NEP and Learning Outcome-based Curriculum Framework (LOCF)

For

B.Sc. Physics (Single Major)

(Scheme UG A2: Undergraduate Programme)

(To be effective from the Academic Session 2025-26)

Department of Physics

Gurugram University, Gurugram

(A State Govt. University Established Under Haryana Act17 of 2017)

Scheme of Programme for B.Sc. (Physics)
(Scheme UG A2: Undergraduate Programme (Single Major)

List of Core Courses (Semester Wise)

Semester I

Course Code	Course Title	Course ID	L	T	P	L	T	P	Total Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
CC-A1	Mechanics	240/PHY/CC101	3	0	2	3	0	1	4	25	50	5	20	100
CC-A2	Waves and Oscillations	240/PHY/CC102	3	0	2	3	0	1	4	25	50	5	20	100
CC-A3	Mathematical Physics-I	240/PHY/CC103	4	0	0	4	0	0	4	30	70	0	0	100

Semester II

Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
CC-A4	Electricity and Magnetism	240/PHY/CC201	3	0	2	3	0	1	4	25	50	5	20	100
CC-A5	Elements of Modern Physics	240/PHY/CC202	3	0	2	3	0	1	4	25	50	5	20	100
CC-A6	Electronics-I	240/PHY/CC203	3	0	2	3	0	1	4	25	50	5	20	100

Ranjit

Semester III

Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
CC-A7	Quantum-I	240/PHY/ CC301	3	0	2	3	0	1	4	25	50	5	20	100
CC-A8	Electromagnetic Theory	240/PHY/ CC302	3	0	2	3	0	1	4	25	50	5	20	100
CC-A9	Physics of Semiconductor Devices	240/PHY/ CC303	3	0	2	3	0	1	4	25	50	5	20	100

Semester IV

Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
CC-A10	Quantum Mechanics -II	240/PHY/ CC401	3	0	2	3	0	1	4	25	50	5	20	100
CC-A11	Optics	240/PHY/ CC402	3	0	2	3	0	1	4	25	50	5	20	100
CC-A12	Mathematical Physics-II	240/PHY/ CC403	3	0	2	3	0	1	4	25	50	5	20	100

Ranjit

Semester V

Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
CC-A16	Classical Mechanics	240/PHY/ CC601	3	0	2	3	0	1	4	25	50	5	20	100
CC-A17	Atomic & Molecular Physics	240/PHY/ CC602	3	0	2	3	0	1	4	25	50	5	20	100
CC-A18	Nuclear and Particle Physics	240/PHY/ CC603	3	0	2	3	0	1	4	25	50	5	20	100

Semester VI

Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
CC-A13	Heat and Thermodynamics	240/PHY/ CC501	3	0	2	3	0	1	4	25	50	5	20	100
CC-A14	Solid State Physics	240/PHY/ CC502	3	0	2	3	0	1	4	25	50	5	20	100
CC-A15	Statistical Mechanics	240/PHY/ CC503	3	0	0	3	0	0	3	25	50	0	0	75

1. ***The curriculum for semesters 7^{th}, 8^{th}, 9^{th} and 10^{th} will be provided in due course of time.***
2. ***The MDC, AEC, SEC, and VAC courses could be chosen from the university pool or from Departmental shortlisted Swayam-NPTEL Course list.***

Ranjit

SEMESTER-I

Course ID - 240/PHY/CC101
MECHANICS

Marks (Theory): 50 **Credits :3 (45 Lectures)**
Marks (Internal Assessment): 25 **Time: 3 Hrs.**

Note: The paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of five short answer type questions, each of two marks. The rest of the eight questions are to be set uniformly, with two questions from each unit selected. A student is required to attempt five questions, selecting one from each unit along with compulsory question no 1. The question paper shall contain 20 % numerical problems in the relevant papers.

Course 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 Outcome:** The student will be able to understand the concept and the applications of Newtonian mechanics. The origin and applications of special theory of relativity should be clear to students.

Unit - I

Time derivative of a vector, Motion in plane polar coordinates, Newton's law, Dynamics of a system of particles, Principle of conservation of momentum, Impulse, Work and kinetic energy theorem, Conservative forces and examples (Gravitational and electrostatic), Non-Conservative forces, and examples (velocity-dependent forces e.g. frictional force, magnetic force). Potential Energy, Energy diagram, Stable, Unstable and Neutral Equilibrium, Force as gradient of the potential energy, Collisions: Elastic and Inelastic Collisions between two Spherical Bodies, Kinematics of 2→2 scattering in the Centre of Mass and Laboratory Frames.

Unit - II

Angular momentum of a particle and system of particles, Torque, Principle of conservation of Angular Momentum, Rotation about a fixed axis, Determination of Moment of Inertia of symmetric Rigid Bodies (rectangular, cylindrical and spherical) using Parallel and Perpendicular axes theorems, Kinetic energy of rotation, Motion involving both translation and rotation, Vector Nature of Angular Velocity and Angular Momentum, Gyroscope, Non-Inertial Systems: Non-inertial frames and fictitious forces, Uniformly rotating frame, Centrifugal force, Coriolis force and its applications.

Unit - III

Central forces, Law of conservation of Angular Momentum for Central Forces, Two-Body problem and its reduction to equivalent One-Body problem and its solution, Concept of

Ranjit

effective potential energy and stability of orbits for central potentials, Discussion on Trajectories, Solution of Kepler's Problem, Kepler's Laws for planetary motion, Orbit for Artificial Satellites.

Unit - IV

Inertial and Non-Inertial Frames, Invariance of Newton's Laws of motion under Galilean transformations, Postulates of Special Theory of Relativity, Lorentz Transformations, simultaneity, Length Contraction, Time Dilation, Proper Length and Proper Time, Life Time of a Relativistic Particle (for example Muon Decay Time and Decay Length), Relativistic Transformation of Velocity and Acceleration, Variation of Mass with Velocity, Mass-Energy Equivalence.

References:

1. An introduction to Mechanics, D. Kleppner, R.J. Kolenkow, McGraw-Hill.
2. Mechanics, Berkeley Physics, Vol.1, C. Kittel, W. Knight, et.al., Tata McGraw-Hill.
3. Fundamentals of Physics, R. Resnick, D. Halliday and J. Walker, Wiley Publications.
4. Mechanics, D.S. Mathur, S. Chand and Company Limited.
5. Feynman Lecture Series, Vol. I, R. P. Feynman, R. B. Leighton, M. Sands, Pearson Educaticn.

MECHANICS (LAB)

Marks (External): 20 **Credits: 1 (30 Hrs.)**
Marks (Internal Assessment): 05 **Time: 3 Hrs.**

1. Each student should perform at least five experiments.
2. The students are required to calculate the error involved in a particular experiment.
3. List of experiments may vary.

List of Experiments:

1. Measurements of Length (or Diameter) using Vernier Caliper, Screw Gauge and Travelling Microscope.
2. To Study the Random Error in observations.
3. To determine the Height of a Building using a Sextant.
4. To determine the vertical distance between two given points using Sextant.
5. To determine the Moment of Inertia of a Flywheel.

Ranjit

6. To determine g and velocity for a freely falling body using Digital Timing Technique
7. To determine the Young's Modulus of a Wire by Optical Lever Method.
8. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
9. To determine the elastic Constants of a wire by Searle's method.

References:

1. Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. BSc Practical Physics, Harnam Singh, S. Chand Publications, 2020.
3. BSc Practical Physics, Geeta Sanon, R. Chand Publications, 2020.
4. Advanced level Physics Practical's, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
5. A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Edn, 1511, Kitab Mahal.

