SYLLABI AND SCHEME OF EXAMINATIONS FOR DISCIPLINE SPECIFIC COURSES OF MULTIDISCIPLINARY PROGRAMS WITH HONS. IN ONE MAJOR DISCIPLINE

B.Sc. (Physical Sciences) Physics

Based on Curriculum and Credit Framework and formative assessment guidelines for UG Programs under NEP 2020)

MAHARSHI DAYANAND UNIVERSITY ROHTAK (HARYANA)

To be applicable on the students w.e.f. session 2024-25 (3rd Semester onwards) and on the students w.e.f. session 2025-26 (1st semester onwards)

Credit Structure for Undergraduate Programme B.Sc. (Physical Sciences) Physics

Semester	Discipline-Specific Courses (DSC) / Major courses	Minor(MIC)/ Vocational (VOC)/ Skill Enhancement Courses (SEC)/ Internship	Multidisciplinary courses(MDC)	Ability Enhancement courses(AEC)	Research project/ Dissertation	Value-Added Courses (VAC)	Total Credits
I	DSC - A1 @ 4 credits DSC - B1 @ 4 credits DSC - C1 @ 4 credits	MIC1 @ 4 credits SEC1@ 3 credits**	MDC1 @ 3 credits	AEC1 @ 2 credits	--------------------	--------------------	24
II	DSC - A2 @ 4 credits DSC – B2 @ 4 credits DSC – C2 @ 4 credits	SEC2 @ 3 credits**	MDC2 @ 3 credits	AEC2 @ 2 credits	--------------------	VAC1 @ 2 credits VAC2 @ 2 credits	24
Students exiting the programme after second semester and securing 52 credits including 4 credits of summer internship will be awarded UG Certificate in the relevant Discipline/ Subject							
III	DSC – A3 @ 4 credits DSC – B3 @ 4 credits DSC – C3 @ 4 credits	MIC2 @ 4 credits SEC3@ 3 credits**	MDC3 @ 3 credits	AEC3 @ 2 credits		--------------------	24
IV	DSC – A4 @ 4 credits DSC – B4 @ 4 credits DSC – C4 @ 4 credits	MIC3(VOC)@ 4 credits	--------------------	AEC4 @ 2 credits	--------------------	VAC3 @ 2 credits	20
Students exiting the programme after fourth semester and securing 96 credits including 4 credits of summer internship will be awarded UG Diploma in the relevant Discipline/Subject							
V	DSC – A5 @ 4 credits DSC – B5 @ 4 credits DSC – C5 @ 4 credits	MIC4(VOC)@ 4 credits Internship @ 4 credits#	--------------------	--------------------	--------------------	--------------------	20
VI	DSC – A6 @ 4 credits DSC – B6 @ 4 credits DSC – C6 @ 4 credits	MIC5 @ 4 credits MIC6(VOC)@ 4 credits	--------------------	--------------------	--------------------	--------------------	20
Students will be awarded 3-year UG Degree in the relevant Discipline/Subject upon securing 132 credits.							
VII*	DSC – H1 @ 4 credits DSC – H2 @ 4 credits DSC – H3 @ 4 credits DSC – H4 @ 4 credits DSC – H5 @ 4 credits	SEC4 @ 4 credits OR MIC7 (VOC) @ 4 credits OR Internship @ 4 credits	--------------------	--------------------	--------------------	--------------------	24
VIII* (4yr UG Hon.)	DSC – H6 @ 4 credits DSC – H7 @ 4 credits DSC – H8 @ 4 credits DSC – H9 @ 4 credits DSC – H10 @ 4 credits	SEC5 @ 4 credits OR MIC8 (VOC) @ 4 credits OR Internship @ 4 credits	--------------------	--------------------	--------------------	--------------------	24
VIII* (4yr UG Hon. with Research)	DSC – H6@ 4 credits DSC – H7@ 4 credits -------------------- --------------------	SEC5 @ 4 credits OR MIC8 (VOC) @ 4 credits OR Internship @ 4 credits	--------------------	--------------------	Research project/ Dissertation@ 12 credits	--------------------	24
						TOTAL CREDITS	180

* Student should select one major discipline (Out of A, B, or C studied during first three years of UG Programmes) in which he/she wishes to pursue Honors. This framework is subject to modification as per UGC guidelines at the University level. The universities may decide to offer the Honours degree Programmes subject to the fulfilment of credit point table

** SEC for imparting practical skills related to Major (A, B and C)/minor.

#Four credits of internship earned by a student during summer internship after 2nd semester or 4th semester will be counted in 5th semester of a student who pursue 3 year UG Programmes without taking exit option.

Discipline Specific Courses/ Major Course	Nomenclature of Course	Course Code	Credits Distribution L	T	P	Total Credits	Workload L	T	P	Total Workload	Marks: Theory Internal	Theory External	Practical	Total Marks
Semester I														
DSC @ 4 credits	Mechanics and Theory of Relativity	24PHYM401DS01	2	0	2		2	0	4	06	15	35	50	100
Semester II														
DSC @ 4 credits	Electricity and Magnetism	24PHYM402DS01	2	0	2		2	0	4	06	15	35	50	100
Semester III														
DSC @ 4 credits	Optics	25PHY403DS01	2	0	2		2	0	4	06	15	35	50	100
Semester IV														
DSC @ 4 credits	Thermodynamics and Statistical Mechanics	25PHYM404DS01	2	0	2		2	0	4	06	15	35	50	100
Semester V														
DSC @ 4 credits	Quantum Mechanics and Nuclear Physics	26PHYM405DS01	2	0	2		2	0	4	06	15	35	50	100
Semester VI														
DSC @ 4 credits	Solid State Physics and Electronic Devices	26PHYM406DS01	2	0	2		2	0	4	06	15	35	50	100
Semester VII														
DSC – H1 @ 4 credits	Mathematical Physics	24PHY201DS01	3	1	0	4	4	0	0	4	70	30	-	100
DSC – H2 @ 4 credits	Classical Mechanics	24PHY201DS02	3	1	0	4	4	0	0	4	70	30	-	100
DSC – H3 @ 4 credits	Quantum Mechanics –I	24PHY201DS03	3	1	0	4	4	0	0	4	70	30	-	100
DSC – H4 @ 4 credits	Physics of Electronic Devices	24PHY201DS04	3	1	0	4	4	0	0	4	70	30	-	100
DSC – H5 @ 4 credits	Practical: General Physics -I	24PHY201DS05	0	0	4	4	0	0	4	8	00	00	100	100

Semester VIII **OPTION-I** **(4 Year UG Hons.)**														
DSC – H6 @ 4 credits	Statistical Mechanics	24PHY202DS01	03	01	0	04	03	01	0	04	30	70	-	100
DSC – H7 @ 4 credits	Quantum Mechanics -II	24PHY202DS02	03	01	0	04	03	01	0	04	30	70	-	100
DSC – H8 @ 4 credits	Atomic & Molecular Physics	24PHY202DS03	03	01	0	04	03	01	0	04	30	70	-	100
DSC – H9 @ 4 credits	Solid State Physics	24PHY202DS04	03	01	0	04	03	01	0	04	30	70	-	100
DSC – H10 @ 4 credits	Practical: General Physics -II	24PHY202DS05	0	0	04	04	0	0	08	08	-	-	100	100

Semester VIII **OPTION-II** **(4 Year UG Hons. With Research)**														
DSC – H7 @ 4 credits	Quantum Mechanics -II	24PHY202DS02	03	01	0	04	03	01	0	04	30	70	-	100
DSC – H9@ 4 credits	Solid State Physics	24PHY202DS04	03	01	0	04	03	01	0	04	30	70	-	100
Dissertation Course	Research Project /Dissertation	27PHYS408PD01	0	0	0	12	0	0	24	24	-	-	300	300

L: Lecture; T: Tutorial; P: Practical

Note:

The Syllabi and Scheme of Examinations (SOE) for Discipline Specific Courses/Major Courses for UG Semester 7 and Semester 8 will be same as applicable for Syllabi and S.O.E. for Post Graduate semester 1 and semester 2 respectively.

Syllabi for B.Sc. (Physical Sciences) Physics

Semester-I

Name of Program	B.Sc. (Physical Sciences)	**Program Code**	UMPS4
Name of the Course	Mechanics and Theory of Relativity	**Course Code**	24PHYM401DS01
Hours per Week	06(2+4)	**Credits**	04
Maximum Marks	Theory: 15+35 Practical: 50 Total: 100	**Time of Examinations**	Theory: 03 Hours Practicals: 03 Hours

Note:

Examiner will set nine questions of seven marks each and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes (CLO):

CLO 1: Understand the dynamics of system of particles, conservation of energy and momentum application of both translational and rotational dynamics motions simultaneously in analysing rolling with slipping

CLO 2: Differentiate between elastic and plastic body. Elastic constants, determination and their physical significance. Torque and its significance.

CLO 3: Familiar about the special theory of relativity and its applications. Michelson's Morley experiments and its finding.

Unit 1:

Basics of Mechanics: Mechanics of single and system of particles, Conservation law of linear momentum, Angular momentum and mechanical energy for a particle and a system of particles, Centre of Mass and equation of motion, Constrained Motion. Work and Kinetic Energy Theorem. Conservative and neoconservative forces. Potential Energy. Energy diagram. Stable and unstable equilibrium. Elastic potential energy. Force as gradient of potential energy. Work & Potential energy. Work done by non-conservative forces. Law of conservation of Energy.

Unit 2:

Generalized Notations: Degrees of freedom and Generalized coordinates, Transformation equations, Generalized Displacement, Velocity, Acceleration, Momentum, Force and Potential, Components of Velocity and Acceleration in Cylindrical and Spherical Coordinate Systems. Hamilton's variational principle, Lagrange's equation of motion from Hamilton's principle, Linear Harmonic oscillator, Simple pendulum, Atwood's machine

Unit 3:

Rotational Dynamics: Rotation of Rigid body, moment of inertia, torque, angular momentum, kinetic energy of rotation. Theorems of perpendicular and parallel axes with proof. Moment of inertia of solid sphere, hollow sphere, spherical shell, solid cylinder, hollow cylinder and solid bar of rectangular cross-section. Acceleration of a body rolling down on an inclined plane. Kinetic energy of rotation. Motion involving both translation and rotation.

Unit 4:

Special Theory of Relativity: Non-inertial frames and fictitious forces. Uniformly rotating frame. Laws of Physics in rotating coordinate systems. Centrifugal force. Coriolis force and its applications. Michelson-Morley Experiment and its outcome. Postulates of Special Theory of Relativity. Lorentz Transformations. Simultaneity and order of events. Lorentz contraction. Time dilation. Relativistic transformation of velocity, frequency and wave number. Relativistic addition of velocities. Variation of mass with velocity. Massless Particles. Mass-energy Equivalence. Relativistic Doppler effect. Relativistic Kinematics. Transformation of Energy and Momentum. Energy-Momentum Four Vector.

Practicals:

1. Measurements of length (or diameter) using Vernier calliper, 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 study the Motion of Spring and calculate (a) Spring constant, (b) g and (c) Modulus of rigidity.
5. To determine the Moment of Inertia of a Flywheel.
6. Moment of Inertia of irregular body using a Torsion Pendulum.
7. Young's Modulus by Bending of Beam.
8. To determine g and velocity for a freely falling body using Digital Timing Technique
9. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
10. To determine the Young's Modulus of a Wire by Optical Lever Method.
11. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
12. To determine the elastic Constants of a wire by Searle's method.
13. To determine the value of g using Bar Pendulum.
14. To compare Moment of Inertia of a solid Sphere, Hollow Sphere and solid Disc of same mass with the help of Torsion Pendulum.
15. To determine the bending moment of a cantilever beam with uniformly distributed load, uniformly varying load and point load.

Note: A student has to perform atleast eight (08) experiments from the above list.

References:

1. Classical Mechanics by H. Goldstein (2^{nd} Edition).
2. Berkeley Physics Course. Vol. 1. Mechanics by E.M. Purcell
3. Concepts of Modern Physics by Arthur Beiser
4. Mechanics by D.S. Mathur
5. University Physics. FW Sears, MW Zeman sky & HD Young 13/e, 1986.Addison-Wesley
6. Physics – Resnick, Halliday & Walker 9/e, 2010, Wiley
7. Feynman Lectures, Vol. I, R. P. Feynman, R. B. Leighton, M. Sands, 2008, Pearson Education
8. Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.
9. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
10. Advanced Practical Physics for students, B. L. Flint and H.T. Workshop, 1971, Asia Publishing House.
11. Practical Physics, S.L. Gupta and V. Kumar, Pragati Prakashan Meerut

Semester-II

Name of Program	B.Sc. (Physical Sciences)	**Program Code**	UMPS4
Name of the Course	Electricity and Magnetism	**Course Code**	24PHYM402DS01
Hours per Week	06(2+4)	**Credits**	04
Maximum Marks	Theory: 15+35 Practical: 50 Total: 100	**Time of Examinations**	Theory: 03 Hours Practicals: 03 Hours

Note:
Examiner will set nine questions of seven marks each and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes (CLO):
After completing this course, the learner will be able to:
CLO 1: Develop an understanding of the basic concepts of electricity and magnetism; including electric and magnetic fields and their effects on matter.
CLO 2: Demonstrate the ability to successfully apply a conceptual understanding to specific problems in electricity and magnetism.
CLO 3: Apply problem-solving strategies to problems electricity and magnetism
CLO 4: Demonstrate the ability to perform mathematical analyses of problems in electricity and magnetism
CLO 5: Understand and communicate the role electricity and magnetism play daily life and in commonly used technologies.

