 questions; selecting one question from each unitand the compulsory

| question. All questions will carry equal marks. | | |
|---|---|---|
| **Unit** | **Topics** | **Contact Hours** |
| I | **Field Effect Transistors and Multivibrators:** Basic structure and operation of JFET, calculation of pinch off voltage, V-I characteristics of JFET, the FET small signal model, metal oxide semiconductor field effect transistor (MOSFET), physical structure, operation and characteristics, enhancement and depleted modes of operation, metal semiconductor field effect transistor (MESFET), low frequency common source and common drain FET amplifiers, FET biasing, FET as a voltage variable resistor (VVR); Multivibrators: a fixed biased transistor, a self-biased transistor and a direct connected bistablemultivibrator circuits, Schmitt trigger circuit, triggering techniques for bistablemultivibrators, collector-coupled and emitter-coupled monostable and astablemultivibrators. | 15 |
| II | **OPAMPs and Negative Resistance Devices**: The basic OPAMP, inverting and non-inverting mode of operation of OPAMP, effect of negative feedback on input and output resistances of OPAMPs, the differential amplifier, common mode rejection ratio (CMRR), the emitter coupled differential amplifier, the transfer characteristics of a differential amplifier, an IC OPAMP (MC-1530 Motorola) and its dc analysis, offset voltages and currents, universal balancing techniques, measurement of OPAMP parameters; basic working principles, characteristics and applications of uni-junction transistor (UJT), four layer diode (pnpn-diode), tunnel diode and silicon controlled rectifier. | 15 |
| III | **Digital Circuits:** Digital (binary) operation of a system, logic systems, the OR gate, the AND gate, the NOT gate, the exclusive OR gate, De Morgan's laws, Boolean algebra, the NAND and NOR diode-transistor gates, Modified DTL gates, fan-in and fan-out, wired logics, high threshold logic (HTL) gates, transistor- transistor logic (TTL) gates, output stages for TTL gates, resistance-transistor logic (RTL) gates, direct coupled transistor logic (DCTL) gates, emitter coupled logic (ECL) gates, digital MOSFET circuits, complementary MOS (CMOS) logic gates, comparison of logic families, Karnaugh- map (K-map) up to four variable and its applications. | 15 |
| IV | **Optoelectronic and Temperature Sensing Devices:**Radiative and nonradiative transitions, basic construction, operation, characteristics and applications of solar cells, light dependent resistance (LDR), photodiodes, p-i-n diodes, metal semiconductor photodiodes, avalanche photodiodes, light emitting diodes (LEDs), semiconductor diode lasers, photo transistors, resistance thermometers, thermocouples and thermistors. | 15 |
| | **Total Contact Hours** | 60 |

**SuggestedEvaluationMethods**

| **InternalAssessment: 30** | | **End Term Examination: 70** | |
|---|---|---|---|
| ➢ **Theory** | **30** | ➢ **Theory:** | **70** |
| • Class Participation: | 5 | Written Examination | |

| | | |
|---|---|---|
| • Seminar/presentation/assignment/quiz/class test etc.: | 10 | |
| • Mid-Term Exam: | 15 | |

**PartC-Learning Resources**

**Recommended Books/e-resources/LMS:**

1. Integrated Electronics by J. Millman and C. C. Halkias
2. Pulse, digital and switching waveforms by J. Millman and H. Taub
3. Electronic devices and circuits by Y. N. Bapat
4. Microwave devices and circuits by Samuel Y. Liao
5. Physics of semiconductor Devices by S. M. Sze
6. Electronic instrumentation and measurement techniques by W. D. Cooper and A. D. Helfrick
7. OPAMPs and linear IC circuits by Ramakant A. Gayakwad
8. Electronics for Scientists and Engineers: Devices, Circuits and Systems by TV Viswanathan, GK Mehta and V Rajaraman