Course ID - 240/PHY/CC102

WAVES AND OSCILLATIONS

Marks (Theory): 50 **Credits :3 (45 Lectures)**
Marks (Internal Assessment): 25 **Time: 3 Hrs.**

Note: The paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of five short answer type questions, each of two marks. The rest of the eight questions are to be set uniformly, with two questions from each unit selected. A student is required to attempt five questions, selecting one from each unit along with compulsory question no 1. The question paper shall contain 20% numerical problems in the relevant papers.

Course Objective: The objective of this course is to introduce the basics of oscillatory motion, wave motion, transmission linens, ultrasonic and their applications.	**Course Outcome:** After completion of this course, students will be familiar with the concept of wave and oscillations.

UNIT – I

Simple Harmonic Motion (SHM): Oscillatory motion, Oscillations of a Spring-Mass System; Simple harmonic oscillator: Equation of motion, solution, characteristics and energy stored; Examples of Physical Systems Executing SHM: Simple Pendulum, Compound Pendulum, LC-Circuit; Principle of Superposition; Superposition of Two Collinear Harmonic Oscillations of

Ranjit

Same/Different Frequencies; Beats; Superposition of Two Perpendicular Simple Harmonic Oscillations of Same/Different Frequencies and Lissajous Figures.

UNIT – II

Damped Oscillations and Forced Oscillation: Equation of Motion of a Damped Oscillator and its Solutions; Heavy Damping; Critical Damping; Weak Damping and its Characteristics: Logarithmic Decrement, Relaxation Time, Quality Factor; Forced Oscillator: Differential Equation and its Solution, Resonance, Power Absorbed; Quality Factor.

UNIT – III

Coupled Oscillations: Coupled Oscillator comprising Two Oscillators and its Solution; Normal Coordinates; Degrees of Freedom and Normal Modes of Vibration, Energy relations in Coupled Oscillations, Many Coupled Oscillators.

UNIT – IV

Waves: Waves in One Dimension; Superposition of waves; Stationary Waves; Waves on a Stretched String with Fixed Ends; Phase Velocity and Group Velocity; The Doppler Effect.

References:

1. Vibrations and Waves by A. P. French. (CBS Pub. and Dist., 1987).
2. Wave and Oscillation by W. F. Smith (OUP USA, 2010).
3. The Physics of Waves and Oscillations by N.K. Bajaj (Tata McGraw-Hill, 1988).
4. The Physics of Vibrations and Waves by H. J. Pain (Wiley, 2006).
5. An Introduction to Mechanics by Daniel Kleppner, Robert J. Kolenkow (McGraw-Hill, 1973).

WAVES AND OSCILLATIONS (LAB)

Marks (External): 20 **Credits: 1 (30 Hrs.)**
Marks (Internal Assessment): 05 **Time: 3 Hrs.**

1. Each student should perform at least five experiments.
2. The students are required to calculate the error involved in a particular experiment.
3. List of experiments may vary.

List of Experiments:

1. Estimate limits on angular displacement for SHM by measuring the time period at different angular displacements and compare it with the expected value of time period for SHM using Bar Pendulum.
2. To determine the value of acceleration due to gravity (g) using bar pendulum.
3. To study the damped oscillations using bar pendulum.
4. To study the effect of area of the damper on damped oscillations. Also plot amplitude as a function of time and determine the damping coefficient and Q factor for different dampers.
5. To determine the value of acceleration due to gravity using Kater's pendulum for
   (a) $T1 \approx T2$ and (b) $T1 \neq T2$
   and discuss the relative merits of both cases by estimation of error in the two cases.
6. Understand the applications of CRO by measuring voltage and time period of a periodic waveform using CRO.
7. To study the superposition of two perpendicular simple harmonic oscillations using CRO (Lissajous figures).
8. To calculate g, spring constant and mass of a spring using static and dynamic methods.
9. To calculate spring constant of series and parallel combination of two springs.
10. To determine the frequency of an electrically maintained tuning fork by Melde's experiment and to verify λ^2 –T Law.

References:

1. Advanced Practical Physics for students, B. L. Flint and H. T. Worsnop, 1971, Asia Publishing House.
2. Engineering Practical Physics, S. Panigrahi and B. Mallick, 2015, Cengage Learning India Pvt. Ltd.
3. Practical Physics, G. L. Squires, 2015, 4/e, Cambridge University Press.
4. A Text Book of Practical Physics, Vol I and II, Prakash and Ramakrishna, 11/e, 2011, Kitab Mahal.
5. An Introduction to Error Analysis: The study of uncertainties in Physical Measurements, J. R. Taylor, 1997, University Science Books List of experiments.

Ranjit

Course ID - 240/PHY/CC103

MATHEMATICAL PHYSICS-I

Marks (Theory): 70 **Credits: 4 (60 Lectures)**
Marks (Internal Assessment): 30 **Time: 3 Hrs.**

Note: The paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. The rest of the eight questions are to be set uniformly, with two questions from each unit selected. A student is required to attempt five questions, selecting one from each unit along with compulsory question no 1. The question paper shall contain 20% numerical problems in the relevant papers.

Course Objective: The present course introduces about the vector calculus, differential equation and Curvilinear Coordinates and their applications. It also develops an understanding of Special mathematical functions required for advanced physics problems.	**Course Outcome:** After completing this course, students would be able to deal with mathematics that appears in other papers such as Classical Mechanics, Quantum Mechanics, Nuclear Physics, Condensed Matter Physics, etc.

Unit - I

Calculus: Limit, continuity and differentiability of a function, geometrical significance of derivative, successive differentiation, Leibnitz theorem, partial derivatives, total differential, Approximations: Binomial & Taylor Series.

Unit - II

Ordinary Differential Equations: First order differential equations of degree one and those reducible to this form, Homogeneous differential equations of second order with constant coefficients, Wronskian and linearly independent functions. Complete Solution, complimentary function, particular integral and general solution.

Unit - III

Vector Calculus: Scalar and vector function, del operator, gradient of a scalar field, Divergence and curl of a vector field, Laplacian operator, Line, surface and volume integrals of vector fields. Flux of a vector field. Gauss divergence theorem, Green's and Stokes' Theorems and their applications.

Unit - IV

Curvilinear Coordinates: Orthogonal Curvilinear Coordinates, Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and cylindrical Coordinate systems, transformation of Cartesian coordinates into spherical and cylindrical coordinates

References:

1. Mathematical Methods for Physicists, G. B. Arfken, H. J. Weber, F. E. Harris,2013, 7th Edn., Elsevier.
2. An introduction to ordinary differential equations, E.A.Coddington, 2009, PHI learning
3. Mathematical Physics, Goswami, 1st edition, Cengage Learning
4. Engineering Mathematics, S.Pal and S.C. Bhunia, 2015, Oxford University Press
5. Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.

SEMESTER II
Course ID - 240/PHY/CC201

ELECTRICITY AND MAGNETISM

Marks (Theory): 50 **Credits :3 (45 Lectures)**
Marks (Internal Assessment): 25 **Time: 3 Hrs.**

Note: The paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. The rest of the eight questions are to be set uniformly, with two questions from each unit selected. A student is required to attempt five questions, selecting one from each unit along with compulsory question no 1. The question paper shall contain 20% numerical problems in the relevant papers.

Course Objective: The course on electricity and magnetism deals with Coulomb's law, the electric field, potential formulation of electrostatic, capacitors, magnetism, and magnetic materials, along with the application of these concepts. The physical context and derivation of Maxwell equations is covered.	**Course Outcome:** The student will be able to understand Gauss's Divergence theorem, Stokes's theorem in dielectrics, and the electrical and magnetic properties of materials. The origin and applications of Maxwell's equations should be clear to students.