Unit 1:
Electric Field and Electric Potential: Scalars and Vectors, dot and cross product, Triple vector product, Scalar and Vector fields, Differentiation of a vector, Gradient of a scalar and its physical significance, Integration of a vector (line, surface and volume integral and their physical significance), Gauss's divergence theorem and Stocks theorem. Derivation of field E from potential as gradient, derivation of Laplace and Poisson equations. Electric flux, Gauss's Law and its application to spherical shell, uniformly charged infinite plane and uniformity charged straight wire, mechanical force of charged surface, Energy per unit volume.

Unit 2:
Magnetic Field: Biot-Savart's Law and its simple applications. Ampere's Circuital Law and its application. Properties of B: curl and divergence. Vector Potential. Magnetic Properties of Matter: Force on a dipole in an external field, Electric currents in Atoms, Electron spin and Magnetic moment, types of magnetic materials, Magnetization vector (M), Magnetic Intensity (H), Magnetic Susceptibility and permeability, Relation between B, H and M, Electronic theory of Dia and Para-magnetism, Domain theory of ferromagnetism (Langvein's theory), Cycle of Magnetization- B-H curve and hysteresis loop: Energy dissipation, Hysteresis loss and importance of Hysteresis Curve.

Unit 3:

Electromagnetic induction: Faraday's laws of induction and Lenz's Law, Self-inductance, Mutual inductance, Energy stored in a Magnetic field, Maxwell equation and their derivations, Displacement Current. Vector and scalar potentials, boundary conditions at interface between two different media, Propagation of electromagnetic wave (Basic idea, no derivation). Poynting vector and Poynting theorem.

Unit 4:

DC current Circuits: Electric current and current density, Electrical conductivity and Ohm's law (Review), Applications to dc circuits. Growth and decay of current in a circuit with (a) Capacitance and resistance (b) resistance and inductance (c) Capacitance and inductance (d) Capacitance resistance and inductance. Alternating Current Circuits: A resonance circuit, Phasor, Complex Reactance and Impedance, Analysis for RL, RC and LC Circuits, Series LCR Circuit: (1) Resonance, (2) Power Dissipation (3) Quality Factor and (4) Band Width, Parallel LCR Circuit.

Practicals:

1. Use of multi-meter for measuring Resistance, A.C. and D.C. Voltage and Current, checking of electrical fuses.
2. To determine an unknown Low Resistance using Potentiometer.
3. To determine an unknown Low Resistance using Carey Foster's Bridge with calibration.
4. Determination of Impedance of an A.C. circuit and its verification.
5. To determine Frequency of A.C. mains using an electromagnet.
6. To determine Frequency of A.C. mains Electrical vibrator.
7. To determine High resistance by substitution method.
8. To compare capacitances using De'Sauty bridge.
9. To verify the Thevenin's and Norton theorems.
10. To verify the Superposition, and Maximum power transfer theorems.
11. To study a series LCR circuit and determine its (a) Resonant frequency, (b) Quality factor.
12. To study a parallel LCR circuit and determine its (a) Anti-resonant frequency and (b) Quality factor.

Note: A student has to perform atleast eight (08) experiments from the above list.

References:

1. Electricity, Magnetism & Electromagnetic Theory, S. Mahajan and Choudhury, 2012, Tata McGraw
2. Introduction to Electrodynamics, D.J. Griffiths, 3rd Edn. 1998, Benjamin Cummings.
3. Feynman Lectures Vol.2, R.P. Feynman, R.B. Leighton, M. Sands, 2008, Pearson Education
4. Elements of Electromagnetics, M.N.O. Sadiku, 2010, Oxford University Press.
5. Electricity and Magnetism, J. H. Fewkes & J. Yarwood. Vol. I, 1991, Oxford Univ. Press.
6. Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-Hill Education
7. Field and Wave Electromagnetics (2nd Edn.), David K. Cheng, Addison-Wesley Publishing Company
8. A Textbook of Practical Physics, I. Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
9. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
10. A Laboratory Manual of Physics for undergraduate classes, D.P. Khandelwal, 1985, Vani Pub.

Semester -III

Name of Program	B.Sc. (Physical Sciences)	**Program Code**	UMPS4
Name of the Course	Optics	**Course Code**	25PHYM403DS01
Hours per Week	06 (2+4)	**Credits**	04
Maximum Marks	Theory: 15+35 Practical: 50 Total: 100	**Time of Examinations**	Theory: 03 Hours Practicals: 03 Hours

Note:

Examiner will set nine questions of seven marks each and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes (CLO):

After completing this course, the learner will be able to:

CLO 1: Understand phenomenon based on light and related theories.

CLO 2: Get skills to identify and apply formulas of optics and wave physics

CLO 3: Understand the event like reflection, refraction, interference, diffraction etc

CLO4: Understand the applications of interference in design and working of interferometers.

CLO5: Understand the applications of diffraction and polarization.

CLO6: Understand the resolving power of different optical instruments.

CLO7: Understand working of optical fiber and their applications in communication

Unit–I

INTERFERENCE: Interference by Division of Wave front: Young's double slit experiment, Coherence, Conditions of interference, Fresnel's biprism and its applications to determine the wavelength of sodium light and thickness of 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–II

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–III

POLARIZATION: 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 polarized Light. Nicol prism, Quarter wave plate and half wave plate, production and detection of (i) Plane polarized light (ii) Circularly polarized light and (iii) Elliptically polarized light. Optical activity, Fresnel's theory of optical rotation, Specific rotation, Polarimeters (half shade and Biquartz)

Unit–IV

LASERS: Basic concept of absorption and emission of radiations, amplification and population inversion; Main components of lasers: (i) Active Medium (ii) Pumping (iii) Optical Resonator; Properties of laser beam: Monochromaticity, Directionality, Intensity, Coherence (Spatial & Temporal coherence); Metastable state, Excitation mechanism and Types of Lasers (He-Ne Laser & Ruby Laser), Applications of Lasers.

FIBRE OPTICS: Optical fibres and their properties, Principal of light propagation through a optical fibre, Acceptance angle and numerical aperture, Types of optical fibres: Single mode and multimode fibres, Advantages and Disadvantages of optical fibres.

Practicals:

1. Refractive index and dispersive power of a prism material by spectrometer.
2. To draw a graph between wave length and minimum deviation for various lines from a Mercury discharge source.
3. Determination of wave length of Na light and the number of lines per centimetre using a diffraction grating.
4. Determination of wave length of sodium light using Newton's Rings
5. Resolving power of a telescope.
6. Comparison of Illuminating Powers by a Photometer.
7. Measurement of (a) Specific rotation (b) concentration of sugar solution using polarimeter.
8. Ordinary and extra ordinary refractive indices for calcite or quartz.
9. Resolving power of a prism.
10. Resolving power of a grating.
11 Wave length 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 sit interference by He-Ne laser.
14. Diameter of a thin wire by diffraction method (using He-Ne Laser).

Note: A student has to perform atleast eight (08) experiments from the above list.

Reference/Text Books Suggested:

1. Principles of Optics, M. Born and E. Wolf, Pergamaman Press
2. Optics by Ajoy Ghatak, 2008, Tata McGraw Hill
3. Fundamentals of Optics, Jenkins and White, McGraw Hill Book Co. Ltd., New Delhi
4. Optics, K.D. Muller, University Science Books, Mill ally California
5. A textbook of optics by N. Subrahmanyam and Brijlal, S. Chand & Company
6. Lasers and Non-Linear Optics, B.B. Laud, New Age International (P) Ltd., Publishers, New Delhi
7. Laser, Theory & Applications by K. Thyagarajan and A.K. Ghatak, Macmillan India limited
8. B.Sc. Practical Physics, C.L. Arora, S. Chand Publisher, New Delhi
9. Advanced Level Practical Physics, M. Nelkon and Ogborn, Henemann Education Books Ltd., New Delhi
10. Practical Physics, S.S. Srivastava and M.K. Gupta, Atma Ram & Sons, Delhi
11.Practical Physics, S.L. Gupta and V. Kumar, Pragati Prakashan Meerut
12. Modern Approach to Practical Physics, R.K. Singla, Modern Publishers, Jalandhar
13. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, Asia Publishing House

Semester -IV

Name of Program	B.Sc. (Physical Sciences)	**Program Code**	UMPS4
Name of the Course	Thermodynamics and Statistical Mechanics	**Course Code**	25PHYM404DS01
Hours per Week	06(2+4)	**Credits**	04
Maximum Marks	Theory: 15+35 Practical: 50 Total: 100	**Time of Examinations**	Theory: 03 Hours Practicals: 03 Hours

Note:
Examiner will set nine questions of seven marks each and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes (CLO):
After completing this course, the learner will be able to:
CO1: Understand the process of thermal conductivity in gases.

CO2: Understand the basic statistical methods and concepts like probability, random variables, expected value, variance, estimators and common probability distributions.

CO3: Understand the relation between microscopic and macroscopic description through statistical mechanics; know and can apply the laws of thermodynamics and principles of free energy; describe thermodynamic processes and heat engines and master the use of the chemical potential to describe diffusive equilibrium, phase equilibrium and chemical processes.

CO4: Understand the efficiency of Carnot's engine and the significance of first law and second of thermodynamics and implications of the second law of thermodynamics and limitations placed by the second law on the performance of thermodynamic systems.

CO5: Ability to evaluate entropy changes in a wide range of processes and determine the reversibility or irreversibility of a process from such calculations.

CO6: Understand the interrelationship between thermodynamic functions and ability to use such relationships to solve practical problems.

Unit–I Thermodynamics-I: Second law of thermodynamics, Carnot theorem, Absolute scale of temperature, Absolute Zero, Entropy, show that dQ/T=O, T-S diagram Nernst heat law, Joule's free expansion, Joule Thomson (Porous plug) experiment. Joule - Thomson effect.

Unit–II Thermodynamics-II: Derivation of Clausius - Clapeyron latent heat equation. Phase diagram and triple point of a substance. Development of Maxwell thermodynamical relations. Application of Maxwell relations in the derivation of relations between entropy, specific heats and thermodynamic variables. Thermodynamic functions: Internal energy (U), Helmholtz function (F), Enthalpy (H), Gibbs-function (G) and the relations between them.

Unit–III Distribution of N (for N = 2, 3, 4) distinguishable and indistinguishable particles in two boxes of equal size, microstates and macrostates, thermodynamical probability, constraints and accessible states, statistical fluctuations, general distribution of distinguishable particles in compartments of different sizes, β-parameter, entropy and probability; Concept of phase space, division of phase space into cells, postulates of statistical mechanics; Classical and quantum statistics, basic approach to these statistics, Maxwell-Boltzmann statistics applied to an ideal gas in equilibrium-energy distribution law, Maxwell's distribution of speed & velocity (derivation required), most probable speed, average and r.m.s. speed, mean energy for Maxwellian distribution.

Unit–IV Dulong and Petit Law, derivation of Dulong and Petit law from classical physics; Need of Quantum statistics- classical versus quantum statistics, Bose-Einstein energy distribution Law, Application of B. E. Statistics to Planck"s radiation law, degeneracy and B. E. condensation; Fermi-Dirac energy distribution Law, F. D. gas and degeneracy, Fermi energy and Fermi temperature; F. D. energy distribution Law for electron gas in metals, zero point energy, average speed (at 0 K) of electron gas

Practicals:

1. To determine the coefficient of thermal conductivity of copper by Searle's Apparatus.
2. E.C.E. of hydrogen using an Ammeter.
3. Thermal conductivity of a bad conductor by Lee's method.
4. Calibration of thermocouple by potentiometer.
5. To determine the coefficient of increase of volume of air at constant pressure.
6. To determine the coefficient of increase of pressure of air at constant volume.
7. Mechanical Equivalent of heat (J) by Joule's calorimeter.
8. Heating efficiency of electrical kettle with varying voltage.
9. To calibrate a thermocouple to measure temperature in a specified range using null method/direct measurement using an op-amp difference amplifier and to determine neutral temperature.
10. To prove the law of probability by using one coin, two coins and 10 or more coins.
11. Computer simulation of Maxwell-Boltzmann, Fermi-Dirac & Bose-Einstein distributions.
12. Study of statistical distribution from the given data and to find most probable, average, and rms value.

Note: A student has to perform atleast eight (08) experiments from the above list.