| Session: 2025-26 (As per scheme 2025-26) | | | |
|---|---|---|---|
| **PartA–Introduction** | | | |
| Name of Programme | M. Sc. Physics | | |
| Semester | $2^{nd}$ | | |
| Name of the Course | Material Science-II | | |
| Course Code | 25PPN-PHY-204M | | |
| CourseType | DEC-4 | | |
| Level of the course | 500-599 | | |
| Pre-requisite for the course (ifany) | --- | | |
| CourseLearningOutcomes (CLOs)<br>After completing this course, the learner will to: | **CLO 204.1:** Comprehend various tests (Tension test, hardness tests, Impact test, fatigue test, creep test) used for measuring the mechanical properties of materials and Realize the difference between strength and hardness of materials. Compute various strength and ductility measures from engineering stress-strain curve and true stress-strain curves.<br>**CLO 204.2:** Understand magnetic processes, Diamagnetism, Paramagnetism, density of states curves for a metal; and Grasp the concepts of Ferromagnetism, exchange interactions, domain structure; Antiferromagnetism, Ferrimagnetism and Ferrites<br>**CLO 204.3:** Elucidate the physics describing dielectrics and ferroelectric materials, with focus on the functionality and Describe the optical properties of insulators<br>**CLO 204.4:** Understanding of the surface and concepts of salvage depth and Grasp the concept, working and applications of different electron and photon based surface analysis techniques. | | |
| Credits | Theory | Practical | Total |
| | 4 | 0 | 4 |
| Teaching Hours per week | 4 | 0 | 4 |
| Internal Assessment Marks | 30 | 0 | 30 |
| End Term Exam Marks | 70 | 0 | 70 |
| Max. Marks | 100 | 0 | 100 |
| Examination Time | 3 hours | | |
| **PartB-Contentsofthe Course** | | | |
| **Instructions for Paper- Setter:** The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The | | | |

| | | |
|---|---|---|
| compulsory question (Question No. 1) will consist of at least 4 parts covering entire syllabus. The question paper is expected to contain problems to the extent of 20% of total marks. The examinee will be required to attempt 5 questions; selecting one question from each unitand the compulsory question. All questions will carry equal marks. | | |
| **Unit** | **Topics** | **Contact Hours** |
| I | **Material Testing:** The Tension Test: engineering stress-strain curve, true stress-strain curve, instability in tension, Considere's construction, ductility measurement, effect of strain rate on flow properties, strain rate sensitivity; notch tensile test; The Hardness Test: Brinell hardness, Meyer hardness, Vicker's hardness number and test, Rockwell hardness test, Knoop hardness number and test; The Impact Test: brittle fracture problem, notched bar impact tests-Carpy and Izod Impact tests; The Fatigue Test: fatigue failures, stress cycles, the S-N curve, fatigue limit; The Creep Test: creep curve, primary, secondary and tertiary creep, effect of temperature and stress on the creep curve. | 15 |
| II | **Magnetic Materials:** Magnetic Processes: Larmor frequency; Diamagnetism, magnetic susceptibility, Langevin's diamagnetism equation; Paramagnetism, Curie constant, density of states curves for a metal; Ferromagnetism, Curie temperature, Curie-Weiss law, exchange interactions, domain structure; Antiferromagnetism and magnetic susceptibility of an antiferromagnetic material; Ferrimagnetism and Ferrites; Paramagnetic, ferromagnetic and cyclotron-resonance. | 15 |
| III | **Dielectric, Optical and Ferroelectric Materials:** Introduction, Energy bands, dielectric constant, complex permittivity, dielectric loss factor, polarization, mechanism of polarization, classification of dielectrics-frequency dependence of dielectric constant; Optical Phenomena in Insulators Colour of crystals - Excitons - weakly bound and tightly bound excitons. Colour centers – F-centers and other electronic centers in alkali halides. Ferroelectrics: General characteristics - piezoelectric, pyroelectric and ferroelectric materials. Classification of ferroelectrics and representative materials. Ferroelectric domains. Polarization catastrophe, Landau theory of first and second-order phase transitions, antiferroelectric materials . | 15 |
| IV | **Solid Surfaces and Analysis:** Surface and its importance, selvedge depths of surface; Methods of Surface Analysis: Auger Electron spectroscopy (AES)- basic principle, methodology, composition analysis and depth profiling; X-ray photoelectron spectroscopy (XPS) or ESCA: principle, methodology and quantitative analysis; Glancing angle X-ray Diffraction (GXRD), basic concept, methodology and structural analysis; Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM): Principle, methodology and Applications in surface analysis; Atomic Force Microscopy (AFM): Basic principle, Methodology, applications in structural analysis. | 15 |
| | **Total Contact Hours** | 60 |
| | **SuggestedEvaluationMethods** | |
| **InternalAssessment: 30** | | **End Term Examination: 70** |

| | | | |
|---|---|---|---|
| ➢ **Theory** | **30** | ➢ **Theory:** | **70** |
| • Class Participation: | 5 | Written Examination | |
| • Seminar/presentation/assignment/quiz/class test etc.: | 10 | | |
| • Mid-Term Exam: | 15 | | |