UNIT-I

Electrostatics: Electric field, Electric field lines, Electric flux, Divergence and curl of electrostatic field, Gauss' Law with applications, Conservative nature of Electrostatic Field, Electrostatic Potential, Potential and Electric Field of a dipole, Force and Torque on a dipole, Electrostatic energy of system of charges, Energy per unit volume in electrostatic field, Electrostatic energy of a charged sphere, Conductors in an electrostatic Field, Surface charge and force on a conductor, Laplace's and Poisson equations, Laplace equation in three dimension, The Uniqueness Theorems.

UNIT-II

The method of images: Point charge in the presence of grounded conducting sphere, Solution of Laplace equation by separation of variables for Cartesian and spherical coordinates, Multipole expansion of potential due to arbitrary charge distribution.
Dielectric Properties: Dielectric medium, Polarization, Bound charges in a polarized dielectric and their physical interpretation, Electric displacement, Gauss's theorem in dielectrics, Linear Dielectrics, Susceptibility, Permittivity & Dielectric constants, Boundary value problems with dielectrics.

UNIT-III

Magnetism: Lorentz force law, Magnetic forces, Magnetostatics: Biot-Savart's law and its applications (1) straight conductor (2) circular coil (3) solenoid carrying current, Divergence and curl of the magnetic field, Ampère's circuital law and its applications for simple current configurations, Magnetic vector potential.
Electromagnetic Induction: Faraday's experiments on induction, Faraday's Law, Induced Electric field, Self and Mutual inductance, Energy in magnetic fields.

UNIT-IV

Magnetic Properties of Matter: Magnetization vector (M), Magnetic Intensity (H), Magnetic Susceptibility and permeability, Relation between B, H, M, Para-, Dia- and Ferromagnetism, B-H curve and hysteresis
Maxwell's Equations: Electrodynamics before Maxwell. Maxwell's fixing of Ampere's law, Maxwell's equations in vacuum and linear dielectrics

References:

1. D.J. Griffith, Introduction to Electrodynamics, Pearson Publication
2. Electricity and Magnetism, Edward M. Purcell, 1986, McGraw-Hill Education.
3. Electricity and Magnetism, J.H. Fewkes & J. Yarwood. Vol. I, 1991, Oxford Univ. Press.

ELECTRICITY AND MAGNETISM (LAB)

Marks (External): 20 **Credits: 1 (30 Hrs.)**
Marks (Internal Assessment): 05 **Time: 3 Hrs.**

1. Each student should perform at least five experiments.
2. The students are required to calculate the error involved in a particular experiment.
3. List of experiments may vary.

Ranjit

List of Experiments:

1. To determine an unknown Low Resistance using Potentiometer.
2. To determine an unknown Low Resistance using Carey Foster's Bridge.
3. Measurement of field strength B and its variation in a solenoid (determine dB/dx)
4. To determine self-inductance of a coil by Rayleigh's method.
5. e/m measurement by Thomson method
6. To determine the mutual inductance of two coils
7. B-H curves for soft and hard ferromagnetic materials.
8. Measurement of self-inductance of a coil by Owen's Bridge

References:

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. BSc Practical Physics, Geeta Sanon, R.Chand Publications, 2020.
3. BSc Practical Physics, Harnam Singh, S. Chand Publications, 2020.
4. A Text Book of Practical Physics, I.Prakash &Ramakrishna, 11th Ed., 1511,Kitab Mahal
5. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
6. Engineering Practical Physics, S.Panigrahi and B.Mallick, 1515, Cengage Learning.

Course ID - 240/PHY/CC202

ELEMENTS OF MODERN PHYSICS

Max. Marks: 50 **Credit: 3 (45 Hrs)**
Internal Assessment: 25 **Time: 3 Hours**

Note: 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 unit and the compulsory.

Ranjit

Course Objective: The course on electricity and magnetism deals with Coulomb's law, the electric field, potential formulation of electrostatic, capacitors, magnetism, and magnetic materials, along with the application of these concepts. The physical context and derivation of Maxwell equations is covered.	**Course Outcome:** The student will be able to understand quantum theory of light and wave-particle duality. He will also be able to solve the Schrödinger equation for simple systems and distinguish between different types of radioactive decays

Course Outcomes:

After successful completion of the course on Modern Physics, a student will be able to:

- *Understand the quantum theory of light and wave-particle duality.*
- *Describe Heisenberg uncertainty principle and linear superposition principle.*
- *Solve the Schrödinger equation for simple systems and interpret wave functions in terms of probabilities and normalization.*
- *Distinguish between different types of radioactive decays.*

Unit-I

Blackbody Radiation (observations and models), Plank's proposition and quantum theory of light, Photoelectric effect, X-rays, X-ray production, Compton scattering, Pair Production, De Broglie Waves, Davisson-Germer experiment. Wave description of particles by wave packets. Group and Phase velocities and the relation between them. Two-Slit experiment with electrons, Probability, Wave amplitude and wave functions, Rutherford Model, Hydrogen spectra and Bohr model of atom, Explanation of Hydrogen spectra, Nuclear mass effect on spectra of Atoms.

Unit-II

Position measurement- gamma-ray microscope thought experiment; Wave-particle duality, Heisenberg uncertainty principle (Uncertainty relations involving Canonical pair of variables, Estimating minimum energy of a confined particle using uncertainty principle; Energy-time uncertainty principle application to virtual particles and range of interaction. Two slit interference experiment with photons, atoms and particles; linear superposition principle as a consequence; Matter waves and wave amplitude; Schrodinger equation for non-relativistic particles; Momentum and Energy operators; stationary states; physical interpretation of a wave function, probabilities and normalization; Probability and probability current densities in one dimension.

Unit-III

Solution of Schrodinger equation for one-dimensional problems: One dimensional infinitely rigid box- energy eigenvalues and eigenfunctions, normalization; Quantum dot as an example; Quantum mechanical scattering and tunnelling in one dimension-across a step potential & rectangular potential barrier.

Ranjit

Unit-IV

Nuclear Decay: Stability of the nucleus; Law of radioactive decay; Mean life and half-life; Alpha decay; Beta-decay- energy released, spectrum and Pauli's prediction of neutrino; Gamma-ray emission, energy-momentum conservation: electron-positron pair creation by gamma photons in the vicinity of a nucleus.

Lasers: Einstein's A and B coefficients, Metastable states, Spontaneous and Stimulated emissions, Optical Pumping and Population Inversion, Three-Level and Four-Level Lasers, Ruby Laser and He-Ne Laser.

References/Books:

1. Concepts of Modern Physics, Arthur Beiser, 2009, McGraw-Hill
2. Modern Physics, John R. Taylor, Chris D. Zafiratos, M. A. Dubson,2009, PHI Learning
3. Six Ideas that Shaped Physics: Particle Behave like Waves, T. A. Moore, 2003, McGraw Hill
4. Quantum Physics, Berkeley Physics Course, Vol.4. E.H. Wichman, 2008, Tata McGraw-Hill Co.
5. Modern Physics, R.A. Serway, C.J. Moses, and C.A. Moyer, 2005, Cengage Learning. Modern Physics, G. Kaur and G.R. Pickrell, 2014, McGraw Hill

ELEMENTS OF MODERN PHYSICS (LAB)

Marks (Internal): 5 **Credits: 1 (30Hrs)**

Marks (End Semester exam): 20 **Time: 3 Hours**

Students assigned the Elements of Modern Physics laboratory work will perform at least 5 experiments of the following sections:

1. Demonstration of energy quantization using the Franck-Hertz Experiment.
2. To determine the wavelength of laser light using Michelson interferometer experiment.
3. To determine the value of Planck's constant using photocell/LED.
4. To determine the e/m ratio of an electron using Magnetron.
5. To study Hall Effect and to determine Hall coefficient.
6. To verify the existence of different harmonics and measure their relative amplitudes in a complex wave using CRO (square, clipped sine wave, triangular wave, etc.).
7. To determine the ionization potential of mercury.
8. To determine the half-life of Indium.
9. Statistics using G. M. Counter.