References:

1. Thermal Physics, S. Garg, R. Bansal and C. Ghosh, 1993, Tata McGraw-Hill.
2. A Treatise on Heat, Meghnad Saha, and B.N. Srivastava, 1969, Indian Press.
3. Thermodynamics, Enrico Fermi, 1956, Courier Dover Publications.
4. Thermodynamics, Kinetic theory & Statistical thermodynamics, F.W. Sears and G.L. Salinger. 1988, Narosa University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
5. Advanced Practical Physics for students, B.L. Flint & H.T. Worsnop, 1971, Asia Publishing House.
6. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi. 78
7. A Laboratory Manual of Physics for Undergraduate Classes, D.P. Khandelwal, 1985, Vani Publication.
8. Thermal Physics and Statistical Mechanics, S.K. Roy, New Age International Publishers, New Delhi.
9. Thermodynamics and Statistical Physics, J.K. Sharma and K.K. Sarkar, Himalaya Publishing House, Bombay.
10. Introduction to Thermodynamics and its Applications, Stowe Keith, University Press (India) Pvt. Ltd, Hyderabad

11. Thermodynamics and Its Applications, Jefferson Tester, Michael Modell, 3rd Edition
12. Thermodynamics, Statistical Thermodynamics & Kinetics, Thomas Engel, Philip Reid, 2nd Edition 8. Advanced Practical Physics for students, B.L .Flint & H.T. Worsnop, 1971, Asia Publishing House.
13. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
14. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.

Semester -V

Name of Program	B.Sc. (Physical Sciences)	**Program Code**	UMPS4
Name of the Course	Quantum Mechanics and Nuclear Physics	**Course Code**	26PHYM405DS01
Hours per Week	06(2+4)	**Credits**	04
Maximum Marks	Theory: 15+35 Practical: 50 Total: 100	**Time of Examinations**	Theory: 03 Hours Practicals: 03 Hours

Note:
Examiner will set nine questions of seven marks each and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes (CLO):
After completing this course, the learner will be able to:
CLO 1: Understand the origins of quantum mechanics.
CLO 2: The main objective of this course is to make students aware about the basic formulations in quantum mechanics.
CLO 3: Understand and explain the differences between classical and quantum mechanics.
CLO 4: Understand the idea of wave function.
CLO 5: Understand the uncertainty relations.
CLO 6: Solve the Schrodinger equation for simple 1D time-independent potentials.
CLO 7: Understand the ideas of basics of nucleus and their energy.

Unit–I Failure of Classical E.M. Theory, quantum theory of radiation (old quantum theory), Photon, photoelectric effect and Einstein's photoelectric equation Compton effect (theory and result). Franck-Hertz experiment. Inadequacy of old quantum theory, de-Broglie hypothesis. Davisson and Germer experiment. Phase velocity group velocity, Heisenberg's uncertainty principle. Time-energy and angular momentum, position uncertainty. Uncertainty principle from de-Broglie wave, (wave-particle duality). Gamma Ray Microscope.

Unit–II Basic postulates and formalism: properties of Wave Function, Interpretation of Wave Function, Condition for physical acceptability of Wave Functions. Eigenvalues and Eigen functions, Probability current density, Expectation values of position and linear momentum. Time dependent and time independent Schrodinger equation, Mathematical consideration of Schrodinger equation: Normalization, Orthogonality, Observables. Application of Schrodinger equation in the solution of the following one-dimensional problems: (i) Free particle in one-dimensional box (solution of Schrodinger wave equation, eigen functions, eigen values, quantization of energy and momentum, nodes and anti-nodes, zero-point energy).

Unit–III Nuclear mass and binding energy, systematics nuclear binding energy, nuclear stability, nuclear size, spin, parity, statistics magnetic dipole moment, quadrupole moment (shape concept), Determination of charge by Mosley law Determination of size of nuclei by Rutherford Back Scattering. Interaction of heavy charged particles (Alpha particles), alpha disintegration and its theory Energy loss of heavy charged particle (idea of Bethe formula, no derivation), Energetics of alpha -decay, Range and straggling of alpha particles. Geiger-Nuttal law.

Unit–IV Introduction of light charged particle (Beta-particle), Origin of continuous beta-spectrum (neutrino hypothesis) types of beta decay and energetics of beta decay, Energy loss of beta-particles (ionization), Range of electrons, absorption of beta-particles. Interaction of Gamma Ray, Nature of gamma rays, Energetics of gamma rays, passage of Gamma radiations through matter (photoelectric, Compton and pair production effect) electron position anhelation. Absorption of Gamma rays (Mass attenuation coefficient) and its application. Nuclear Reactors General aspects of Reactor design. Nuclear fission and fusion reactors (Principles, construction, working and use). Ionization chamber, proportional counter, G.M. counter detailed study.

List of Experiments:

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. Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light.
7. Measurement of Planck's constant using black body radiation and photo-detector
8. To determine the value of e/m by (a) Magnetic focusing or (b) Bar magnet.
9. To setup the Millikan oil drop apparatus and determine the charge of an electron.
10. To show the tunnelling effect in tunnel diode using I-V characteristics.
11. (a) Draw the plateau using G M counter
    (b) Determine the mass attenuation coefficient by G M counter.
12. Solve the s-wave Schrodinger equation for the ground state and the first excited state of the hydrogen atom using *Python/Fortran.*

Note: A student has to perform **atleast eight (08)** experiments from the above list.

Reference/Text Books Suggested:

1. Quantum Mechanics: Theory & Applications, A. K. Ghatak & S. Lokanathan, 2004, Macmillan.
2. Quantum Mechanics: Concepts and Applications, Nouredine Zettili, Wiley publications.
3. Advanced Quantum Mechanics, Satya Prakash, Kadar Nath Ram Nath publications.
4. Introduction to Quantum Mechanics, David J. Griffiths, Pearson publications.
5. Modern Quantum Mechanics, J. J. Sakurai, Pearson publications

6. Nuclear Physics, D C Tayal, Himalaya Publishing
7. Nuclear Physics- An Introduction, S B Patal, New Age International Publisher.
8. Quantum Physics, Berkeley Physics, Vol.4. E. H. Wichman, 1971, Tata McGraw-Hill Co.
9. Basic ideas and concepts in Nuclear Physics, K. Heyde, 3rd Edn., Institute of Physics Pub.
10. Nuclear Physics, S. N Ghosal, S. Chand Publications.

Semester -VI

Name of Program	B.Sc. (Physical Sciences)	**Program Code**	UMPS4
Name of the Course	Solid State Physics and Electronic Devices	**Course Code**	26PHYM406DS01
Hours per Week	06(2+4)	**Credits**	04
Maximum Marks	Theory: 15+35 Practical: 50 Total: 100	**Time of Examinations**	Theory: 03 Hours Practicals: 03 Hours

Note:
Examiner will set nine questions of seven marks each and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes (CLO):
After completing this course, the learner will be able to:
CLO 1: understand and apply key concepts of crystalline and glassy materials, including Unit cell, primitive cell, Bravais lattices, Miller indices
CLO 2: appreciate the crystal structures of Zinc Sulphide, Sodium Chloride, and Diamond
CLO 3: understand the concept of reciprocal lattices, their physical significance, and apply Bragg's Law to interpret X-ray diffraction pattern
CLO 4: explain and apply Einstein's and Debye's theories to understand the specific heat of solids
CLO5: apply understanding of P-N junction diode, LED, photodiode, solar cells, and Zener diodes for designing electronic circuits such as rectifiers, voltage regulator, solar panel etc.
CLO6: able to design amplifier circuits using Bipolar junction transistors

Unit 1:
Crystalline and glassy forms, liquid crystals. Crystal structure, periodicity, lattice and basis, crystal translational vectors and axes, Unit cell and primitive cell, Winger Seitz primitive Cell, symmetry operations for a two-dimensional crystal, Bravais lattices in two and three dimensions, crystal planes and Miller indices, Interplanar spacing, Crystal structures of Zinc sulphide, Sodium Chloride and diamond

Unit 2: Reciprocal lattice and its physical significance, reciprocal lattice vectors, reciprocal lattice to a simple cubic lattice, body centred cubic lattice and face centred cubic lattice; X-ray diffraction, Bragg's Law and experimental x-ray diffraction methods; Specific heat: Specific heat of solids, Einstein's theory of specific heat, Debye model of specific heat of solids.
Unit 3: Energy bands in solids. Intrinsic and extrinsic semiconductor, Hall's effect, P-N junction diode and its V-I characteristics, Resistance of a diode, Zener and avalanche breakdown, Light Emitting diodes (LED), Photo conduction in semiconductors, photodiode, Solar Cell, P-N junction half wave and full wave rectifier, passive filter circuits, Zener diode as voltage regulator, simple regulated power supply.
Unit 4: Bipolar junction transistors: working of NPN and PNP transistors, Transistor connections (C-B, C-E, C-C mode), constants of transistor, Transistor characteristic curves advantage of C-B configuration, Transistor Amplifiers: Transistor biasing, methods of Transistor biasing and stabilization. D.C. load line, Common-base and common-emitter transistor biasing. Common-base, common, emitter amplifier, Classification of amplifiers, Resistance-capacitance (R-C) coupled amplifier, Feed-back in amplifier, advantage of negative feedback, Emitter follower.
Practicals: 1. To study resistivity of Ge crystal as a function of temperature and to find the band gap energy using Four Probe method 2. To study Hall's effect in semiconductors and to find carrier type and concentration. 3. To draw forward and reverse bias characteristics of a semiconductor diode. 4. Zener Diode volage regulation characteristics. 5. Verification of Inverse square law by photocell. 6. To study the characteristics of a solar cell 7. Input and output characteristics of C-B Configuration of npn/pnp transistor 8. Input and output characteristics of C-E Configuration of npn/pnp transistor 9. Transistor as voltage Amplifier in C-B Configuration 10. Transistor as voltage Amplifier in C-E Configuration 11. To find Boltzmann constant using I-V characteristics of Ge and Si diodes. 12. Study of half and full wave rectifier using p-n junction diode. **Note:** A student has to perform atleast eight (08) experiments from the above list.
References: 1. Introduction to Solid State Physics by Charles Kittel 2. Integrated Electronics by J. Millman and C.C. Halkias (Tata-McGraw Hill). 3. Electronic Devices and Circuit Theory by Robert L. Boylestad (Pearson). 4. Solid State Electronic Devices by Ben G. Streetman (PHI).

Semester-VII

Name of Program	B.Sc. (Physical Sciences)	**Program Code**	UMPS4
Name of the Course	Mathematical Physics	**Course Code**	24PHY201DS01
Hours per Week	04 (1+3)	**Credits**	04
Maximum Marks	Theory: 30 (internal) +70 (external) Total: 100	**Time of Examinations**	03

Note:
Examiner will set nine questions of fourteen marks each and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes (CLO):

CLO1: The students would get sufficient exposure /understanding of the linear vector space and applications of matrices to physical problems

CO2: The students would be able to solve problems based on differential equations

CO3: The analysis of special functions would equip a student for effective tackling of specific problems.

CO4: The students would be able to realize various applications with proper understanding of series expansion and integral transforms

Unit 1: Vector spaces, Norm of a Vector, Linear independence & dependence, Basis and dimension, Isomorphism of Vector spaces, Scalar/Inner product of vectors, Orthonormal basis, Gram-Schmidt Orthogonalization process, Linear operators, Matrices, Cayley-Hamiltion Theorem, Inverse of matrix, Orthogonal, Unitary and Hermitian matrices, Eigenvalues and eigenvectors of matrices, Similarity transformation, Matrix diagonalization, Simultaneous diagonalization and commutativity

Unit 2: Second order linear differential equation with variable coefficients, Ordinary point, Singular point, Series solution around an ordinary point, Series solution around a regular singular point; the method of Frobenius, Wronskin and getting a second solution, Solution of Legendre's equation, Solution of Bessel's equation, Solutions of Laguerre and Hermite's equations

Unit 3: Special functions, Generating functions for Bessel function of integral order $J_n(x)$, Recurrence relations, Integral representation; Legendre polynomials $P_n(x)$, Generating functions for $P_n(x)$, Recurrence relations, orthogonality, Rodrigue's Relation; Hermite Polynomials; Generating functions, Rodrigue's relation &orthogonality for Hermite polynomials; Laguerre polynomials; Generating function and Recurrence relations, Orthogonality, Rodrigue's Relation, The Gamma Function, The Dirac – Delta Function

Unit 4: Integral transform, Laplace transform, Properties of Laplace transforms such as first and second shifting property, Laplace Transform of Periodic Functions, Laplace transform of derivatives, Laplace Transform of integrals, Inverse Laplace Transform by partial fractions method, Fourier series, Evaluation of coefficients of Fourier series Cosine and Sine series, Applications of Fourier Series, Fourier Transforms, Fourier sine Transforms, Fourier cosine Transforms, Fourier transform of derivatives, Applications of Fourier Transforms

References:

1. Mathematical Physics by P.K. Chattopadhyay (T)

2. Mathematical Physics by B. S. Rajput
3. Matrices and Tensors for Physicists, by A. W Joshi
4. Mathematical Physics by Mathews and Walkers
5. Mathematics for Physicists by Mary L Boas

Semester-VII

Name of Program	B.Sc. (Physical Sciences)	**Program Code**	UMPS4
Name of the Course	Classical Mechanics	**Course Code**	24PHY201DS02
Hours per Week	04 (1+3)	**Credits**	04
Maximum Marks	Theory: 30 (Internal) +70 (external) Total: 100	**Time of Examinations**	03

Note: Examiner will set nine questions of fourteen marks each and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes (CLO):

CLO1: Student would be able to describe and understand the motion of a mechanical system using Lagrange and Hamilton formalisms.

CLO2: Students would become able to understand the concepts of central force motion and moving co-ordinate systems.

