NEP and Learning Outcome-based Curriculum Framework

For B.Sc. Physical Science (Physics)

UG-A1

Academic Session (w.e.f. 2025-2026)

DEPARTMENT OF PHYSICS

GURUGRAM UNIVERSITY, GURUGRAM

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

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1. Core Courses

Scheme UG A1: B.Sc. in Physical Science (Physics)

Course Code	Course Title	Course ID	L (Hrs)	T (Hrs)	P (Hrs)	L Credits	T Credits	P Credits	Total Credits	MARKS TI	MARKS TE	MARKS PI	MARKS PE	MARKS Total
Core Course(s)														
CC-A1	Mechanics	240/PHYP/CC101	3	0	2	3	0	1	4	25	50	5	20	100

Course Code	Course Title	Course ID	L (Hrs)	T (Hrs)	P (Hrs)	L Credits	T Credits	P Credits	Total Credits	MARKS TI	MARKS TE	MARKS PI	MARKS PE	MARKS Total
Core Course(s)														
CC-A2	Electricity and Magnetism	240/PHYP/CC201	3	0	2	3	0	1	4	25	50	5	20	100

Course Code	Course Title	Course ID	L (Hrs)	T (Hrs)	P (Hrs)	L Credits	T Credits	P Credits	Total Credits	MARKS TI	MARKS TE	MARKS PI	MARKS PE	MARKS Total
Core Course(s)														
CC-A3	Wave and Optics	240/PHYP/CC301	3	0	2	3	0	1	4	25	50	5	20	100

Course Code	Course Title	Course ID	L (Hrs)	T (Hrs)	P (Hrs)	L Credits	T Credits	P Credits	Total Credits	MARKS TI	MARKS TE	MARKS PI	MARKS PE	MARKS Total
Core Course(s)														
CC-A4	Quantum Mechanics	240/PHYP/CC401	3	0	2	3	0	1	4	25	50	5	20	100

Course Code	Course Title	Course ID	L (Hrs)	T (Hrs)	P (Hrs)	L Credits	T Credits	P Credits	Total Credits	MARKS TI	MARKS TE	MARKS PI	MARKS PE	MARKS Total
Core Course(s)														
CC-A5	Electronics	240/PHYP/CC501	3	0	2	3	0	1	4	25	50	5	20	100

Course Code	Course Title	Course ID	L (Hrs)	T (Hrs)	P (Hrs)	L Credits	T Credits	P Credits	Total Credits	MARKS TI	MARKS TE	MARKS PI	MARKS PE	MARKS Total
Core Course(s)														
CC-A6	Nuclear & Particle Physics	240/PHYP/CC601	3	0	2	3	0	1	4	25	50	5	20	100

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*Students exiting the program after second semester and securing 52 credits including 4 credits of summer internship will be awarded UG certificate in the relevant Discipline/Subject

*Students exiting the program after forth semester and securing 92 credits including 4 credits of summer internship will be awarded UG Diploma in the relevant Discipline/Subject

*Student will be awarded 3-year UG degree in the relevant Discipline/Subject upon securing 130 Credits

** Syllabus for 5th and 6th semesters will be provided in due course of time.

Detailed Syllabus for 1st Year

Semester-I

Course ID - 240/PHYP/CC101
Subject: MECHANICS

Max. Marks: 50 **Credit 3 (45Hrs)**
Internal Assessment: 25 **Time: 2 hrs**

Note: The paper setter is to set Nine questions. 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 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: This course's objective is to teach the students the fundamentals of Newtonian Mechanics, rigid body dynamics, the 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. He/she will be clear about origin and applications of the special theory of relativity.

Unit – I

Newton's Law: Newton's laws of motion, Mechanics of single and systems of particles, conservation of laws of linear momentum, angular momentum and mechanical energy, Central forces, fictitious forces. Rotational Dynamics: Rotation of a rigid body, Moment of inertia, torque, angular momentum, kinetic energy of rotation. Theorems of perpendicular and parallel axes with proof. Moment of inertia of simple systems, Kinetic energy of rotation. Motion involving both translation and rotation.

Unit - II

Generalized Notations: Degrees of freedom and Generalised coordinates, Generalised Displacement, Velocity, Acceleration, Momentum, Force and Potential, Hamilton's

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variational principle, Lagrange's equation of motion from Hamilton's principle, Linear Harmonic oscillator, Simple pendulum, Atwood's machine.

Unit – III

Elasticity: Elasticity, Hooke's law, Elastic constants and their relations, Poisson's ratio, torsion of a cylinder and twisting couple. Bending of beam (bending moment and its magnitude), cantilevers, and Dispersion of a centrally loaded beam supported at its ends.

Unit – IV

Special Theory of Relativity: Inertial and Non-Inertial Frames and their examples, Invariance of Newton's Laws of motion under Galilean transformations, Postulates of Special Theory of Relativity, Length Contraction, Time Dilation, 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 Education.