Ranjit

10. Thickness of Al Sheet using G. M. Counter.

Course ID - 240/PHY/CC203

ELECTRONICS-I

Max. Marks: 50 **Credit: 3 (45 Hrs)**
Internal Assessment: 25 **Time: 3 Hours**

Course Objective: The course on electricity and magnetism deals with Coulomb's law, the electric field, potential formulation of electrostatic, capacitors, magnetism, and magnetic materials, along with the application of these concepts. The physical context and derivation of Maxwell equations is covered.	**Course Outcome:** The student will be able to understand basic circuit laws, network theorems, oscillators, amplifiers and integrated circuits. The concepts Transistors and IC's can also be applied by the students.

UNIT-I

Ideal constant-voltage and constant-current Sources, Kirchhoff's Current Law & Kirchhoff's Voltage Law, Mesh & Node Analysis, Thevenin theorem, Norton theorem, Star Delta Transformation, Superposition theorem, Reciprocity Theorem, Maximum Power Transfer theorem, Applications to DC circuits.

UNIT-II

Concept of feedback in amplifier, Type of feedback, Small signal amplifiers, Analysis of stage amplifier by Graphical and Equivalent Circuit methods, Requirement of multistage amplifiers, Gain of multistage amplifier, Coupling of two stages, Frequency response of RC-coupled amplifiers, Distortion in amplifier, Classification of amplifiers, Power amplifier, Push-pull amplifier, Voltage gain in feedback amplifier, Negative feedback and its advantages, Classification of oscillators, LC and RC oscillators.

UNIT-III

Graphical Analysis of the CE Configuration, Two-port Devices and the Hybrid Model, Transistor Hybrid Model, Conversion Formulas for the Parameters of the Three Transistor Configurations, Analysis of a Transistor Amplifier Circuit Using h Parameters, The Emitter Follower, Comparison of Transistor Amplifier Configurations, Linear Analysis of a Transistor Circuit, Cascading Transistor Amplifiers, Simplified Common-emitter Hybrid Model, The Common-emitter Amplifier with an Emitter Resistance.

UNIT-IV

Ranjit

Integrated Circuits (IC): Fabrication and Characteristics: Integrated circuit Technology, Basic monolithic IC, Epitaxial Growth, Masking and Etching, Diffusion of impurities, Transistors for Monolithic circuits, Monolithic diodes, Integrated resistors, Integrated capacitors and inductors, Large scale and medium scale integration (LSI and MSI), Metal Semiconductor contacts

Reference Books:

1. Basic Electronics and Linear Circuits, N. N. Bhargava et. al., 2nd Edition, McGraw Hill Education, India
2. A textbook in Electrical Technology, B. L. Theraja, S. Chand & Co.
3. Circuit and Networks, 2nd Edition, A Sudhakar and Shyammohan S Palli, Tata McGraw-Hill.
4. Integrated Electronics by Jacob Millman, Christos Halkias, Chetan Parikh, McGraw Hill Education, India.

Electronics-I (LAB)

Marks (Internal): 5 **Credits: 1 (30 Hrs)**
Marks (End Semester exam): 20 **Time: 3 Hours**

Students assigned the Elements of Electronics-I laboratory work will perform at least 5 experiments of the following sections:

List of Experiments:

1. Verify Thevenin and Norton Network Theorem
2. To verify the Superposition, and Maximum power transfer theorems.
3. Study frequency response of R-C Coupled Amplifier
4. Study characteristics of a Push-Pull Amplifier
5. Study a LC/RC Oscillator using transistors
6. Study of Analog Communication System.
7. Study of NPN transistor as Amplifier.
8. Study of PNP transistor as Amplifier.
9. Study of Tunnel Diode characteristics.
10. Study of h-parameter of a transistor.

Ranjit

NEP and Learning Outcome-based Curriculum Framework

Pool Courses for

B.Sc. Physics (Single Major)

(Scheme UG A2: Undergraduate Programme)

(To be effective from the Academic Session 2025-26)

DEPARTMENT OF PHYSICS

GURUGRAM UNIVERSITY, GURUGRAM

(A State Govt. University Established Under Haryana Act17 of 2017)

Pool Courses

Scheme UG A1: Undergraduate Programme

Course Code	Course Title	Course ID	L	T	P	L	T	P	Total Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
Minor Course(s)														
MIC-1	Modern Physics-I	240/PHYP/ MI101	2	0	0	2	0	0	2	15	35	0	0	50
MIC-2	Modern Physics-II	240/PHYP/ MI201	2	0	0	2	0	0	2	15	35	0	0	50
MIC-3	Modern Physics-III	240/PHYP/ MI301	3	0	2	3	0	1	4	25	50	5	20	100
MIC-4	Renewable Energy	240/PHYP/ MI401	3	0	2	3	0	1	4	25	50	5	20	100
Multidisciplinary Course(s)														
MDC-1	Rational Thinking and Science	240/PHYP/ MD101	3	0	0	3	0	0	3	25	50	0	0	75
MDC-2	Physics In Everyday Life	240/PHYP/ MD201	3	0	0	3	0	0	3	25	50	0	0	75
MDC-3	Our Universe	240/PHYP/ MD301	3	0	0	3	0	0	3	25	50	0	0	75
Skill Enhancement Course														
SEC-1	Basics of Instrumentation Skills	240/PHYP/ SE101	1	0	4	1	0	2	3	5	20	15	35	75
SEC-2	Basics of Programming	240/PHYP/ SE201	1	0	4	1	0	2	3	5	20	15	35	75

Ranjit

Detailed Syllabus of First Year

SEMESTER-I

Minor Course

COURSE ID: 240/PHYP/MI101

MODERN PHYSICS-I

Marks (External): 35 **Credits: 2 (30 lectures)**
Marks (Internal Assessment): 15 **Time: 2 Hrs**

Note: The paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of five short answer type questions. The rest of the eight questions are to be set uniformly, with two questions from each unit selected. A student is required to attempt five questions, selecting one from each unit along with compulsory question no 1. The question paper shall contain 20% numerical problems in the relevant papers.

Course Objective: The course is based on imparting basic knowledge of special theory of relativity, particle nature of electromagnetic waves and wave nature of microscopic particles.	**Course Outcome:** After completion of this course, students will be able to understand the basic relativity and its applications. Student will be able to grasp the basic ideas initiating the quantum revolution.

Unit I

Relativity: Inadequacy of Galilean Transformations, Michelson-Morley experiment, Postulates of Special relativity, Lorentz transformation, Time dilation, length contraction, twin paradox, velocity transformation and its applications

Unit II

Relativistic energy and momentum, Mass-energy equivalence, Four vectors, Doppler Effect for light, Gravity and light, Principal of equivalence, Spacetime: timelike and spacelike intervals, Introductory idea of general theory of relativity (no derivation).

Unit III

Particle Properties of Waves: Electromagnetic waves, Blackbody radiation, Planck's radiation formula, Quantum nature of light, Photoelectric effect. X-rays, X-rays spectra, X-ray diffraction, Compton effect, Pair production, Photon absorption, Photons and gravity, gravitational red shift.