CLO3: Student would get basic ideas about the theory of small oscillations and use of Poisson's bracket which will lead to understand the concepts of quantum mechanics.

Unit 1: Survey of Elementary Principles and Lagrangian Formulation: Newtonian mechanics of one and many particle systems, Conservation laws, Constraints and their classification, Generalized coordinates and momenta, Principle of virtual work, D' Alembert's principle and Lagrange's equation, Velocity dependent potentials and dissipation function, Simple applications of Lagrangian formulation, Cyclic coordinates, Symmetries of space and time and conservation laws, Invariance of Lagrangian under Galilean transformation

Unit 2: Moving coordinate systems and Motion in a central force field: Rotating frames, inertial forces, terrestrial applications of Coriolis force, two body problem: Reduction to equivalent one body problem, Central force definition and characteristics, the equation of motion and first integrals, differential equation for the orbit, general analysis of orbits, condition for closure and stability of circular orbits, Kepler's laws and equations, Rutherford scattering.

Unit 3: Legendre Transformation and Hamilton's equations of motion, Some techniques of calculus of variation, Variational principle, Hamilton's principle from D'Alembert's principle, Lagrange's equation from Hamilton's principle, Hamilton's equations from variational principle, variation and end points, Principle of least action and its forms, Hamilton-Jacobi equation and their solutions, Use of Hamilton-Jacobi method for the solution of Harmonic oscillator problem, Hamilton's principle function, Hamilton's characteristic function and their properties

Unit 4: Canonical transformations, Generating functions, Properties of Poisson bracket, Equation of motion in Poisson bracket, Angular momentum and Poisson bracket relations, Jacobi identity, Invariance of Poisson brackets using canonical transformations, Potential Energy and equilibrium: Stable, unstable and neutral equilibrium, One-dimensional Oscillator, Two coupled oscillators: Solution of differential equation to find normal coordinates and normal modes, Theory of small oscillations, Examples of coupled oscillators: Two coupled pendulum, double pendulum, Free vibrations of a linear triatomic molecule.

References:

1. Classical Mechanics by N C Rana and P S Joag (Tata McGraw Hill, 1991)
2. Classical Mechanics by H Goldstein (Addison Wesley, 1980)
3. Mechanics by A. Sommerfeld (Academic Press, 1952)
4. Introduction to Dynamics by I Perceival and D Richards (Cambridge Univ. Press, 1982)

Semester-VII

Name of Program	B.Sc. (Physical Sciences)	**Program Code**	UMPS4
Name of the Course	Quantum Mechanics –I	**Course Code**	24PHY201DS03
Hours per Week	04 (1+3)	**Credits**	04
Maximum Marks	Theory: 30 (internal) +70 (external) Total: 100	**Time of Examinations**	03

Note:
Examiner will set nine questions of fourteen marks each and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes (CLO):
CLO1: Student would be able to understand the concepts of operators in Quantum mechanics.
CLO2: Students would be able to apply Pauli spin matrices to explain angular momentum.
CLO3: Students would be capable to solve problems such as hydrogen atom.
CLO4: Students can determine energies and wave functions of first and second order.

Unit 1: General formalism of Quantum Mechanics: States and operators; Representation of States and dynamical variables; Linear vector space; Bra Ket notation, Linear operators; Orthonormal set of vectors, Completeness relation; Hermitian operators, their eigenvalues and eigenvectors, The fundamental commutation relation; Commutation rule and the uncertainty relation; Simultaneous eigenstates of commuting operators; The unitary transformation; Dirac delta function; Relation between kets and wave functions; Matrix representation of operators; Solution of linear harmonic oscillator problem by operator methods

Unit 2: Angular momentum operator: Angular momentum operators and their representation in spherical polar co-ordinates; Eigenvalues and eigenvectors of L^2, spherical harmonics; Commutation relations among L_x L_y L_z; Rotational symmetry and conservation of angular momentum; Eigenvalues of J^2 and J_z and their matrix representation; Pauli spin matrices; Addition of angular momentum

Unit 3: Solution of Schrodinger equation for three dimensional problems: The three-dimensional harmonic oscillator in both Cartesian and spherical polar coordinates, Eigen values, Eigen functions and the degeneracy of the states; Solution of the hydrogen atom

problem, the eigenvalues, Eigen functions and the degeneracy
Unit 4: Perturbation Theory: Time independent perturbation theory; Non degenerate case, the energies and wave functions in first order the energy in second order; Anharmonic perturbations of the form λx^3 and λx^4; Degenerate perturbation theory; Stark effect of the first excited state of hydrogen.
References: 1. Quantum Mechanics by Ghatak and Loknathan 2. Quantum Mechanics by Powell and Craseman 3. Quantum Mechanics by S. Gasiorowicz 4. Quantum Mechanics by A.P. Messiah 5. Modern Quantum Mechanics by J.J. Sakurai 6. Quantum Mechanics by L.I. Schiff 7. Quantum Mechanics by Mathews and Venkatesan

Semester-VII

Name of Program	B.Sc. (Physical Sciences)	**Program Code**	UMPS4
Name of the Course	Physics of Electronic Devices	**Course Code**	24PHY201DS04
Hours per Week	04 (1+3)	**Credits**	04
Maximum Marks	Theory: 30 (internal) +70 (external) Total: 100	**Time of Examinations**	03

Note: Examiner will set nine questions of fourteen marks each and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.
Course Learning Outcomes (CLO): CLO1: Students would get familiarity with semiconductor materials and charge transport in semiconductors CLO2: Students would be able to appreciate the functioning and applications of various optoelectronic and memory devices. CLO3: Students would be able to explain the basic physics and application of different transistor types. CLO4: Students having familiarization with negative resistance devices and will be in a position to design switching circuits involving these devices.
Unit 1: Charge carriers in semiconductors: Energy bands, metals, Semiconductors and insulators, Direct and indirect band gap semiconductors, Variation of energy bands with alloy composition, Electrons and holes, effective mass, Intrinsic and extrinsic semiconductors, Concept of Fermi level, Electron and hole concentration at equilibrium, Temperature dependence of carrier concentrations, Compensation and space charge neutrality, Conductivity and mobility, Effect of temperature and doping on mobility, Hall effect, Invariance of Fermi level
Unit 2: Carrier transport in semiconductors: Optical absorption and luminescence, Carrier lifetime and photoconductivity, Direct/indirect recombination of electrons and holes, Traps and defects, Steady state carrier generation, Quasi Fermi levels, Diffusion and drift of carriers, Diffusion and recombination, Diffusion length, Haynes Shockley experiment, Gradient in quasi-Fermi level, External and internal photoelectric effect
Unit 3: Diode physics and optoelectronic devices: P-N junction diode: Basic structure, Energy band diagram, Built-in potential, Electric field, Space charge width and qualitative

description of current flow, Derivation of diode current equation, Zener diode: breakdown mechanisms, Voltage regulator circuit, Power diode, Varactor diode, Optoelectronic devices: Vacuum photodiode, Photo-multipliers tube, P-N junction photodiode, Pin photodiode, Avalanche photodiode, Phototransistor, Solar cell, Light emitting diode (LED), Diode laser: Condition for laser action and optical gain
Unit 4: Transistors: Bipolar junction transistor (BJT), Transistor operating modes, Transistor action, Transistor biasing configurations and characteristics, Field effect transistors: Junction field effect transistor (JFET), Metal oxide semiconductor field effect transistor (MOSFET), Negative resistance devices: Tunnel diode, Backward diode, Uni-junction transistor, p-n-p-n devices and their characteristics, Silicon controlled rectifier and switch and their characteristics.
References: 1. Semiconductor Devices - Physics and Technology by S.M. Sze (Wiley). 2. Solid State Electronic Devices by Ben G. Streetman (PHI). 3. Semiconductor Physics and Devices by Donald A Neamen (Tata-McGraw Hill). 4. Integrated Electronics by J. Millman and C.C. Halkias (Tata-McGraw Hill). 5. Semiconductor Devices by Kanaan Kano (PHI). 6. Semiconductor Optoelectronic Devices by Pallab Bhattacharya (Pearson) 7. Semiconductor Device Fundamentals by Robert F Pierret (Addison-Wesley). 8. Electronic Devices and Circuit Theory by Robert L. Boylestad (Pearson).

Semester-VII

Name of Program	B.Sc. (Physical Sciences)	**Program Code**	UMPS4
Name of the Course	Practical: General Physics -I	**Course Code**	24PHY201DS05
Hours per Week	08	**Credits**	04
Maximum Marks	Practical: 100 Total: 100		

Note:

	Marks distribution
Regular assessment through observation and class discussion	20
Lab work (practical file) / field work (report)/Portfolio	30
Assignment/Case study / Mini project (3 X 10)	30
Seminar / Presentation (2 X 7.5)	15
Attendance	05
Total	**100**

Out of the list of experiments given below one experiment will be allotted through lottery method to each student on the day of examination to perform and then followed by Viva-voce.

Course Learning Outcomes (CLO):

CLO1: Students would be able to determine the values of Stefan's constant, Boltzmann constant and e/m ratio of electron and experimental errors in each case.

CLO2: Students would be able to understand magnetization and related aspects in a ferromagnetic material. CLO3: Students get familiarized with advanced spectroscopy. CLO4: Students would be able to understand the different harmonics and their amplitudes in a Fourier series experimentally which provide direct connect between theory and experiment.
List of Experiments 1. To determine the dielectric constant of polar and non-polar liquids 2. To determine the Magnetic susceptibility of a solid sample. 3. To study B-H curve of a given ferrite sample and find energy loss in case of ferrite Core. 4. Stefan's constant by the black copper radiation plates (Electrical Method). 5. To determine the heat capacity of solids 6. To verify the existence of different harmonics and measure their relative amplitudes using Fourier Analysis kit 7. To study of dielectric constant as a function of temperature and determine the Curie temperature 8. To determine the dielectric constant of different solid samples 9. Study of lead tin phase diagram 10. To determine Boltzmann Constant (k) using I-V characteristics of Si/Ge P-N junction diode 11. Dissociation Energy of I_2 molecule 12. Measurement of minority carrier life time using Haynes Shockley experiment **Note:** Out of the list as above, a student has to perform atleast 08 (eight) practicals in the semester

Semester-VIII

Name of Program	B.Sc. (Physical Sciences)	**Program Code**	UMPS4
Name of the Course	Statistical Mechanics	**Course Code**	24PHY202DS01
Hours per Week	04 (1+3)	**Credits**	04
Maximum Marks	Theory: 30 (internal) + 70 (external) Total: 100	**Time of Examinations**	03
Note: Examiner will set nine questions of fourteen marks each and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.			
Course Learning Outcomes (CLO): CLO1 The students are able to appreciate cellular nature of phase space and interface of Statistical Mechanics with Thermodynamics CLO2 Knowledge of ensemble theory would result in greater insight into solutions of various complex problems CLO3 The students would be able to analyse the peculiar gas behaviour and are in a position to extend the treatment to complex problems CLO4 The students would be equipped to explore the applications of Ising Model and to understand different approximations.			
Unit 1: Phase space, Ensembles, Liouville theorem, conservation of extension, Equation of motion, Equal a priori probability, Statistical equilibrium, Micro-canonical ensemble, Quantization of phase space, classical limit, symmetry of wave functions effect of symmetry			

on counting, Various distributions using micro canonical ensemble Entropy of an ideal gas, Equilibrium Conditions, Quasi – Static Process, Entropy of an ideal gas using Micro-canonical Ensemble, Gibbs paradox, Sackur-Tetrode equation, Probability distribution and entropy of a two level system.

Unit 2: Entropy of a system in contact with a reservoir, Canonical ensemble, Ideal gas in a canonical ensemble, Equipartition of energy, Third law of thermodynamics, Photons, Grand canonical ensemble, Ideal gas in Grand Canonical ensemble, Comparison of various ensembles, Quantum distribution using other ensembles

Unit 3: Transition from classical statistical mechanics to quantum statistical mechanics, Indistinguishability and quantum statistics, identical particles and symmetry requirements, Bose Einstein statistics, Fermi Dirac statistics, Maxwell Boltzmann statistics. Bose Einstein Condensation, Thermal properties of B.E. gas, liquid Helium, Energy and pressure of F-D gas, Electrons in metals, Thermionic Emission, Saha Theory of Thermal Ionization

Unit 4: Cluster expansion for a classical gas, Virial equation of state, Van der Waals gas, Phase transition of second kind, Ising Model, Bragg Williams Approximation, Ising Model in one and two dimensions, fluctuations in ensembles, Energy fluctuation in quantum statistics, Concentration fluctuation in quantum statistics, One dimensional random walk, Brownian motion.

References:

1. Statistical Mechanics by K. Huang
2. Statistical Mechanics by B.K. Aggarwal and M. Eisner
3. Statistical Mechanics by R.K. Patharia
4. Statistical Mechanics by Donald A McQuarrie
5. Statistical Mechanics by Avijit Lahiri
6. Statistical Mechanics R Kubo

Semester-VIII

Name of Program	B.Sc. (Physical Sciences)	**Program Code**	UMPS4
Name of the Course	Quantum Mechanics –II	**Course Code**	24PHY202DS02
Hours per Week	04 (1+3)	**Credits**	04
Maximum Marks	Theory: 30 (internal) +70 (external) Total: 100	**Time of Examinations**	03

Note: Examiner will set nine questions of fourteen marks each and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes (CLO):

CLO1: Students would be able to explain ground state of hydrogen and helium molecules.
CLO2: Students get enabled to analyse various transitions and their selection rules.
CLO3: Students would be capable to understand 3D collisions.
CLO4: Students would be capable to calculate spin states of identical particles.