MECHANICS 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. 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.
6. M.I. of an irregular body using a torsion pendulum.
7. To determine g and velocity for a freely falling body using Digital Timing Technique
8. To determine the Young's Modulus of a Wire by Optical Lever Method.
9. Young's modulus by bending of beam.
10. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
11. 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

Semester-II

Course ID - 240/PHYP/CC201

ELECTRICITY AND MAGNETISM

Max. Marks: 50 **Credit 3(45Hrs)**

Internal Assessment: 25 **Time: 2 hrs**

*Note: The paper setter is to set **Nine** questions. 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 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: The course on electricity and magnetism deals with Coulomb's law, the electric field, the potential formulation of electrostatics, capacitors, magnetism, magnetic materials, and the application of these concepts. The physical context and derivation of the Maxwell equations are covered.	**Course Outcome:** The student will be able to understand Gauss's Divergence theorem, Stokes's theorem in dielectrics, and materials' electrical and magnetic properties. He/She will be able to apply and solve Maxwell's equations.

UNIT-I

Electrostatics: Coulomb's Law, Electric field, Electric field lines, Electric flux, Gauss's Law, and its applications, Concept of electrical potential, Energy stored in a charge distribution, Conductors and Dielectric materials inside electric field, Capacitors, Polarization of dielectric materials, Electrical Susceptibility& Permittivity, and Dielectric constants.

UNIT-II

Magnetostatics: Lorentz force law, Magnetic forces, Biot-Savart's law, Ampère's circuital law and its applications for simple current configurations, Magnetization vector (M), Magnetic Intensity (H), Magnetic Susceptibility and permeability, Relation between B, H, M, Para-, Dia- and Ferro-magnetism, B-H curve and hysteresis

UNIT-III

Maxwell's equations: Faraday's experiments on induction, Faraday's Law, Self and Mutual inductance, and Energy in magnetic fields, Inductor, Maxwell's equation and its derivation, Displacement Current, Poynting vector, and Poynting theorem.

UNIT-IV

A.C. Circuit: Introduction to Alternating Current, Kirchhoff's law for AC circuit, Complex Reactance and impedance, Series LCR Circuit: (i) Resonance, (ii) Power dissipation, (iii) Quality Factor and (iv) Bandwidth, Parallel LCR circuit.

Network Theorem: Ideal constant-voltage and constant-current sources, Review of Kirchhoff's Current Law & Kirchhoff's Voltage Law, Mesh & Node Analysis, Thevenin Theorem, Norton Theorem, Superposition Theorem, Reciprocity Theorem, Maximum Power Transfer theorem, Applications to D.C. circuit.

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.
4. Electricity and Magnetism by Reitz and Milford (Prentice Hall of India)
5. Electricity and Magnetism by A.S. Mahajan and A.A. Rangwala (Tata McGraw-Hill).

ELECTRICITY AND MAGNETISM 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 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.

Ranjit

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.

Semester-III

Course ID - 240/PHYP/CC301

WAVES AND OPTICS

Max. Marks: 50 **Credit 3(45Hrs)**

Internal Assessment: 25 **Time: 2 hrs**

*Note: The paper setter is to set **Nine** questions. 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 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: The course on waves and optics deals with basic concepts of optics like interference, diffraction and polarisation. It also discusses many of the applications of these concepts. An introductory-level discussion about waves is also included.	**Course Outcome:** The student will be able to understand phenomena based on waves, light and related topics. He/she will get skills to identify and apply formulae of optics and wave physics, understand events like reflection, refraction, interference, diffraction, etc.

UNIT-I

Waves: Oscillatory motion, Simple harmonic motion, Wave motion, Wave Equation and its solution, Transverse and longitudinal waves and their examples, Waves in One Dimension; Superposition of Waves; Stationary Waves; Waves on a Stretched String with Fixed Ends; Phase Velocity and Group Velocity; Light as a transverse wave.

UNIT-II

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

UNIT-III

Diffraction: Fresnel's diffraction: Huygens-Fresnel's theory, Fresnel's assumptions, rectilinear propagation of light, diffraction at a straight edge, rectangular slit and diffraction at a circular aperture. Fraunhoffer diffraction: Single slit diffraction, double slit diffraction, plane transmission grating spectrum, dispersive power of grating, limit of resolution, Rayleigh's criterion, resolving power of telescope and a grating.

UNIT-IV

Polarisation: Polarisation by reflection, refraction and scattering, Malus Law, Phenomenon of double refraction, Huygens's wave theory of double refraction (Normal and oblique incidence), Analysis of polarised Light. Nicol prism, Quarter wave plate and half wave plate, production and detection of (i) Plane polarised light (ii) Circularly polarised light and (iii) Elliptically polarised light. Optical activity, Fresnel's theory of optical rotation, Specific rotation, Polarimeters (half shade and Biquartz).

Reference Books:

1. The Physics of Waves and Oscillations by N.K. Bajaj (Tata McGraw-Hill, 1988).
2. The Physics of Vibrations and Waves by H. J. Pain (Wiley, 2006).
3. Optics by Ajay Ghatak, Tata McGraw-Hill, 1977.
4. Introduction of Optics by Frank L. Pedrotti and Leno S. Pedrotti, Prentice Hall 1987.