Unit IV

Wave properties of particles: De Broglie Matter waves, waves of probability, characteristics of general waves, phase and group velocities, diffraction from particles-Davisson-Germer experiment, Particle in a box (No derivation), Uncertainty principle and its applications

References:

1. Concepts of Modern Physics, Arthur Beiser, 2009, McGraw-Hill
2. Modern Physics, John R. Taylor, Chris D. Zafiratos, M. A. Dubson,2009, PHI Learning
3. Six Ideas that Shaped Physics: Particle Behave like Waves, T. A. Moore, 2003, McGraw Hill
4. Quantum Physics, Berkeley Physics Course, Vol.4. E.H. Wichman, 2008, Tata McGraw-Hill Co.
5. Modern Physics, R.A. Serway, C.J. Moses, and C.A. Moyer, 2005, Cengage Learning. Modern Physics, G. Kaur and G.R. Pickrell, 2014, McGraw Hill

Multidisciplinary Course

Course ID-240/PHYP/MD101
Rational Thinking and Science

Marks (Theory): 50 **Credits:3 (45 lectures)**
Marks (Internal Assessment) : 25 **Time : 3 Hrs**

Note: The paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of five short answer type questions, each of two marks. The rest of the eight questions are to be set uniformly, with two questions from each unit selected. A student is required to attempt five questions, selecting one from each unit along with compulsory question no 1. The question paper shall contain 20% numerical problems in the relevant papers.

Course Objective: To develop critical thinking and scientific reasoning skills by exploring the principles of rational thought, the scientific method, and landmark discoveries that reshaped our understanding of the natural world.	**Course Outcome:** By the end of this course, learners will be able to apply rational thinking and the scientific method to evaluate claims, distinguish evidence-based reasoning from biases/myths, and appreciate how foundational scientific discoveries transformed human understanding.

Unit-I

Scientific Approach and Rational Thinking: Fundamentals of rational thinking, faith vs belief, the scientific method: observation, hypothesis, experimentation, and conclusion, origin of science through curiosity and inquiry, myth-busting discoveries in physics: 1) heliocentrism (Copernicus, Galileo), 2) gravity and motion (Newton), 3) theory of relativity (Einstein), 4) nature of lightning (Benjamin Franklin), 5) Vacuum and air pressure (Evangelista Torricelli, Otto von Guericke)

Unit-II

Myths and Scientific Thinking: Science vs faith, science vs pseudoscience, definition, origin, and types of myths and beliefs, evolution of myths and misconceptions in explaining natural phenomena, influence of cultural and social beliefs on scientific progress, Darwin's theory as a case study in scientific thinking

Unit-III

The Paradox of Science & Technology: Distinction between science and technology, understanding the science-technology acceptance paradox, case studies: 1) acceptance and rejection of new technologies, 2) rejection and resistance to scientific ideas, the future of Artificial intelligence (AI) and its societal acceptance, potential problems in AI

Unit-IV

Challenges in Promoting Rational Thinking: Barriers to rational thinking, role of education and media in promoting or hindering rationality, scientific temper, and constitutional duty: relevance in Indian context (Article 51A(h)), case studies: superstition and blind beliefs (e.g., astrology, miracle claims), science communication: importance of clear communication of science to the public

References:

1. Mythakon Se Vigyan Tak by Gauhar Raza, Penguin Random House India
2. The Scientific Attitude: Defending Science from Denial, Fraud, and Pseudoscience by Lee McIntyre, The MIT Press, Cambridge
3. In Search of Superstitions by Narendra Nayak, Mythri Books

Skill Enhancement Course

Course ID - 240/PHYP/SE101
BASICS OF INSTRUMENTATION SKILLS

Marks (Theory): 20 **Credits:1 (15 lectures)**
Marks (Internal Assessment): 05 **Time: 2 Hrs**

Note: The paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions. The rest of the eight questions are to be set uniformly, with two questions from each unit selected. A student is required to attempt five questions, selecting one from each unit along with compulsory question no 1. The question paper shall contain 20% numerical problems in the relevant papers.

Course Objective: The course imparts practical knowledge about commonly used electronic instruments, including a multimeter, cathode ray oscilloscope, and LCR circuit, to undergraduate physics students.	**Course Outcome:** After completing this course, students will be able to understand the basic equipment used in a physics laboratory.

Ranjit

Unit I

Basic of Measurement: Instrument accuracy, precision, sensitivity, Resolution range, etc. Errors in measurements and loading effects, Random and systematic errors, Error propagation, Voltage, Current, Resistance, and Power. Ohm's law. Series, parallel, and series-parallel combinations. AC Electricity and DC Electricity.

Unit II

Principles of measurement of DC voltage and DC current, AC voltage, AC current and resistance. Specifications of a multimeter and their significance, Electronic Voltmeter/Multimeter: their advantages and significance, Digital Instruments: Comparison of analog & digital instruments. Characteristics of a digital meter.

Unit III

Oscilloscope: Block diagram of basic CRO, CRT, electrostatic focusing and acceleration (qualitative only), brief discussion on screen phosphor, visual persistence, Time base operation, synchronization, Use for the measurement of voltage (dc and ac), frequency and time period.

Unit IV

Diode and rectifiers. Components in Series or in shunt. Response of inductors and capacitors with DC or AC sources, Generators and Transformers: DC Power sources. AC/DC generators. Inductance, capacitance, and impedance.

References:

1. A text book in Electrical Technology - B L Theraja - S Chand and Co. Performance and design of AC machines - M G Say ELBS Edn.
2. Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill. Logic circuit design, Shimon P. Vingron, 2012, Springer.
3. Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.
4. Electronic Devices and circuits, S. Salivahanan & N. S. Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill

BASICS OF INSTRUMENTATION SKILLS LAB

Marks (External): 35 **Credits: 2 (60 Hrs)**
Marks (Internal Assessment): 15 **Time: 3 Hrs**

1. Each student should perform at-least five (any) experiments.
2. The students are required to calculate the error involved in a particular experiment.
3. List of experiments may vary.

Ranjit

List of Experiments:

1. To observe the loading effect of a multimeter while measuring voltage across a low resistance and high resistance.
2. To observe the limitations of a multimeter for measuring high frequency voltage and currents.
3. To measure Q of a coil and its dependence on frequency, using a Q- meter.
4. To observe sine wave, square wave, triangular wave and ramp waveforms on the C.R.O. and to measure amplitude and frequency of the waveforms.
5. Measurement of time period, frequency, average period using universal counter/ frequency counter.
6. Measurement of rise, fall and delay times using an Oscilloscope.
7. Measurement of R, L and C using a LCR bridge/ universal bridge.
8. To study the variation in current and voltage in a series LCR circuit and hence determine the resonant frequency of the circuit
9. To study the variation in current and voltage in a parallel LCR circuit and hence determine the resonant frequency of the circuit
10. To study the effect of voltmeter resistance on voltage measurement.

References:

1. A text book in Electrical Technology - B L Theraja - S Chand and Co. Performance and design of AC machines - M G Say ELBS Edn.
2. Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill. Logic circuit design, Shimon P. Vingron, 2012, Springer.
3. Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.
4. Electronic Devices and circuits, S. Salivahanan & N. S.Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill.

Ranjit

SEMESTER-II

Minor Course

COURSE ID: 240/PHYP/ MI201

MODERN PHYSICS-II

Marks (External) : 35 **Credits : 2 (30 lectures)**
Marks (Internal Assessment) : 15 **Time : 2 Hrs**

Note: The paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of five short answer type questions. The rest of the eight questions are to be set uniformly with two questions from each unit selected. A student is required to attempt five questions, selecting one from each unit along with compulsory question no 1. The question paper shall contain 20% numerical problems in the relevant papers.

Course Objective: The course is based on imparting basic knowledge of atomic spectra, lases, and introductory quantum mechanics. It also includes some basic applications of Quantum mechanics also.	**Course Outcome:** After completion of this course, students will be able to understand the basic atomic spectra and its applications. Student will be able to grasp the basic ideas of quantum mechanics and its application.