**PartC-Learning Resources**

**Recommended Books/e-resources/LMS:**

1. Material Science, J.C. Anderson, K.D. Leaver, J. M. Alexander and R. D. Rawlings
2. Mechanical Metallurgy, G.E. Dieter.
3. Electronic Processes in Materials, L. V. Azaroff and J. J. Brophy
4. Fundamentals of Surface and Thin Film Analysis, L.C. Feldman and J. W. Mayer
5. Surface Analysis Methods in Material Science, D. J. O'Connor, B. A. Sexton and R. St. CSmart (Eds), Springer Series in Surface Sciences 23
6. Solid State Physics – A J Dekker (McMillan, 1971)
7. Materials Science and Engineering by William D. Callister

**Session: 2025-26**

**PartA - Introduction**

| | |
|---|---|
| Name of the Programme | M.Sc. Physics |
| Semester | $2^{nd}$ |
| Name of the Course | General Electronics-II |
| Course Code | 25PN-PHY-205 |
| Course Type | PC-3 |
| Level of the course | 500-599 |
| Pre-requisite for the course (ifany) | -- |
| CourseLearningOutcomes (CLO)<br>After completing this course, the learner will be able to: | **CLO 205.1:** Draw V-I characteristics of an UJT and also able to design and able to determine the frequency ofsaw-tooth waves using UJT.<br>**CLO 205.2:** Design and draw load characteristics of a push-pullamplifier and design and verify truthtables of the basic logic gates.<br>**CLO 205.3:** Design and understand the operations of astablemultivibrator. Also draw the characteristics of various opto-electronic devices.<br>**CLO 205.4:** Explain the FET as VVR, the V-I characteristics of an emitter coupled differential amplifier, pnpn-diode and thermistor. |

| Credits | Theory | Practical | Total |
|---|---|---|---|
| | 0 | 4 | 4 |
| Teaching Hours per week | 0 | 8 | 8 |
| Internal Assessment Marks | 0 | 30 | 30 |
| End Term Exam Marks | 0 | 70 | 70 |
| Max. Marks | 0 | 100 | 100 |
| Examination Time | 0 | 4 hours | |

**PartB-Contentsofthe Course**

| Practicals | Contact Hours |
|---|---|
| **Note: Student will perform at least six experiments. The examiner will allot one practical at the time of end term examination.**<br>1. To draw the V-I characteristics of a Uni-Junction Transistor.<br>2. To generate saw-tooth waves using UJT and find its frequency.<br>3. To design circuits for OR, AND, NOT, NAND and NOR logic gates and verify their truth tables.<br>4. To study the astablemultivibrator.<br>5. To draw characteristics of opto-electronic devices.<br>6. To study a FET as voltage variable resistance (VVR).<br>7. To draw transfer characteristics of an emitter-coupled BJT differential amplifier.<br>8. To draw characteristics of a negative resistance thermistor | 120 |

| | | |
|---|---|---|
| | 9. To draw the V-I characteristics of a pnpn-diode.<br>10. To generate square waves using a Schmitt's trigger circuit.<br>11. Designing of an integrator using operational amplifier for a given specification & study of its frequency response.<br>12. Designing of a differentiator using operational amplifier for a given specification & study its frequency response.<br>13. Designing a first order Low-pass filter by using operational amplifier.<br>14. Designing a first order High-pass filter using operational amplifier. | |

| **SuggestedEvaluationMethods** | | | |
|---|---|---|---|
| **InternalAssessment: 30** | | **End Term Examination: 70** | |
| ➢ **Practicum** | **30** | ➢ **Practicum** | **70** |
| • Class Participation: | 5 | Lab record, Viva-Voce, write-up and execution of the practical | |
| • Seminar/Demonstration/Viva-voce/Lab records etc.: | 25 | | |