Unit 1: Variational methods: Ground state of Helium by both variational and perturbation methods; The hydrogen molecule; WKB approximation; Time dependent perturbation theory; Constant perturbation; Harmonic perturbation; Fermi's golden rule; Adiabatic and sudden approximation.

Unit 2: Semi-classical theory of radiation: Transition probability for absorption and induced emission; Electric dipole transition and selection rules; Magnetic dipole transitions;

Forbidden transitions; Higher order transitions; Einstein's coefficients.
Unit 3: Collision in 3D and scattering: Laboratory and C.M. reference frames; scattering amplitude; Differential scattering cross section and total scattering cross section; The optical theorem; Scattering by spherically symmetric potentials; Partial waves and phase shifts; Scattering by a perfectly rigid sphere and by square well potential; Complex potential and absorption; The Born approximation.
Unit 4: Identical particles: The principle of indistinguishability; Symmetric and antisymmetric wave functions; Spin and statistics of identical particles; The Slater determinant; The Pauli exclusion principle; Spin states of a two-electron system; States of the helium atom; Collision of identical particles.
References: 1. Quantum Mechanics by Ghatak and Loknathan 2. Quantum Mechanics by Powell and Crassman 3. Quantum Mechanics by S. Gasiorowicz 4. Quantum Mechanics by A.P. Messiah 5. Modern Quantum Mechanics by J.J. Sakurai 6. Quantum Mechanics by L.I. Schiff 7. Quantum Mechanics by Mathews and Venkatensan.

Semester-VIII (OPTION-1) (4 Year UG Hons.)

Name of Program	B.Sc. (Physical Sciences)	**Program Code**	UMPS4
Name of the Course	Atomic and Molecular Physics	**Course Code**	24PHY202DS03
Hours per Week	04 (1+3)	**Credits**	04
Maximum Marks	Theory: 30 (internal) +70 (external) Total: 100	**Time of Examinations**	03
Note: Examiner will set nine questions of fourteen marks each and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.			
Course Learning Outcomes (CLO): CLO1: Atomic spectra of one and two electron atoms. CLO2: The change in behaviour of atoms in external applied electric and magnetic field. CLO3: Diatomic molecules and their rotational vibrational and rotational vibrational spectra. CLO4: Energy levels and spectrum in diatomic molecules			
Unit 1: One Electron systems and Pauli principle: Quantum states of one electron atoms, atomic orbitals, Hydrogen spectrum, Pauli principle, spectra of alkali elements, spin orbit interaction and fine structure in alkali spectra, Spectra of two electron systems, equivalent and non-equivalent electrons			
Unit 2: The influence of external fields, Two electron system Hyperfine structure and Line broadening: Normal and anomalous Zeeman effect, Paschen Back effect, Stark effect, Two electron systems, interaction energy in LS and JJ coupling, Hyperfine structure (magnetic and electric, only qualitative)			
Unit 3: Diatomic molecules and their rotational spectra: Types of molecules, Diatomic linear symmetric top, asymmetric top and spherical top molecules, Rotational spectra of diatomic molecules as a rigid rotator, energy levels and spectra of non-rigid rotor, intensity of			

rotational lines
Unit 4: Vibrational and Rotational Vibration spectra of Diatomic molecules: Vibrational energy of diatomic molecule, Diatomic molecules as a simple harmonic oscillator, Energy levels and spectrum, Morse potential energy curve, Molecules as vibrating rotator, vibration spectrum of diatomic molecules, PQR Branches
References: 1. Introduction to Atomic and Molecular Spectroscopy by V.K. Jain 2. Introduction to Atomic spectra by H.E. White 3. Fundamentals of molecular spectroscopy by C.B. Banwell 4. Spectroscopy Vol I and II by Walker and Straughen 5. Introduction to Molecular spectroscopy by G. M. Barrow 6. Spectra of diatomic molecules by Herzberg 7. Molecular spectroscopy by Jeanne. L. McHale 8. Molecular spectroscopy by J.M. Brown 9. Spectra of atoms and molecules by P. F. Bemath 10. Modern spectroscopy by J.M. Holias

Semester-VIII (OPTION-1) (4 Year UG Hons.)

Name of Program	B.Sc. (Physical Sciences)	**Program Code**	UMPS4
Name of the Course	Solid State Physics	**Course Code**	24PHY202DS04
Hours per Week	04 (1+3)	**Credits**	04
Maximum Marks	Theory: 30 (internal) +70 (external) Total: 100	**Time of Examinations**	03

Note: Examiner will set nine questions of fourteen marks each and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.
Course Learning Outcomes (CLO): CLO1: Differentiate between different lattice types and explain the concept of reciprocal lattice and crystal diffraction using X-rays CLO2: Explain motion of electron in periodic lattice of solids under different binding conditions, concept of energy band and effect of same on electrical properties. CLO3: Lattice vibrations in solids and identity different types of defects in crystals CLO4: Explain various types of magnetic phenomena, superconductivity, Physics behind them and their possible applications.
Unit 1: Crystalline solids, Lattice, The basis, Lattice translation vectors, Direct lattice, Two and three dimensional Bravais lattice, Conventional units cells of FCC, BCC, NaCl, CsCl, Diamond and cubic ZnS, Primitive lattice cell of FCC, BCC and HCP, Packing fraction: Simple Cubic, BCC, FCC, HCP and diamond structures, Interaction of x-rays with matter, Absorption of x-rays, elastic scattering from a perfect lattice, The reciprocal lattice and its application to diffraction techniques, Ewald's construction, The Laue, Powder and rotating crystal methods, Atomic form factor, Crystal structure factor and intensity of diffraction maxima, Crystal structure factors of BCC, FCC, monatomic diamond lattice, polyatomic CuZn.
Unit 2: Vibration of one-dimensional mono and diatomic chains, Phonon momentum, Density of normal modes in one and three dimensions, Quantization of lattice vibrations,

Measurement of phonon dispersion using inelastic neutron scattering, Point defects, Line defects and planer (stacking) faults, Fundamental ideas of the role of dislocation in plastic deformation and crystal growth, Observation of imperfection in crystals, X-rays and electron microscopic techniques.
Unit 3: Electron in periodic lattice, Block theorem, Kronig-Penny model and band theory, Classification of solids, Effective mass, Weak-binding method and its application to linear lattice, Tight-binding method and its application to Simple cubic, BCC and FCC crystals, Concepts of holes, Fermi surface: Construction of Fermi surface in two-dimension, de Hass van Alfen effect, Cyclotron resonance, Magneto-resistance.
Unit 4: Weiss Theory of Ferromagnetism Heisenberg model and molecular field theory of ferromagnetism of spin waves and Magnons, Curie-Weiss law for susceptibility. Ferri and Anti Ferro-magnetic order, Domains and Block wall energy, Occurrence of superconductivity, Meissner effect, Type-I and Type-II superconductors, Heat capacity, Energy gap, Isotope effect, London equation, Coherence length, Postulates of BCS theory of superconductivity, BCS ground state, Persistent current. High temperature oxide super conductors (introduction and discovery).

References:

1. Verma and Srivastava: Crystallography for Solid State Physics
2. Azaroff: Introduction to Solids
3. Omar: Elementary Solid-State Physics
4. Ashcroft & Mermin : Solid State Physics
5. Kittel: Solid State Physics
6. Chaikin and Lubensky: Principles of Condensed Matter Physics
7. H. M. Rosenberg: The solid State.

Semester-VIII (OPTION-I) (4 Year UG Hons.)

Name of Program	B.Sc. (Physical Sciences)	**Program Code**	UMPS4
Name of the Course	Practical: General Physics -II	**Course Code**	24PHY202DS05
Hours per Week	08	**Credits**	04
Maximum Marks	Practical: 100 Total: 100		

Note:

	Marks distribution
Regular assessment through observation and class discussion	20
Lab work (practical file) / field work (report)/Portfolio	30
Assignment/Case study / Mini project (3 X 10)	30
Seminar / Presentation (2 X 7.5)	15
Attendance	05
Total	**100**

Out of the list of experiments given below one experiment will be allotted through lottery

method to each student on the day of examination to perform and then followed by Viva-voce.
Course Learning Outcomes (CLO): CLO1: Students would be able to determine the values of Ionization potential of Hg, Planks and e/m ratio of electron and experimental errors in each case. CLO2: Students would be able determine band gap energy of semiconductor crystals CLO3: Students get familiarized with LEDs CLO4: Students would be able to understand the working of p-n junction solar cells CLO5: Students will be able to measure dielectric constant of ferroelectric solids and their ferroelectric transition temperature. .
List of Experiments 1. Determination of ionization potential of mercury 2. Determination of e/m of electron by helical method 3. To study of dielectric constant as a function of temperature and determine the Curie temperature 4. To determine Planck's Constant (h) by measuring the voltage drop across light-emitting diodes (LEDs) of different colours 5. To determine the value of energy levels using Frank-Hertz experiment 6. Characteristics of Phototransistor 7. To calibrate a prism spectrometer with mercury lamp and hence to find the Cauchy's constants 8. To determine refractive indices of liquids, transparent and translucent solutions and solids using Abbe-refractometer 9. To study the velocity of sound and its variation with temperature using Ultrasonic interferometer. 10. To study the characteristics (illumination, I-V, Power-load, Areal and Spectral characteristics) of a Solar cell 11. To Measure the resistivity of Ge crystal using four probe method at different temperatures and hence find the band gap **Note:** Out of the list as above, a student has to perform atleast 08 (eight) practicals in the semester

Semester-VIII (OPTION-II) (4 Year UG Hons. With Research)

Name of Program	B.Sc. (Physical Sciences)	**Program Code**	UMPS4
Name of the Course	Quantum Mechanics –II	**Course Code**	24PHY202DS02
Hours per Week	04 (1+3)	**Credits**	04
Maximum Marks	Theory: 30 (internal) +70 (external) Total: 100	**Time of Examinations**	03

Note: Examiner will set nine questions of fourteen marks each and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes (CLO):

CLO1: Students would be able to explain ground state of hydrogen and helium molecules.
CLO2: Students get enabled to analyse various transitions and their selection rules.
CLO3: Students would be capable to understand 3D collisions.
CLO4: Students would be capable to calculate spin states of identical particles.

Unit 1: Variational methods: Ground state of Helium by both variational and perturbation methods; The hydrogen molecule; WKB approximation; Time dependent perturbation theory; Constant perturbation; Harmonic perturbation; Fermi's golden rule; Adiabatic and sudden approximation.

Unit 2: Semi-classical theory of radiation: Transition probability for absorption and induced emission; Electric dipole transition and selection rules; Magnetic dipole transitions; Forbidden transitions; Higher order transitions; Einstein's coefficients.

Unit 3: Collision in 3D and scattering: Laboratory and C.M. reference frames; scattering amplitude; Differential scattering cross section and total scattering cross section; The optical theorem; Scattering by spherically symmetric potentials; Partial waves and phase shifts; Scattering by a perfectly rigid sphere and by square well potential; Complex potential and absorption; The Born approximation.

Unit 4: Identical particles: The principle of indistinguishability; Symmetric and antisymmetric wave functions; Spin and statistics of identical particles; The Slater determinant; The Pauli exclusion principle; Spin states of a two-electron system; States of the helium atom; Collision of identical particles.

References:

1. Quantum Mechanics by Ghatak and Loknathan
2. Quantum Mechanics by Powell and Crassman
3. Quantum Mechanics by S. Gasiorowicz
4. Quantum Mechanics by A.P. Messiah
5. Modern Quantum Mechanics by J.J. Sakurai
6. Quantum Mechanics by L.I. Schiff
7. Quantum Mechanics by Mathews and Venkatensan.

Semester-VIII (OPTION-II) (4 Year UG Hons. With Research)

Name of Program	B.Sc. (Physical Sciences)	**Program Code**	UMPS4
Name of the Course	Solid State Physics	**Course Code**	24PHY202DS04
Hours per Week	04 (1+3)	**Credits**	04
Maximum Marks	Theory: 30 (internal) +70 (external) Total: 100	**Time of Examinations**	03

Note:
Examiner will set nine questions of fourteen marks each and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes (CLO):

CLO1: Differentiate between different lattice types and explain the concept of reciprocal lattice and crystal diffraction using X-rays

CLO2: Explain motion of electron in periodic lattice of solids under different binding conditions, concept of energy band and effect of same on electrical properties.

CLO3: Lattice vibrations in solids and identity different types of defects in crystals

CLO4: Explain various types of magnetic phenomena, superconductivity, Physics behind them and their possible applications.