Unit I

Atomic Structure: Rutherford's scattering experiment, Rutherford Model, Nuclear dimensions, Failures of classical picture of atom, Atomic spectra: emission and absorption, Bohr's model of atom: energy levels and spectra, correspondence principle, Franck-Herts experiment.

Unit II

Basics of Laser: Introduction to Stimulated and spontaneous emission introduction to LASER, Important properties of laser light, Principle of laser- Light amplification, population inversion and pumping; Working of laser- schematic diagram for functioning of laser, three level and four level Laser systems

Unit III

Introductory Quantum Mechanics: The wave equation, Postulates of quantum mechanics, Probability amplitude, Schrodinger equation in time-dependent form, Linearity and superposition, expectation values, operators, Schrodinger equation in time-independent form, Orthogonalization and normalization,

Unit IV

Application of Schrodinger wave equations: Particle in a box, Properties of wave functions, Particle in a finite potential well, Quantum tunneling process and its applications (Conceptual).

References:

1. Concept of Modern Physics by Arthur Beiser, McGraw Hill Education.
2. Modern Physics (2nd edition), by S.L. Kakani and Shubhra Kakani, Viva Books, New Delhi.
3. Semiconductor Devices - Physics and Technology by S.M .Sze ,Wiley (1985)
4. Laser and Non-linear optics by B. B. Laud. ,Wiley Eastern Limited (1985)
5. Semiconductor Electronics by A. K. Sharma, New Age International Publisher (1996)
6. Kenneth S. Krane, Introductory Nuclear Physics, Wiley, New York, 1988
7. Radiation detection and measurement: G.F. Knoll (Wiley, New York) (2000)
8. Verma and Srivastava : Crystallography for Solid State Physics
9. Rajnikant; Solid State Physics, Willey India, 2011.
10. J.C. Anderson, KD. Leaver, R.D. Rawlings and J.M. Alexander, Materials Science, 4thEdition (Chapman Hall, London, 1990).
11. V. Raghavan, Materials Science and Engineering, 3rd Ed. (Prentice-Hall India, New Delhi,1993).

Multidisciplinary Course

Course ID - 240/PHYP/MD201
PHYSICS IN EVERYDAY LIFE

Marks (Theory): 50 **Credits : 3 (45 lectures)**
Marks (Internal Assessment) : 25 **Time : 3 Hrs**

Note: The paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of five short answer type questions, each of two marks. The rest of the eight questions are to be set uniformly, with two questions from each unit selected. A student is required to attempt five questions, selecting one from each unit along with compulsory question no 1. The question paper shall contain 20% numerical problems in the relevant papers.

Course Objective: To introduce some concepts of reflection, refraction, interference, scattering,law of motion, hydroelectric power generationand universe for day to day applications.	**Course Outcome:**After completion of this course, students will be able to apply and visualize the laws of physics to everyday life.

Unit I

Fundamental and derived quantities. Units and dimensions, dimensional analysis, order of magnitude, significant figures, errors. Reflection, refraction, diffraction, interference, scattering (elementary ideas only) – examples from daily life – apparent depth, the blue colour of the sky, twinkling of stars.

Total internal reflection, mirage, sparkling of diamond, Rainbow, Concave and convex mirrors, lenses – focal length, power of a lens, refractive index, prism, dispersion, Human eye.

Unit II

Velocity, acceleration, momentum, Idea of inertia, force - laws of motion. Newton's law of gravitation, acceleration due to gravity, mass and weight, apparent weight, weightlessness.

Unit III

Voltage and current, ohms law. Electric energy, electric power, microwave oven, transformer, generator, hydroelectric power generation – wind power – solar power – nuclear power

Unit IV

Planets, – solar system, moon, lunar and solar eclipses, Different types of stars, Galaxies, Satellites, Artificial satellites, Global positioning system.

References:

1. Fundamentals of Physics with Applications by Arthur Beiser
2. Conceptual Physics by Paul G Hewitt
3. D.S. Mathur, Elements of properties of matter and acoustics, S. Chand & Company Ltd., New Delhi(2010)
4. N. Subramaniyam, Brijlal and M.N.Avadhanulu, A Textbook of Optics S. Chand & Co, New Delhi (2012).

Skill Enhancement Course

Course ID - 240/PHYP/SE201
BASICS OF PROGRAMMING

Max. Marks: 20 **Credit: 1 (15 Hrs)**
Internal Assessment: 05 **Time: 2 hrs**

*Note: The paper setter is to set **Nine** questions. Question no. 1 (compulsory based on the entire syllabus) will consist of short answer type questions. The rest of the **eight** questions will be set uniformly, with two questions from each unit selected. A student is required to attempt **five** questions, selecting one from each unit along with compulsory question no 1. The question paper shall contain 20 % numerical problems in the relevant papers.*

Course Objective: Grasping fundamental programming concepts and Python syntax involves understanding how to declare and use variables, recognize different data types (integers, floats, strings, and booleans), and perform basic operations such as arithmetic, string	**Course Outcome:** Upon successful completion of this course, students will be able to understand and utilize the Python interpreter, execute basic print statements, perform variable assignments, develop programs using Python's control flow mechanisms,

concatenation, and logical operations. This foundation enables beginners to write and understand basic Python code effectively.	including loops and conditional statements, implement and use functions, lists, strings, dictionaries, and other data structures in Python to solve computational problems.

Unit I

Basics of Python-I: The python interpreter, print statement, variables and assignment, numbers and strings, comments, debugging, input and output statements, data types and data conversion, list and its operations, arithmetic, comparison and logical operators.

Unit II

Basics of Python-II: Creating Python Programs: Identifiers and keywords; Literals, Expressions; Defining Functions; Control structures (conditional statements, loop control statements, break, continue and pass, exit function), default arguments. Mutable and immutable objects.

Unit III

Basics of Fortran-I: Data types: Integer and Floating-point arithmetic; Fortran variables; Real and Integer variables; Input and Output statements; Formats; Expressions; Built in functions; Executable and non-executable statements; Control statements; Go To statement; Arithmetic IF and logical IF statements;

Unit IV

Basics of Fortran-II: Flow charts; Truncation errors, Round off errors; Propagation of errors. Block IF statement; Do statement; Character DATA management; Arrays and subscripted variables, matrix addition and multiplication.

References:

1. Python Crash Course by Eric Matthes (No Starch Press, 2nd ed., 2019).
2. Python Programming: An Introduction to Computer Science by John Zelle (Franklin, Beedle & Associates Inc., 2003).
3. Computation Physics: Problem Solving with Python, 3rd Edition by Rubin H. Landau, Manuel J Páez, Cristian C. Bordeianu (Wiley VCH, 2015).
4. Python documentation available at the Python web page (https://docs.python.org/3/).
5. Computer programming in Fortran 77 by V. Rajaraman, Phi learning.

BASICS OF PROGRAMMING LAB

Marks (External) : 35 **Credits : 2(60Hrs)**
Marks (Internal Assessment) : 15 **Time : 3 Hrs**

1. Each student should perform at least five experiments.
2. The students are required to calculate the error involved in a particular experiment.

3. List of experiments may vary.

List of Experiments:

1. Program to calculate the factorial of a number.
2. Program to print sequences/series using loops.
3. Program to generate Fibonacci series up to n terms.
4. Program for performing basic arithmetic operations (addition, subtraction, multiplication, division) based on user input.
5. Program to convert Celsius to Fahrenheit.
6. Programs to add and multiply two matrices.
7. Program to count the number of lines, words, and characters in a file
8. Least square fitting for linear regression.
9. Solution of ordinary differential equations using built in python functions.
10. Solution of a Quadratic equation.