WAVES AND OPTICS 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. Refractive index and dispersive power of a prism material by a spectrometer.
2. To draw a graph between wavelength and minimum deviation for various lines from a
3. Mercury discharge source.
4. Determination of the wavelength of Na light and the number of lines per centimetre using a diffraction grating.
5. Determination of wave length of sodium light using Newton's Rings
6. Resolving power of a telescope.
7. Measurement of (a) Specific rotation (b) concentration of sugar solution using polarimeter.
8. Ordinary and extraordinary refractive indices for calcite or quartz.
9. Resolving power of a prism.
10. Resolving power of a grating.
11. Wavelength of Sodium light by Fresnel's biprism
12. To determine the dispersive power and Cauchy constants of the material of a prism using Mercury discharge source.
13. To study double slit interference by He-Ne laser.

Ranjit

14. Diameter of a thin wire by diffraction method (using He-Ne Laser).

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.

Semester-IV

Course ID - 240/PHYP/CC401

QUANTUM MECHANICS

Max. Marks: 50 **Credit 3(45Hrs)**

Internal Assessment: 25 **Time: 3 hrs**

*Note: The paper setter is to set **Nine** questions. 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 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: The course on waves and optics deals with basic concepts of optics like interference, diffraction and polarisation. It also discusses many of the applications of these concepts. An introductory-level discussion about waves is also included.	**Course Outcome:** The student will be able to understand the concepts of black body radiation, Planck's quantum theory, Photoelectric effect, Compton effect, wave function and its characteristics. He/she will get skills to apply Schrödinger wave equation for various one-dimensional problems and hydrogen-like atoms.

Unit-I

The origin of quantum theory: Failures of classical physics, black body radiation, Planck's quantum theory, Photoelectric effect, Compton effect, Atomic-spectra and Bohr model of atom, The Bohr correspondence principle, The Franck and Hertz experiment, Stern-Gerlach experiment, De Broglie's hypothesis: Wave properties of matter, Davisson-Germer experiment; Wave-particle duality, Double slit experiment, the Heisenberg uncertainty principle: stability of atoms, energy width and natural lifetime of excited states.

Unit-II

Wave function and the Schrödinger wave equation: Time dependent and time independent Schrodinger equation, dynamical evolution of a quantum state; properties of Wave Function, Interpretation of Wave Function, Condition for physical

acceptability of Wave Functions. Eigenvalues and Eigen functions, Mathematical consideration of Schrodinger equation: Normalization, Orthogonality, Observables, Stationary states, Position, Linear momentum & Energy operators; commutator of position and linear momentum operators; Postulates of quantum mechanics, Probability current density, Expectation values of position and linear momentum, Ehrenfest's theorem.

Unit-III

One-Dimensional problems: Eigen Functions and Eigenvalues for a Particle in a One-Dimensional Box, Potential step: reflectance and transmittance, Penetration of a barrier: reflectance, transmittance and tunnel effect, Application of barrier penetration, Tunnel diode and alpha decay (Qualitative description), One Dimensional Simple Harmonic Oscillator: Energy Levels and Wave Functions. Zero Point Energy.

Unit-IV

Quantum theory of hydrogen-like atoms: time independent Schrödinger equation in spherical polar coordinates; separation of variables for second order partial differential equation; angular momentum operator & quantum numbers; Radial wavefunctions from Frobenius method; shapes of the probability densities for ground & first excited states; Orbital angular momentum quantum numbers l and m; s, p, d, shells, Pauli exclusion principle.

References:

1. A Text book of Quantum Mechanics, P. M. Mathews and K. Venkatesan, 2nd Ed., 2010, McGraw Hill
2. Quantum Mechanics, Robert Eisberg and Robert Resnick, 2nd Edn., 2002, Wiley.
3. Quantum Mechanics, Leonard I. Schiff, 3rd Edn. 2010, Tata McGraw Hill.
4. Quantum Mechanics for Scientists & Engineers, D.A.B. Miller, 2008, Cambridge University Press
5. Quantum Mechanics, B. H. Bransden and C. J. Joachain, 2000, Pearson Education.
6. Quantum Mechanics, Eugen Merzbacher, 2004, John Wiley and Sons, Inc.
7. Introduction to Quantum Mechanics, D.J. Griffith, 2nd Ed. 2005, Pearson Education.

QUANTUM MECHANICS 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:

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1. To determine value of Boltzmann constant using V-I characteristic of PN diode.
2. To determine work function of material of filament of directly heated vacuum diode.
3. To determine the ionization potential of mercury.
4. To determine value of Planck's constant using LEDs of at least 4 different colours.
5. To determine the wavelength of H-alpha emission line of Hydrogen atom.
6. To determine the absorption lines in the rotational spectrum of Iodine vapour.
7. To study the diffraction patterns of single and double slits using laser and measure
8. its intensity variation using Photosensor & compare with incoherent source – Na.
9. Photo-electric effect: photo current versus intensity and wavelength of light; maximum

10. energy of photo-electrons versus frequency of light.
11. To determine the value of e/m by (a) Magnetic focusing or (b) Bar magnet.
12. To setup the Millikan oil drop apparatus and determine the charge of an electron.
13. Determination of Planck's constant using photocell.

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
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