Unit 1: Crystalline solids, Lattice, The basis, Lattice translation vectors, Direct lattice, Two and three dimensional Bravais lattice, Conventional units cells of FCC, BCC, NaCl, CsCl, Diamond and cubic ZnS, Primitive lattice cell of FCC, BCC and HCP, Packing fraction: Simple Cubic, BCC, FCC, HCP and diamond structures, Interaction of x-rays with matter, Absorption of x-rays, elastic scattering from a perfect lattice, The reciprocal lattice and its application to diffraction techniques, Ewald's construction, The Laue, Powder and rotating crystal methods, Atomic form factor, Crystal structure factor and intensity of diffraction maxima, Crystal structure factors of BCC, FCC, monatomic diamond lattice, polyatomic CuZn.

Unit 2: Vibration of one-dimensional mono and diatomic chains, Phonon momentum, Density of normal modes in one and three dimensions, Quantization of lattice vibrations, Measurement of phonon dispersion using inelastic neutron scattering, Point defects, Line defects and planer (stacking) faults, Fundamental ideas of the role of dislocation in plastic deformation and crystal growth, Observation of imperfection in crystals, X-rays and electron microscopic techniques.

Unit 3: Electron in periodic lattice, Block theorem, Kronig-Penny model and band theory, Classification of solids, Effective mass, Weak-binding method and its application to linear lattice, Tight-binding method and its application to Simple cubic, BCC and FCC crystals, Concepts of holes, Fermi surface: Construction of Fermi surface in two-dimension, de Hass van Alfen effect, Cyclotron resonance, Magneto-resistance.

Unit 4: Weiss Theory of Ferromagnetism Heisenberg model and molecular field theory of ferromagnetism of spin waves and Magnons, Curie-Weiss law for susceptibility. Ferri and Anti Ferro-magnetic order, Domains and Block wall energy, Occurrence of superconductivity, Meissner effect, Type-I and Type-II superconductors, Heat capacity, Energy gap, Isotope effect, London equation, Coherence length, Postulates of BCS theory of superconductivity, BCS ground state, Persistent current. High temperature oxide super conductors (introduction and discovery).

References:

1. Verma and Srivastava: Crystallography for Solid State Physics

2. Azaroff: Introduction to Solids
3. Omar: Elementary Solid-State Physics
4. Ashcroft & Mermin: Solid State Physics
5. Kittel: Solid State Physics
6. Chaikin and Lubensky: Principles of Condensed Matter Physics
7. H. M. Rosenberg: The solid State.

REVISED SYLLABI AND SCHEME OF EXAMINATIONS FOR MINOR COURSES FOR UNDER GRADUATE PROGRAMS B.Sc. PHYSICAL SCIENCES (SINGLE MAJOR / MULTIDISCIPLINARY PROGRAMS)

B.Sc. (Physical Sciences) Physics

(Based on Curriculum and Credit Framework and formative assessment guidelines for UG Programs under NEP 2020)

MAHARSHI DAYANAND UNIVERSITY ROHTAK (HARYANA)

To be applicable on the students w.e.f. session 2024-25 (3rd Semester onwards) and on the students w.e.f. session 2025-26 (1st semester onwards)

Credit structure for minor courses for

Under graduate multidisciplinary programs/ single major program after 2nd semester of multidisciplinary program

Minor Courses (MIC)/ Minor (Vocational) Course MIC(VOC)	**TYPE OF PROGRAM**			**Credits Distribution**			**Total Credits**	**Workload**			**Total Workload**	**Marks**			
	MULTIDISCIPLINARY PROGRAM / SINGLE MAJOR PROGRAM AFTER 2nd SEMESTER OF MULTIDISCIPLINARY PROGRAM	**Nomenclature of Course**	**Course Code**	**L**	**T**	**P**		**L**	**T**	**P**		**Theory**		**Practical**	**Total Marks**
	SEMESTER											**Internal**	**External**		
MIC 1 @ 4 credits	1	Physics in Everyday Life	24PHY401MI01	02	0	02	04	02	0	04	06	15	35	50	100
MIC 2 @ 4 credits	3	Elements of Modern Physics	25PHY403MI01	02	0	02	04	02	0	04	06	15	35	50	100
MIC 3 @ 4 credits	4	Laser Physics & Applications	25PHY404MV01	02	0	02	04	02	0	04	06	15	35	50	100
MIC 4 (VOC) @ 4 credits	5	Nanotechnology	26PHY405MV01	02	0	02	04	02	0	04	06	15	35	50	100
MIC 5 (VOC) @ 4 credits	6	Radiation Safety	26PHY406MV01	03	1	0	04	03	01	0	04	30	70	-	100
MIC 6 (VOC) @ 4 credits	6	Renewable Energy	24PHY402MI01	02	0	02	04	02	0	04	06	15	35	50	100
MIC 7 (VOC) @ 4 credits		-	--	-	-	-	-	-	--	-	-	-	-		-
MIC 8 (VOC) @ 4 credits		-	-	-	--	-	-	-	-	-	--	-	-		-

L: Lecture; T: Tutorial; P: Practical

Note:

1. The Syllabi and Scheme of Examinations (SOE) for Minor (Vocational) Courses for UG Semester 7 and Semester 8 will be same as applicable for Vocational Course in Post Graduate semester 1 and semester 2 respectively.
2. Course coding of Minor courses for Single Major Programs will be applicable for Multidisciplinary Programs/ Multidisciplinary Programs after 2nd semester irrespective of their offering in any semester.
3. The student who selects any Minor Course (MIC) of any discipline in first semester should study the Minor courses (MIC) in the same discipline in the subsequent semesters. However, while exercising the option for choosing Minor Vocational Course MIC (VOC), the student may opt the discipline either related to the discipline of Minor Course or the discipline of Major Course or any other discipline as per his/her choice.

Semester-I

Name of Program	Not to be filled	**Program Code**	Not to be filled
Name of the Course	Physics in Everyday Life	**Course Code**	24PHY401MI01
Hours per Week	06(2+4)	**Credits**	04
Maximum Marks	Theory: 15+35 Practical: 50 Total: 100	**Time of Examinations**	Theory: 03 Practicals: 03

Note:
Examiner will set nine questions of seven marks each and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes (CLO):
CLO1. Understand Newton's laws of motion and the role they play in predicting motion and apply them to solve quantitative problems in mechanics.
CLO2. Understand and apply the wave nature and behaviour of sound and light to solve conceptual and quantitative problems.
CLO3. Explain and apply gas laws, thermal energy, mechanical waves, and pressure through an understanding of the concept of atoms.
CLO4. Understand and apply basic concepts of electricity and apply the knowledge of electricity to simple circuits

Unit 1:
MECHANICS: Every day activities related to Force, weight, work, energy, power and centrifuge; washing machine.

Unit 2:
HEAT: Variation of boiling point with pressure, pressure cooker, cooling by expansion, refrigerator, air conditioner, Bernoulli principle Bunsen burner, aero-plane

Unit 3:
SOUND AND OPTICS: Sound waves, Doppler Effect, power of lens, long sight and short sight, microscope, telescope, binocular camera, video camera.

Unit 4:
ELECTRICAL AND ELECTRONIC APPLIANCES: Working of the tube light and fan, kilowatt hour, fuse and heating elements, microwave oven, electric heater, photoelectric effect

Practicals:
1 To measure the diameter of a small spherical / cylindrical body.
2 To measure the length, width and height of the given rectangular block.
3 To measure the internal diameter and depth of a given beaker/calorimeter and hence

find its volume.

4 Use of screw gauge:(i) to measure diameter of a given wire and (ii) to measure thickness of a given sheet

5 To determine radius of curvature of a given spherical surface by a spherometer.

6 To study the random error in observations.

7 To determine the height of a building using a Sextant.

8 Use of Multi-meter for measuring Resistance, A.C. and D.C. Voltage and Current, checking of electrical fuses.

9 To determine an unknown Low Resistance using Potentiometer.

10 To determine Frequency of A.C. mains using an electromagnet.

11 To determine Frequency of A.C. mains Electrical vibrator.

12 Verification of Inverse square law by photo-cell.

Note: A student has to perform atleast eight (08) experiments from the above list.

References:

1. R. Murugeshan, Allied Physics I & II, S. Chand & Co, New Delhi (2006).
2. D.S. Mathur, Elements of properties of matter and acoustics, S. Chand & Company Ltd., New Delhi (2010).
3. R. Murugeshan, Properties of matter and acoustics, S. Chand & Co, New Delhi (2012)
4. Brijal & Dr. N. Subramanyan and P.S. Hemne, Heat and Thermodynamics, S. Chand & Co, New Delhi, (2004).
5. R. Murugeshan, Electricity, S. Chand & Co, New Delhi (2010).
6. R. Murugeshan and Kiruthiga Sivaprasath, Modern Physics, S. Chand & Co, New Delhi (2016).
7. N. Subramaniyam, Brijlal and M.N. Avadhanulu, A textbook of Optics S. Chand & Co, New Delhi (2012).
8. B.Sc. Practical Physics, C. L. Arora, R Chand & Co. New Delhi.
9. 2. B.Sc. Practical Physics, Harnam Singh and Dr. P.S. Hemne, S Chand & Company Ltd.

Semester-III

Name of Program	Not to be filled	**Program Code**	Not to be filled
Name of the Course	Elements of Modern Physics	**Course Code**	25PHY403MI01
Hours per Week	06(2+4)	**Credits**	04
Maximum Marks	Theory: 15+35 Practical: 50 Total: 100	**Time of Examinations**	Theory: 03 Practicals: 03

Note:

Examiner will set nine questions of seven marks each and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes (CLO):

CLO1: Demonstrate an understanding of fundamental quantum concepts such as Planck's quantum theory, photoelectric effect, and matter waves.

CLO2: Explain the limitations of classical atomic models, Bohr's model of atomic structure, and the wave-particle duality of matter.

CLO3: Understand the principles of quantum mechanics, including the Schrödinger equation and tunneling phenomena, and their relevance to modern technologies like quantum dots.

CLO4: Explain the structure and stability of atomic nuclei, the processes of radioactivity, and the principles of nuclear fission and fusion.

Unit 1: Foundations of Quantum Physics: Planck's quantum hypothesis and the concept of photons. Photoelectric effect: Qualitative explanation and applications. Compton scattering: Basic understanding. De Broglie wavelength and matter waves, Davisson-Germer experiment: Experimental verification of matter waves.

Unit 2: Atomic Structure and Wave-Particle Duality: Limitations of Rutherford's model: Atomic instability and discrete spectra. Bohr's quantization rule and energy levels of hydrogen-like atoms (qualitative only). Wave-particle duality and Heisenberg uncertainty principle: Simple examples and applications. Energy-time uncertainty principle

Unit 3: Basics of Quantum Mechanics: Two-slit interference experiment with photons and particles, Introduction to Schrödinger equation, Physical interpretation of the wave-function and probability concepts. One-dimensional infinitely rigid box: Energy levels and relevance in quantum dots. Tunnelling effect, Step potential (qualitative only) and applications.

Unit 4: Nuclear Physics and Applications: Basic structure of the nucleus: Size, atomic weight, and binding energy. Radioactivity: Stability of nucleus, laws of decay, and half-life. Overview of α decay, β decay (neutrino hypothesis), and γ-ray emission. Introduction to nuclear fission and fusion: Energy generation, mass deficit, and thermonuclear reactions. Applications of nuclear energy: Brief on nuclear reactors and their principles.

Practicals:

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 its intensity variation using Photosensor & compare with incoherent source – Na.
8. Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light
9. To determine the value of e/m by Magnetic focusing
10. To determine the value of e/m by Bar magnet.
11. To setup the Millikan oil drop apparatus and determine the charge of an electron.

Note: A student has to perform at least eight (08) experiments from the above list.
References: 1. Concepts of Modern Physics, Arthur Beiser, 2009, McGraw-Hill 2. Modern Physics, J.R. Taylor, C.D. Zafiratos, M.A. Dubson,2009, PHI Learning 3. Quantum Physics, Berkeley Physics, Vol.4. E.H. Wichman, 2008, Tata McGraw-Hill Co. 4. Modern Physics, R.A. Serway, C.J. Moses, and C.A. Moyer, 2005, Cengage Learning

Semester-IV

Name of Program	Not to be filled	**Program Code**	Not to be filled
Name of the Course	Laser Physics & Applications	**Course Code**	25PHY404MV01
Hours per Week	06 (2+4)	**Credits**	04
Maximum Marks	Theory: 15+35 Practical: 50 Total: 100	**Time of Examinations**	Theory: 03 Hrs Practicals: 03 Hrs

Note: Examiner will set nine questions of seven marks each and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.
Course Learning Outcomes (CLO): After completing this course, the learner will be able to: CLO1: understand the principles, working mechanisms, and applications of Ruby and He-Ne lasers CLO2: perform different experiments using lasers such as size of lycopodium power, wavelength of laser light, diffraction patters CLO3: appreciate the tremendous applications of lasers in medicine and other daily life activities. CLO4: aware of biological aspects of laser safety
Unit 1: Main features of a laser: Directionality, high intensity, high degree of coherence, spatial and temporal coherence, Einstein's coefficients and possibility of amplification, momentum transfer, lifetime of a level, kinetics of optical absorption. Threshold condition for laser emission, Laser pumping, He-Ne laser and RUBY laser (Principle, Construction and Working)
Unit 2: Medical Applications: Operating Regimes of Medical Lasers, Laser Surgery, Removal of Skin Lesions, Ablation of Tumor Precursors and Tumors, Removing Deposits in Vessels, Tissue Cutting, Medical and Surgical Treatment of Eye Diseases, Urology, ENT Surgery, Laser in Dentistry, Dermatology, Aesthetic Surgery

Unit 3:

Bio-photonics and Spectroscopic Diagnostics: Absorption and Fluorescence, Fluorescence Microscopy and Imaging Techniques, Two-Photon Fluorescence and Second Harmonic Imaging Microscopy, Raman Spectroscopy and CARS, Optical Biosensors, Flow Cytometry, Optical Coherence Tomography, Optical Tweezer, Opto-acoustic Imaging

Unit 4:

Lasers in Everyday Life and Consumer Goods: Laser Pointer, Barcode Reader, CD, DVD and Blu-Ray Disc, Laser Printer, Laser Projectors, Optical Communication, Light Detection and Ranging, Airborne Laser Scanning, Doppler Wind Lidar, Biological Aspects of Laser Safety, Interaction of Laser Radiation with Tissue, Eye Hazards, Skin Damage Risks, Maximum Permissible Exposure

Practicals:

1. Use polarizers and wave plates to study linear, circular, and elliptical polarization.
2. Measure the refractive index of transparent materials using the polarization property at Brewster's angle.
3. To measure the laser wavelength using a diffraction grating.
4. To study intensity distribution patterns and measure slit width and spacing in Single-slit.
5. To study interference fringes and measure the laser’s coherence length using He-Ne Laser.
6. To determine He-Ne laser wavelength using a Ruler.
7. To determine the size of Lycopodium Particle using diode laser.
8. To determine the diameter of wire using He-Ne laser.
9. To determine angular spread of He-Ne laser using plane diffraction grating.
10. To study intensity distribution patterns and measure slit width and spacing in Multiple-slit Diffraction.