References:

1. Python Crash Course by Eric Matthes (No Starch Press, 2nd ed., 2019).
2. Python Programming: An Introduction to Computer Science by John Zelle (Franklin, Beedle & Associates Inc., 2003).
3. Computation Physics: Problem Solving with Python, 3rd Edition by Rubin H. Landau, Manuel J Páez, Cristian C. Bordeianu (Wiley VCH, 2015).
4. Python documentation available at the Python web page (https://docs.python.org/3/).
5. Computer programming in Fortran 77 by V. Rajaraman, Phi learning.

Rayt

SEMESTER-III

Minor Course

COURSE ID: 240/PHYP/ MI301

MODERN PHYSICS-III

Marks (External): 50 **Credits: 3 (45 lectures)**
Marks (Internal Assessment) : 25 **Time : 3 Hrs**

Note: The paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of five short answer type questions. The rest of the eight questions are to be set uniformly, with two questions from each unit selected. A student is required to attempt five questions, selecting one from each unit along with compulsory question no 1. The question paper shall contain 20% numerical problems in the relevant papers.

Course Objective: The course is based on imparting basic knowledge of solid state physics, nuclear properties and application of nuclear physics, and introductory particle physics.	**Course Outcome:** After completion of this course, students will be able to understand the elementary solid state, nuclear physics and particle physics.

Unit I

Solid State Physics: Crystalline and amorphous solids, types of bonding in a solid: ionic bond, covalent bond, Van der Waals bond, metallic bond, kinetic theory of electrons in a metal: collision time, drift velocity and Ohm's law, elementary idea of band formation, differentiation between metal, semiconductor and insulators using energy bands, pn-junction diode: depletion region, forward and reverse bias.

Unit II

Nuclear Physics and Applications: Nuclear composition, Basic structure of the nucleus: Size, atomic weight, and binding energy curve. Introductory liquid drop model and shell model (Conceptual Only)

Unit III

Radioactive decay: Half-life, Radioactive series, Alpha decay, Beta decay, Gamma decay, Type of nuclear reactions, Nuclear Fission, Nuclear reactors, Nuclear Fusion in stars

Unit IV

Particle Physics: Interactions and Particles, Leptons, Hadrons and their conservation rules, Quarks Model (elementary discussion), Standard model (elementary discussion)

References:

1. Concept of Modern Physics by Arthur Beiser, McGraw Hill Education.
2. Modern Physics (2nd edition), by S.L. Kakani and Shubhra Kakani, Viva Books, New Delhi.
3. Semiconductor Devices - Physics and Technology by S.M .Sze ,Wiley (1985)
4. Laser and Non-linear optics by B. B. Laud. ,Wiley Eastern Limited (1985)
5. Semiconductor Electronics by A. K. Sharma, New Age International Publisher (1996)
6. Kenneth S. Krane, Introductory Nuclear Physics, Wiley, New York, 1988
7. Radiation detection and measurement: G.F. Knoll (Wiley, New York) (2000)
8. Verma and Srivastava : Crystallography for Solid State Physics
9. Rajnikant; Solid State Physics, Willey India, 2011.
10. J.C. Anderson, KD. Leaver, R.D. Rawlings and J.M. Alexander, Materials Science, 4thEdition (Chapman Hall, London, 1990).
11. V. Raghavan, Materials Science and Engineering, 3rd Ed. (Prentice-Hall India, New Delhi,1993).

COURSE ID: 240/PHYP/ MI301

MODERN PHYSICS LAB -III

Marks (External): 20 **Credits: 1(30Hrs)**

Marks (Internal Assessment): 05 **Time: 3 Hrs**

1. Each student should perform at least five experiments.
2. The students are required to calculate the error involved in a particular experiment.
3. List of experiments may vary.

List of Experiments:

1. To determine the electrical conductivity and band gap of semiconductors.
2. To determine the forward and reverse characteristics of PN Junction Diode.
3. Measurement of Determine type (n/p), carrier concentration, and Hall coefficient using Hall Effect measurement setup.
4. Study of Alpha, Beta, Gamma Decay.
5. To understand Bravais lattices, unit cells, and amorphous vs crystalline solids.
6. To measure the half-life of a simulated radioactive isotope.
7. To classify particles and apply lepton, baryon number conservation.
8. To study of Liquid Drop Model (Demonstration).
9. To study of Shell Model (Demonstration).

Ranjit

10. To verify the Ohm's Law using I-V Characteristics.

References:

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. BSc Practical Physics, Geeta Sanon, R. Chand Publications, 2020.
3. BSc Practical Physics, Harnam Singh, S. Chand Publications, 2020.
4. A Text Book of Practical Physics, I. Prakash& Ramakrishna, 11th Ed., 1511, Kitab Mahal
5. Advanced level Physics Practical's, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
6. Engineering Practical Physics, S. Panigrahi and B. Mallick, 1515, Cengage Learning.

Multidisciplinary Course

Course ID – 240/PHYP/MD301
Our Universe

Marks (Theory): 50
Marks (Internal Assessment) : 25

Credits : 3 (45 lectures)
Time : 3 Hrs

Note: The paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of five short answer type questions, each of two marks. The rest of the eight questions are to be set uniformly, with two questions from each unit selected. A student is required to attempt five questions, selecting one from each unit along with compulsory question no 1. The question paper shall contain 20% numerical problems in the relevant papers.

Course Objective: To ignite curiosity and develop a conceptual understanding of the physical universe	**Course Outcome:** Students will gain a conceptual understanding of the universe's origin, structure, and evolution through scientific discoveries and cosmic phenomena.

Unit I

The Universe and Human Curiosity: The night sky through history: myths, philosophy, and early astronomy, Geocentric vs. Heliocentric views, Timeline of scientific discoveries: from Galileo to Hubble, What is the universe? Size, scale, and structure, Light and telescopes: How we see the cosmos, The role of curiosity and imagination in scientific discovery.

Unit II

The Big Bang and Cosmic Evolution: Origin of the universe: The Big Bang theory (simplified), Cosmic inflation and expansion, Formation of matter, galaxies, stars, and planets, Large Scale structure of Universe, Dark matter and dark energy (conceptually), Life cycle of stars and formation of elements (conceptual only)

Unit III

Our Place in the Universe: The Solar System: planets, moons, and other bodies, Earth's uniqueness and habitability, Introduction to space exploration: past, present, and future, Possibility of life beyond Earth, Chandrayaan and Mars Mission of India.

Unit- IV

Time, Space, and the Quest for Meaning: What is space and time? Introduction to relativity (conceptual), Black holes and gravitational waves, The nature of reality: quantum strangeness (basic ideas), The future of the universe: expansion, heat death, or multiverse?, Philosophical and cultural reflections on our cosmic journey.

References:

1. A Brief History of Timen by Stephen Hawking, Transworld publishers
2. The First Three Minutes by Steven Weinberg, Basic books
3. The Universe: A Biography by John Gribbin, Penguin Books Ltd
4. Night Watch: A Practical Guide to Viewing the Universe by Terence Dickinson, Firefly Books Ltd

SEMESTER-IV

Minor Course

COURSE ID: 240/PHYP/ MI401

RENEWABLE ENERGY

Marks (External): 50 **Credits: 3 (60 lectures)**
Marks (Internal Assessment): 25 **Time: 3 Hrs**

Note: The paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of five short answer type questions. The rest of the eight questions are to be set uniformly, with two questions from each unit selected. A student is required to attempt five questions, selecting one from each unit along with compulsory question no 1. The question paper shall contain 20% numerical problems in the relevant papers.

Course Objective: Course objectives are to introduce the renewable energy concepts, solar energy, wind energy and Geothermal energy	**Course Outcome:** Understand basic idea about renewable energy and its measurement. Learn importance of energy in our daily life and hence they feel the necessity of planned and managed energy consumption. Along with also learn different aspects and challenges about conventional energy sources.