**PartC-Learning Resources**

**Recommended Books/e-resources/LMS:**


1. Integrated Electronics by J. Millman and C. C. Halkias
2. Pulse, digital and switching waveforms by J. Millman and H. Taub
3. Electronic devices and circuits by Y. N. Bapat
4. Microwave devices and circuits by Samuel Y. Liao
5. Physics of semiconductor Devices by S. M. Sze
6. Electronic instrumentation and measurement techniques by W. D. Cooper and A. D. Helfrick
7. OPAMPs and linear IC circuits by Ramakant A. Gayakwad
8. Electronics for Scientists and Engineers: Devices, Circuits and Systems by TV Viswanathan, GK Mehta and V Rajaraman

| Session: 2025-26 | | | |
|---|---|---|---|
| **PartA - Introduction** | | | |
| Name of the Programme | M.Sc. Physics | | |
| Semester | 2nd | | |
| Name of the Course | Physics Lab-II | | |
| Course Code | 25PN-PHY-206 | | |
| Course Type | PC-4 | | |
| Level of the course | 500-599 | | |
| Pre-requisite for the course (ifany) | -- | | |
| CourseLearningOutcomes (CLO)<br>After completing this course, the learner will be able to: | **CLO 206.1:** Calculate the Planck's constant using a suitable light source and half life of Indium.<br>**CLO 206.2:** Measure the mass absorption coefficient of β-rays in Aluminum and the band gap of a semiconductor. Set Michelson interferometer for various practical measurements<br>**CLO 206.3:** Determine the strength of α-source and verify nuclear statistics using SSNTD.<br>**CLO 206.4:** Determine the specific heat of a given solid specimen and the thermoelectric voltage as a function of the temperature differential. Study of Dia-, para- and ferromagnetic materials in an inhomogeneous magnetic field. | | |
| Credits | Theory | Practical | Total |
| | 0 | 4 | 4 |
| Teaching Hours per week | 0 | 8 | 8 |
| Internal Assessment Marks | 0 | 30 | 30 |
| End Term Exam Marks | 0 | 70 | 70 |
| Max. Marks | 0 | 100 | 100 |
| Examination Time | 0 | 4 hours | |
| **PartB-Contentsofthe Course** | | | |
| **Practicals** | | | **Contact Hours** |
| | **Note: Student will perform at least six experiments. The examiner will allot one practical at the time of end term examination.**<br>1. To study absorption of β-rays in Aluminum.<br>2. Michelson interferometer experiment.<br>3. To determine the half-life of Indium.<br>4. To determine the strength of an α-source using SSNTD.<br>5. To study nuclear statistics using SSNTD.<br>6. To determine band-gap of a semiconductor material.<br>7. To determine the specific heat of a given solid specimen.<br>8. Seeback effect: Determining the thermoelectric voltage as a function of the temperature differential. | | 120 |

9. Study Dia-, para- and ferromagnetic materials in an inhomogeneous magnetic field.
10. To find the velocity and compressibility of solid/ liquid sample using Ultrasonic Interferometer
11. Lattice dynamic kit
    a) Study of the Dispersion relation for the "Monoatomic Lattice" and Comparison with theory.
    b) Determination of the Cut-off frequency of the Monoatomic Lattice.
    c) Study of the Dispersion relation for the Di-atomic Lattice, Acoustical mode and Energy gap and Comparison with theory.
12. . To determine the Dielectric constant of polar and non-polar liquids

<table>
<tr><th colspan="4">SuggestedEvaluationMethods</th></tr>
<tr><th colspan="2">Internal Assessment: 30</th><th colspan="2">End Term Examination: 70</th></tr>
<tr><td>➢ Practicum</td><td>30</td><td>➢ Practicum</td><td>70</td></tr>
<tr><td>• Class Participation:</td><td>5</td><td colspan="2" rowspan="2">Lab record, Viva-Voce, write-up and execution of the practical</td></tr>
<tr><td>• Seminar/Demonstration/Viva-voce/Lab records etc.:</td><td>25</td></tr>
</table>