Note: A student has to perform atleast eight (08) experiments from the above list.

References:

1. Laser and Nonlinear Optics by B.B. Laud (New Age)
2. Lasers: Basics, Advances and Applications by Hans Joachim Eichler and Jürgen Eichler Oliver Lux (Springer Series in Optical Sciences)
3. Principles of Lasers by Orazio Svelto (Springer)
4. Lasers: Fundamentals and Applications by Ajoy Ghatak and K. Thyagarajan (Springer)

Semester-V

Name of Program	Not to be filled	**Program Code**	Not to be filled
Name of the Course	Nanotechnology	**Course Code**	26PHY405MV01
Hours per Week	06 (2+4)	**Credits**	04
Maximum Marks	Theory: 15+35 Practical: 50 Total: 100	**Time of Examinations**	Theory: 03 Hrs Practicals: 03 Hrs

Note:

Examiner will set nine questions of seven marks each and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes (CLO):

After completing this course, the learner will be able to:

CLO1: differentiate between 1D, 2D and 3D nanostructures

CLO2: aware of few synthesis techniques of nanomaterials/ nanostructures

CLO3: get familiarity with few characterization techniques of nanomaterials/ nanostructures

CLO4: understand use of nanostructures for fabrication of LEDs, solar cells and MEMS

Unit 1:

Length scales in physics, Nanostructures: 1D, 2D and 3D nanostructures (nanodots, thin films, nanowires, nanorods), Band structure and density of states of materials at nanoscale, Size Effects in nano systems, Quantum confinement: Applications of Schrodinger equation-Infinite potential well, potential step, potential box, quantum confinement of carriers in 3D, 2D, 1D nanostructures and its consequences.

Unit 2:

Top down and Bottom-up approach, Photolithography. Ball milling, Gas phase condensation, Vacuum deposition, Physical vapor deposition (PVD): Thermal evaporation, E-beam evaporation, Pulsed Laser deposition, Chemical vapor deposition (CVD), Sol-Gel. Electro deposition, MBE growth of quantum dots.

Unit 3:

X-Ray Diffraction, FTIR, UV Visible, Optical Microscopy. Scanning Electron Microscopy, Transmission Electron Microscopy, Atomic Force Microscopy.

Unit 4:

Applications of nanoparticles, quantum dots, nanowires and thin films for photonic devices (LED, solar cells), CNT based transistors. Nanomaterial Devices: Quantum dots heterostructure lasers, optical data storage, Magnetic quantum well; magnetic dots -magnetic data storage, Micro Electromechanical Systems (MEMS), Nano Electromechanical Systems (NEMS).

Practicals:

1. To determine the concentration of Allura Red Dye in different drinks using UV-visible spectroscopy.
2. Verification of Lambert Beer's law and determination of the concentration of an

unknown solution by UV-Vis spectrophotometer.

3. To simulate X-Ray Diffraction Experiment.
4. Determination of particle size and lattice strain using Williamson's Halls Plot from x-ray diffraction data of a Nanomaterial.
5. To record the optical absorption spectrum of semiconducting nanoparticles and hence to estimate the size of nanoparticles using Brus equation.
6. To obtain FTIR data of sample and assignment of different functional group present.
7. Analysis of Scanning electron micrograph of a material using ImageJ software.
8. Analysis of Transmission electron micrograph (Bright and Dark Field images) of a material using ImageJ software.
9. To record the optical absorption data of a solid transparent sample such as glass and to find the optical band gap (E_g) energy from cut-off wavelength and find the optical band gap energy (E_g) using Tauc's relation.

Note: A student has to perform atleast eight (08) experiments from the above list.

References:

1. C.P. Poole, Jr. Frank J. Owens, Introduction to Nanotechnology (Wiley).
2. S.K. Kulkarni, Nanotechnology: Principles & Practices (Capital Publishing Company)
3. K.K. Chattopadhyay and A. N. Banerjee, Introduction to Nanoscience and Technology (PHI)
4. Introduction to Nanoelectronics, V.V. Mitin, V.A. Kochelap and M.A. Stroscio, 2011, Cambridge University Press.
5. Richard Booker, Earl Boysen, Nanotechnology (John Wiley and Sons)
6. Evans, C., Brundle, R., & Wilson. S. (1992). Encyclopaedia of Materials Characterization: Surfaces, Interfaces, Thin Films. Butterworth-Heinemann.
7. Leng, Y. (2013). Materials Characterization: Introduction to Microscopic and Spectroscopic Methods. Wiley-VCH.

Semester-VI

Name of Program	Not to be filled	**Program Code**	Not to be filled
Name of the Course	Radiation Safety	**Course Code**	26PHY406MV01
Hours per Week	04(3+1)	**Credits**	04
Maximum Marks	Theory: 30+70 Total: 100	**Time of Examinations**	Theory: 03

Note:
Examiner will set nine questions of seven marks each and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes (CLO):

CLO1: Understand the foundational concepts of atomic and nuclear physics, including atomic structure, nuclear composition, radioactive decay processes.

CLO2: Analyze the interaction of various types of radiation (alpha, beta, gamma, and neutrons) with matter, charged particle interactions, neutron moderation.

CLO3: Demonstrate knowledge of radiation detection and monitoring devices, including their principles, operations, and applications.

CLO4: Apply radiation safety principles, evaluate biological effects of ionizing radiation, and implement radiation protection measures in compliance with international standards.

Unit 1: Basics of Atomic and Nuclear Physics: Basic concept of atomic structure; X rays characteristic and production, the composition of nucleus and its properties, mass number, isotopes of element, spin, binding energy, stable and unstable isotopes, law of radioactive decay, Mean life and half life, basic concept of alpha, beta and gamma decay, Fusion, fission.

Unit 2: Interaction of Radiation with matter: Types of Radiation: Alpha, Beta, Gamma and Neutron and their sources, sealed and unsealed sources, Interaction of Photons - Photoelectric effect, Compton Scattering, Pair Production, Linear and Mass Attenuation Coefficients, Interaction of Charged Particles: Heavy charged particles - Beth-Bloch Formula, Scaling laws, Mass Stopping Power, Range, Straggling, Channelling and Cherenkov radiation. Beta Particles- Collision and Radiation loss (Bremsstrahlung), Interaction of Neutrons- Collision, slowing down and Moderation.

Unit 3: Radiation detection and monitoring devices: Radiation Quantities and Units: Basic idea of different units of activity, KERMA, exposure, absorbed dose, equivalent dose, effective dose, collective equivalent dose, Annual Limit of Intake (ALI) and derived Air Concentration (DAC). Radiation detection: Basic concept and working principle of gas detectors (Ionization Chambers, Proportional Counter, Multi-Wire Proportional Counters (MWPC) and Gieger Muller Counter), Scintillation Detectors (Inorganic and Organic Scintillators), Solid States Detectors and Neutron Detectors, Thermo luminescent Dosimetry.

Unit 4: Radiation safety management: Biological effects of ionizing radiation, Operational limits and basics of radiation hazards evaluation and control: radiation protection standards, International Commission on Radiological Protection (ICRP) principles, justification, optimization, limitation, introduction of safety and risk management of radiation. Nuclear waste and disposal management. Brief idea about Accelerator driven Sub-critical system

(ADS) for waste management.

References:

1. W.E. Burcham and M. Jobes – Nuclear and Particle Physics – Longman (1995)
2. G. F. Knoll, Radiation detection and measurements
3. Thermoluminescence Dosimetry, Mcknlay, A.F., Bristol, Adam Hilger (Medical Physics Handbook 5)
4. W.J. Meredith and J.B. Massey, "Fundamental Physics of Radiology". John Wright and Sons, UK, 1989.
5. J.R. Greening, "Fundamentals of Radiation Dosimetry", Medical Physics Hand Book Series, No.6, Adam Hilger Ltd., Bristol 1981.
6. Practical Applications of Radioactivity and Nuclear Radiations, G.C. Lowental and P.L. Airey, Cambridge University Press, U.K., 2001
7. A. Martin and S.A. Harbisor, An Introduction to Radiation Protection, John Willey & Sons, Inc. New York, 1981.

Semester-VI

Name of Program	Not to be filled	**Program Code**	Not to be filled
Name of the Course	Renewable Energy	**Course Code**	24PHY402MI01
Hours per Week	06 (2+4)	**Credits**	04
Maximum Marks	Theory: 15+35 Practical: 50 Total: 100	**Time of Examinations**	Theory: 03 Hrs Practicals: 03 Hrs

Note: Examiner will set nine questions of seven marks each and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes (CLO):

CLO1. Understand basic idea about 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

CLO2. About some non-conventional energy sources like wind energy, solar energy, hydro energy etc. Furthermore, they will learn working and basic principle of Fuel cell and Nuclear Fusion Reactor

CLO3. About different types of methods to store energy and energy storage devices

CLO4. Understand importance and need of energy conservation in industry, transport, households, buildings, agriculture, and lighting. Students will learn how to reduce energy wastages in thermal and electrical system utilities.

CLO5. Address environmental aspects of energy production and utilization. Students will learn how energy production causes different types of pollution like air, water, soil, noise etc. Including this they will learn how to control and limit the cause of pollution arising due to the energy production.

Unit 1: 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 2: 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 3: 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 4: 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.

Practicals:

Demonstrations and Experiments:

1. Demonstration of Training modules on Solar energy.
2. Demonstration of Training modules on wind energy.
3. Conversion of vibration to voltage using piezoelectric materials.
4. Conversion of thermal energy into voltage using thermoelectric modules.
5. To study pn junction solar cell and to find its fill factor.
6. To design a model on biogas plant.
7. Installation and demonstration of PV module.
8. Demonstration of Training modules on hydro energy.

Note: A student has to perform atleast six (06) experiments/demonstrations from the above list.

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.