Unit I

Fossil fuels and Alternate Sources of energy: Fossil fuels and nuclear energy, their limitation, need of renewable energy, non-conventional energy sources. An overview of developments in Offshore Wind Energy, Tidal Energy, Wave energy systems, Ocean Thermal Energy Conversion, solar energy, biomass, biochemical conversion, biogas generation, geothermal energy tidal energy, Hydroelectricity.

Unit II

Solar energy: Solar energy, its importance, storage of solar energy, solar pond, non-convective solar pond, applications of solar pond and solar energy, solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, solar cell, absorption air conditioning. Need and characteristics of photovoltaic (PV) systems, PV models and equivalent circuits, and sun tracking systems.

Unit III

Wind Energy harvesting: Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces, and grid interconnection topologies. Ocean Energy: Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices. Tide characteristics and Statistics. Tide Energy Technologies, Ocean Thermal Energy, Osmotic Power, Ocean Bio-mass

Unit IV

Geothermal Energy: Geothermal Resources, Geothermal Technologies. Hydro Energy: Hydropower resources, hydropower technologies, environmental impact of hydro power sources. Piezoelectric Energy harvesting: Introduction, Physics and characteristics of piezoelectric effect, materials and mathematical description of piezoelectricity, Piezoelectric parameters and modelling

Ranjit

16

piezoelectric generators, Piezoelectric energy harvesting applications, Human power. Electromagnetic Energy Harvesting: Linear generators, physics mathematical models, recent applications. Carbon captured technologies, cell, batteries, and power consumption. Environmental issues and Renewable sources of energy, sustainability

References:

1. Non-conventional energy sources - G.D Rai - Khanna Publishers, New Delhi
2. Solar energy - M P Agarwal - S Chand and Co. Ltd.
3. Solar energy - Suhas P Sukhative Tata McGraw - Hill Publishing Company Ltd.
4. Godfrey Boyle, "Renewable Energy, Power for a sustainable future", 2004, Oxford University Press, in association with The Open University.
5. P. Jayakumar, Solar Energy: Resource Assessment Handbook, 2009
6. J. Balfour, M. Shaw and S. Jarosek, Photovoltaics, Lawrence J Goodrich (USA).
7. http://en.wikipedia.org/wiki/Renewable.

COURSE ID: 240/PHYP/ MI401

RENEWABLE ENERGY LAB

Marks (External): 20 **Credits: 1(30Hrs)**
Marks (Internal Assessment): 05 **Time : 3 Hrs**

1. Each student should perform at least five experiments.
2. The students are required to calculate the error involved in a particular experiment.
3. List of experiments may vary.

List of Experiments:

1. To study the I-V Characteristics of a Solar Cell.
2. Study of Flat Plate Collector
3. Model Demonstration of Hydroelectric Power Plant
4. Study of Battery Storage Systems (Lead Acid / Li-ion).
5. To simulate the Geothermal Energy Systems
6. Design and Testing of a Solar Cooker
7. Demonstration of Biogas Generation (Lab-scale Model)

8. Simulation/Model Study of Ocean Energy Systems (Wave/Tidal/OTEC).

References:

1. Non-conventional energy sources - G.D Rai - Khanna Publishers, New Delhi
2. Solar energy - M P Agarwal - S Chand and Co. Ltd.
3. Solar energy - Suhas P Sukhative Tata McGraw - Hill Publishing Company Ltd.
4. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.

   P. Jayakumar, Solar Energy: Resource Assessment Handbook, 2009

Ranjit

SEMESTER-IV

Minor Course

COURSE ID: 240/PHYP/ MI401

RENEWABLE ENERGY

Marks (External): 50 **Credits: 3 (60 lectures)**
Marks (Internal Assessment): 25 **Time: 3 Hrs**

Note: The paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of five short answer type questions. The rest of the eight questions are to be set uniformly, with two questions from each unit selected. A student is required to attempt five questions, selecting one from each unit along with compulsory question no 1. The question paper shall contain 20% numerical problems in the relevant papers.

Course Objective: Course objectives are to introduce the renewable energy concepts, solar energy, wind energy and Geothermal energy	**Course Outcome:** Understand basic idea about renewable energy and its measurement. Learn importance of energy in our daily life and hence they feel the necessity of planned and managed energy consumption. Along with also learn different aspects and challenges about conventional energy sources.

Unit I

Fossil fuels and Alternate Sources of energy: Fossil fuels and nuclear energy, their limitation, need of renewable energy, non-conventional energy sources. An overview of developments in Offshore Wind Energy, Tidal Energy, Wave energy systems, Ocean Thermal Energy Conversion, solar energy, biomass, biochemical conversion, biogas generation, geothermal energy tidal energy, Hydroelectricity.

Unit II

Solar energy: Solar energy, its importance, storage of solar energy, solar pond, non-convective solar pond, applications of solar pond and solar energy, solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, solar cell, absorption air conditioning. Need and characteristics of photovoltaic (PV) systems, PV models and equivalent circuits, and sun tracking systems.

Unit III

Wind Energy harvesting: Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces, and grid interconnection topologies. Ocean Energy: Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices. Tide characteristics and Statistics, Tide Energy Technologies, Ocean Thermal Energy, Osmotic Power, Ocean Bio-mass

Unit IV

Geothermal Energy: Geothermal Resources, Geothermal Technologies. Hydro Energy: Hydropower resources, hydropower technologies, environmental impact of hydro power sources. Piezoelectric Energy harvesting: Introduction, Physics and characteristics of piezoelectric effect, materials and mathematical description of piezoelectricity, Piezoelectric parameters and modelling

piezoelectric generators, Piezoelectric energy harvesting applications, Human power. Electromagnetic Energy Harvesting: Linear generators, physics mathematical models, recent applications. Carbon captured technologies, cell, batteries, and power consumption. Environmental issues and Renewable sources of energy, sustainability

References:

1. Non-conventional energy sources - G.D Rai - Khanna Publishers, New Delhi
2. Solar energy - M P Agarwal - S Chand and Co. Ltd.
3. Solar energy - Suhas P Sukhative Tata McGraw - Hill Publishing Company Ltd.
4. Godfrey Boyle, "Renewable Energy, Power for a sustainable future", 2004, Oxford University Press, in association with The Open University.
5. P. Jayakumar, Solar Energy: Resource Assessment Handbook, 2009
6. J. Balfour, M. Shaw and S. Jarosek, Photovoltaics, Lawrence J Goodrich (USA).
7. http://en.wikipedia.org/wiki/Renewable.

COURSE ID: 240/PHYP/ MI401

RENEWABLE ENERGY LAB

Marks (External): 20 **Credits: 1(30Hrs)**
Marks (Internal Assessment): 05 **Time : 3 Hrs**

1. Each student should perform at least five experiments.
2. The students are required to calculate the error involved in a particular experiment.
3. List of experiments may vary.

List of Experiments:

1. To study the I-V Characteristics of a Solar Cell.
2. Study of Flat Plate Collector
3. Model Demonstration of Hydroelectric Power Plant
4. Study of Battery Storage Systems (Lead Acid / Li-ion).
5. To simulate the Geothermal Energy Systems
6. Design and Testing of a Solar Cooker
7. Demonstration of Biogas Generation (Lab-scale Model)

8. Simulation/Model Study of Ocean Energy Systems (Wave/Tidal/OTEC).

References:

1. Non-conventional energy sources - G.D Rai - Khanna Publishers, New Delhi
2. Solar energy - M P Agarwal - S Chand and Co. Ltd.
3. Solar energy - Suhas P Sukhative Tata McGraw - Hill Publishing Company Ltd.
4. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.

P. Jayakumar, Solar Energy: Resource Assessment Handbook, 2009