## PartC-Learning Resources

**Recommended Books/e-resources/LMS:**


1. Introduction to Experimental Nuclear Physics by R. M. Singru.
2. Elements of Nuclear Physics by W. E. Meyerhof.
3. Nuclear Radiation Detectors by S. S. Kapoor and V. S. Ramamurthy
4. Introduction to High Energy Physics (2nd edition) by D. H. Perkins.
5. Radiation Detection and Measurement by G. F. Knoll.
6. Nuclear Physics Theory and Experiment, by R. R. Roy and B. P. Nigam.
7. Introduction to Solid State Physics ($7^{th}$ edition) by Charles Kittel
8. Solid State Physics by Neil W. Ashcroft and N. David Mermin.

| | | | |
|---|---|---|---|
| **Session: 2025-26** | | | |
| **PartA - Introduction** | | | |
| Name of the Programme | Common to all PG Programmes | | |
| Semester | 2nd | | |
| Name of the Course | India's contribution to Science | | |
| Course Code | 25PN-PHY-IKS201 | | |
| CourseType | IKS | | |
| Level of the course | 200-299 | | |
| Pre-requisite for the course (ifany) | --- | | |
| CourseLearningOutcomes (CLO)<br>After completing this course, the learner will be able to: | **CLO 207.1:** Understand the development of astror the Indus, Vedic, and Post-Vedic periods.<br>**CLO 207.2:** Explain the Indian Yuga system, Moon star and planet movements, and Indian systems.<br>**CLO 207.3:** Identify traditional Indian astronomical instruments and their functions.<br>**CLO 207.4:** Analyze the contribution of observatories to astronomy.<br>**CLO 207.5:** Appreciate the lives and works of Indian scientists and their scientific impact<br>**CLO 207.6:** Evaluate the role of Indian scientific ins like CSIR, ISRO, and DAE in development. | | |
| Credits | Theory | Practical | Total |
| | 2 | 0 | 2 |
| Teaching Hours per week | 2 | 0 | 2 |
| Internal Assessment Marks | 15 | 0 | 15 |
| End Term Exam Marks | 35 | 0 | 35 |
| Max. Marks | 50 | 0 | 50 |
| Examination Time | 3 hours | | |

**PartB-Contentsofthe Course**

**Instructions for Paper- Setter:** The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unitand the compulsory question. All questions will carry equal marks.

| Unit | Topics | Contact Hours |
|---|---|---|
| I | Astronomy: Astronomy in Indus and Vedic period, Post Vedic Astronomy: Planetary Kinematics, the early traditions of siddhanta, | 8 |
| II | Brief Idea of Yuga system of India and phases of Moon, rising and setting of stars & Planets Indian Calendar : Pancanga, nakstra, festival dates in the Indian calendar | 8 |
| III | Astronomical Instruments: Samrat Yantra, Disha Yantra, Cakra Yantra, | 8 |

| | | |
|---|---|---|
| | Jai Prakash Yantra, Phalaka-Yantra, Kapala-Yantra, Nalaka-Yantra, Dhanuryantra, Chatl-Yantra, Gola-Yantra, Karttari-Yantra, Pitha-Yantra And Chatra-Yantr, Development of Astronomical Laboratories: Delhi Observatory and Jaipur Observatory | |
| IV | Life and work of Indian Scientists: Sir Jagadish Chandra Bose, P.C. Ray, Srinivasa Ramanujan, Sir C.V. Raman, Meghnad Saha, Satyendra Nath Bose, S.S. Bhatnagar, Homi Jehangir Bhabha andVikram Sarabhai Role and development of CSIR, ISRO and DAE. | 6 |
| | **Note: Scope of the syllabus shall be restricted to generic and introductory level of mentioned topics.** | |
| | **Total Contact Hours** | 30 |

**Suggested Evaluation Methods**

| **Internal Assessment: 15** | | **End Term Examination: 35** | |
|---|---|---|---|
| ➢ **Theory** | **15** | ➢ **Theory** | **35** |
| • Class Participation: | 4 | Written Examination | |
| • Seminar/presentation/assignment/quiz/class test etc.: | 4 | | |
| • Mid-Term Exam: | 7 | | |

**PartC-Learning Resources**

**Recommended Books/e-resources/LMS:**

1. History Of Astronomy In India by S.N. Sen,K.S. Shukla.
2. Indian Mathematics and Astronomy: Some Landmark