SYLLABI AND SCHEME OF EXAMINATIONS FOR SKILL ENHANCEMENT COURSES FOR UNDER GRADUATE PROGRAMS B.Sc. PHYSICAL SCIENCES (MULTIDISCIPLINARY PROGRAMS)

B.Sc. (Physical Sciences) Physics

(Based on Curriculum and Credit Framework and formative assessment guidelines for UG Programs under NEP 2020)

MAHARSHI DAYANAND UNIVERSITY ROHTAK (HARYANA)

To be applicable on the students w.e.f. session 2024-25 (3rd Semester onwards) and on the students w.e.f. session 2025-26 (1st semester onwards)

Credit structure for skill enhancement courses for

Under graduate single major/multidisciplinary programs/ single major program after 2nd semester of multidisciplinary program

Skill Enhancement Course (SEC)	Nomenclature of Course,	Course Code	Credits Distribution			Total Credits	Workload			Total Workload	Marks
			L	T	P		L	T	P	Contact Hours/ Per Week	Internal
SEMESTER 1											
SEC 1 @ 3 credits	Electrical Circuit & Instrumentation Skills	24PHY401SE01	02	0	01	03	02	0	02	04	75
SEMESTER II											
SEC 2 @ 3 credits	Computational Techniques in Physics	24PHY402SE01	02	0	01	03	02	0	02	04	75
SEMESTER III											
SEC 3 @ 3 credits	Workshop Skills in Physics	25PHY403SE01	02	0	01	03	02	0	02	04	75
SEMESTER VI											
SEC 4 @ 2 credits (offered only in case of Single Major Programme)	-	-	-	-	-	-	-	-	-	-	-
SEMESTER VI1											
SEC 5 @ 4 credits (if offered as an option)	Practical: Electronics - I	24PHY201SE01	0	0	04	04	0	0	08	08	100
SEMESTER VII1											
SEC 6 @ 4 credits (if offered as an option)	Practical: Electronics - II	24PHY202SE01	0	0	04	04	0	0	08	08	100

L: Lecture; T: Tutorial; P: Practical

Semester -I

Name of Program	B.Sc. (Physical Sciences)	**Program Code**	UMPS4
Name of the Course	Electrical Circuit & Instrumentation Skills	**Course Code**	24PHY401SE01
Hours per Week	04(2+2)	**Credits**	03
Components			**Marks Distribution**
Written Test (2×10 = 20)			20
Lab work (Practical File)/Field Work (Report)/ Portfolio			20
Assignments/ Case Study/ Mini Project (2×10 = 20)			20
Seminar/Presentation			10
Attendance			05
Total			75

Course Learning Outcomes (CLO):

After completing this course, the learner will be able to:

CLO1: understand basic physics and applications of CRO

CLO2: understand working and usage of digital multimeter, LCR meter, CRO and ac voltammeter

CLO3: Appreciate and learn importance of specifications of various measuring instruments

CLO4: understand working and operational aspects of Signal Generators

Unit 1:

Basic Electricity Principles: Voltage, Current, Resistance, and Power. Ohm's law. Series, parallel, and series-parallel combinations. AC Electricity and DC Electricity. Familiarization with multimeter, voltmeter and ammeter, Multimeter: Principles of measurement of dc voltage and dc current, ac voltage, ac current and resistance. Specifications of a multimeter and their significance. Electronic Voltmeter: Principles of voltage, measurement (block diagram only). Specifications of an electronic Voltmeter/ Multimeter and their significance. AC milli-voltmeter: Type of AC millivoltmeters: Amplifier- rectifier, and rectifier- amplifier. Block diagram ac milli-voltmeter, specifications and their significance.

Unit 2:

Block diagram of basic CRO. Construction of CRT, Electron gun, electrostatic focusing and acceleration (Explanation only– no mathematical treatment), brief discussion on screen phosphor, visual persistence & chemical composition. Time base operation, synchronization. Front panel controls. Specifications of a CRO and their significance. (6 Lectures) Use of CRO for the measurement of voltage (dc and ac frequency, time period. Special features of dual trace, introduction to digital oscilloscope, probes. Digital storage Oscilloscope: Block diagram and principle of working.

Unit 3:

Digital Instruments: Principle and working of digital meters. Comparison of analog & digital instruments. Characteristics of a digital meter. Working principles of digital voltmeter. (3 Lectures) Digital Multimeter: Block diagram and working of a digital multimeter. Working principle of time interval, frequency and period measurement using universal counter/ frequency counter, time- base stability, accuracy and resolution. Voltmeter. (3 Lectures)

Digital Multimeter: Block diagram and working of a digital multimeter. Working principle of time interval, frequency and period measurement using universal counter/ frequency counter, time- base stability, accuracy and resolution.

Unit 4:

Solid-State Devices: Resistors, inductors and capacitors. 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. Operation of transformers. Electric Motors: Single-phase, three-phase & DC motors. Basic design. Interfacing DC or AC sources to control heaters & motors. Speed & power of ac motor.

Practicals:

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. Measurement of voltage, frequency, time period and phase angle using CRO.
5. Measurement of time period, frequency, average period using universal counter/frequency counter.
6. Measurement of rise, fall and delay times using a CRO.
7. To study characteristics of Zener diode.
8. To find high resistance by substitution method
9. Measurement of R, L and C using a LCR bridge/ universal bridge.
10. To study Diode characteristics (I – V).
11. Designing of regulated power supply of 15Volts.
12. To test a diode and transistor using multi-meter and CRO.
13. Designing of B-H loop tracer

Note: A student has to perform at least eight (08) experiments from the above list.

References:

1. A text book in Electrical Technology - B L Theraja - S Chand and Co.
2. Performance and design of AC machines - M G Say ELBS Edn.
3. Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
4. Logic circuit design, Shimon P. Vingron, 2012, Springer.
5. Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.
6. Electronic Devices and circuits, S. Salivahanan & N. S. Kumar, 3rd Ed., 2012,
7. Tata Mc-Graw Hill
8. Electronic circuits: Handbook of design and applications, U. Tietze, Ch.Schenk, 2008, Springer
9. Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India

Semester -II

Name of Program	B.Sc. (Physical Sciences)	**Program Code**	UMPS4
Name of the Course	Computational Techniques in Physics	**Course Code**	24PHY402SE01
Hours per Week	04(2+2)	**Credits**	03
Components			**Marks Distribution**
Written Test (2×10 = 20)			20
Lab work (Practical File)/Field Work (Report)/ Portfolio			20
Assignments/ Case Study/ Mini Project (2×10 = 20)			20
Seminar/Presentation			10
Attendance			05
Total			75

Course Learning Outcomes (CLO):

After completing this course, the learner will be able to:

CLO1: Understand the programming language and their use in various applications

CLO2: Solve difficult integrals using numerical methods

CLO3: Fit experimental data to different types of curves and interpolate the data

CLO4: Students would be able to design Fortran/Python programs to solve numerical computationally

Unit 1:

Introduction to Programming using Python: Structure of a Python Program, Functions, Interpreter shell, Indentation. Identifiers and keywords, Literals, Strings, Basic operators (Arithmetic operator, Relational operator, Logical or Boolean operator, Assignment Operator, Bit wise operator). Standard libraries in Python, notion of class, object and method.

Unit 2:

Creating Python Programs: Identifiers and keywords; Literals, numbers, and strings; Operators; Expressions; Input/output statements; Defining Functions; Control structures (conditional statements, loop control statements, break, continue and pass, exit function), default arguments. Mutable and immutable objects. Testing and debugging a program

Unit 3:

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; Flow charts; Truncation errors, Round off errors; Propagation of errors. Block IF statement; Do statement; Character DATA management; Arrays and subscripted variables

Unit 4:

Numerical differentiation (Forward and Backward difference formula) and Integration (Trapezoidal and Simpson rules), Curve Fitting: Principle of least square; Linear regression; Polynomial regression; Exponential and Geometric regression, Interpolation: Finite differences; Interpolation with equally spaced points; Gregory - Newton's Interpolation formula for forward and backward interpolation; Solution of ODE First order differential equation using Euler, modified Euler and Runge- Kutta second order methods Second order differential equation e.g. First order differential equation, Radioactive decay, Current in RC and LC circuits with DC source

Practicals:

1. To find the area of a triangle, sphere and cylinder.
2. A program that takes a number as an input from the user and computes its factorial.
3. Calculate the sum and product of two compatible matrices.
4. Numerical Integration using trapezoidal and Simpson1/3 rules.
5. Motion of Projectile thrown at an angle.
6. Charging and discharging of Capacitor.
7. Solution of LR and LCR circuits.
8. Least square fitting for linear regression.
9. Numerical solution of ordinary differential equation.
10. Solution of Quadratic equation.

A student has to perform at least eight (08) programs using Python/Fortran from the above list.

References:

1. E. Balagurusamy, Introduction to Computing and Problem-Solving using Python, 2nd edition, McGraw Hill Education, 2018.
2. R C Desai, Fortran Programming and Numerical methods, Tata McGraw Hill, New Delhi.
3. Suresh Chandra, Computer Applications in Physics, Narosa Publishing House.
4. M L De Jong, Introduction to Computation Physics, Addison-Wesley publishing company.
5. R C Verma, P K Ahluwalia and K C Sharma, Computational Physics an Introduction, New Age International Publisher.
6. S S Sastry Introductory methods of numerical Analysis, Prentice Hall of India Pvt. Ltd.
7. V Rajaraman, Computer Oriented Numerical Method, Prentice Hall of India Pvt. Ltd.
8. Computer Programming in FORTRAN 77”. V. Rajaraman (Publisher: PHI).
9. Schaum’s Outline of Theory and Problems of Programming with Fortran, S Lipsdutz and A Poe, 1986Mc-Graw Hill Book Co.

Semester -III

Name of Program	B.Sc. (Physical Sciences)	**Program Code**	UMPS4
Name of the Course	Workshop Skills in Physics	**Course Code**	25PHY403SE01
Hours per Week	04(2+2)	**Credits**	03
Components			**Marks Distribution**
Written Test (2×10 = 20)			20
Lab work (Practical File)/Field Work (Report)/ Portfolio			20
Assignments/ Case Study/ Mini Project (2×10 = 20)			20
Seminar/Presentation			10
Attendance			05
Total			75

Course Learning Outcomes (CLO):

After completing this course, the learner will be able to:

CLO1: Develop skills to measure dimensions, volume, and distances using basic instruments and units.

CLO2: Analyze and build electrical circuits using multimeters, soldering, and network theorems.

CLO3: Understand the working of power supplies and apply voltage regulation and ripple reduction techniques.

CLO4: Operate and utilize a Cathode Ray Oscilloscope (C.R.O.) for measurements and circuit troubleshooting.

Unit 1: Introduction: Measuring units. conversion to SI and CGS. Familiarization with meter scale, Vernier calliper, Screw gauge and their utility. Measure the dimension of a solid block, volume of cylindrical beaker/glass, diameter of a thin wire, thickness of metal sheet, etc. Use of Sextant to measure height of buildings, mountains, etc.

Unit 2: Electrical and Electronic Skill: Use of Multimeter. Soldering of electrical circuits having discrete components (R, L, C, diode) and ICs on PCB. Network theorems: Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum Power Transfer Theorem

Unit 3: Power Supplies: Basics of Power Supplies, AC Power Supplies: Characteristics, use in basic circuits. DC Power Supplies: Fixed voltage vs. variable voltage supplies. Components of power supplies: Transformers, rectifiers (half-wave, full-wave), filters, and regulators. Voltage Regulation and Ripple Reduction, Concepts of regulation, ripple, and stability. Use of capacitors, Zener diodes, and IC voltage regulators (e.g., LM317).

Unit 4: Cathode Ray Oscilloscope (C.R.O.): Introduction to C.R.O., Basic structure and working of a C.R.O. Electron gun, deflection system, and phosphor screen. Block diagram and function of each component. Operating a C.R.O. Adjusting controls: Time base, volts/div, focus, intensity, and trigger. Connecting probes and setting ground reference. Applications of C.R.O. Measurement of voltage, frequency, and phase difference. Observation of waveforms: Sine, square, and triangular waves. Troubleshooting electrical circuits.

Practicals:

A student has to perform at least eight (08) programs from the above list.

1. Measurement of thickness of a wire using screw gauge.

2. Measurement of length (or diameter) using Vernier Caliper travelling microscope
3. To determine height of an object using sextant
4. To determine the area of window using a sextant.
5. To learn the use of multimeter.
6. To learn the use of soldering various components on PCB
7. To design a regulated power supply.
8. Determine the waveform of a given oscillator using a cathode ray oscilloscope.
9. Demonstrate the action of a junction diode as: (a) Half-wave rectifier (b) Full-wave rectifier using a cathode ray oscilloscope.
10. Measure the A.C. voltage using a cathode ray oscilloscope and calculate the deflection sensitivity in mm per RMS volt.
11. Measure D.C. voltage using a cathode ray oscilloscope.
12. Demonstrate the phase difference in a circuit due to resistance, inductance, and capacitance, and measure their values using a cathode ray oscilloscope.
13. Measure the phase difference between current and voltage in (a) A C-R circuit (b) An L-R A.C. circuit using a cathode ray oscilloscope.
14. Compare the frequencies of oscillations produced by two audio oscillators using Lissajous figures.
15. Determine the frequency of an electrically maintained tuning fork using a cathode ray oscilloscope.

References:

1. A text book in Electrical Technology - B L Theraja – S. Chand Publishing.
2. Electronic Instrumentation and Measurements by David A. Bell
3. Basic Electronics: Solid State, By BL Theraja, S. Chand Publishing.
4. Electronic Measurements and Instrumentation, by K. Lal Kishore, Pearson India
5. B.Sc. Practical Physics – By, CL Arora, S. Chand Publishing.

Semester - VII

Name of Program	B.Sc. (Physical Sciences)	**Program Code**	UMPS4
Name of the Course	Practical: Electronics-I	**Course Code**	24PHY201SE01
Hours per Week	08	**Credits**	04

Components	**Marks Distribution**
Regular assessment through observation and Class discussion	15
Lab work (Practical File)/Field Work (Report)/ Portfolio	30
Case Study/ Mini Project/ (2×15 = 30)	30
Assignment/Seminar/Presentation (2×10 = 20)	20
Attendance	05
Total	100

Course Learning Outcomes (CLO):

CLO1: The students would get hands on experience on experiments and relation to theory

CLO2: Theoretical results for different networks matched with experiments would enable students for complex circuits

CLO3: The students would get equipped for applications based on solid state devices

CLO4: The students would be able to differentiate between analog and digital electronics.

List of Experiments

1. Design/study of a Regulated Power Supply.
2. To study the frequency response of a single state negative feedback amplification for various feedback circuit. Negative Feedback (voltage series/shunt and current series/shunt)
3. To study rectifier and filter circuits and draw wave shapes.
4. Study of Network theorems.
5. To study the frequency variation in RC phase shift, Colpitts and Hartley Oscillators.
6. Frequency response of RC coupled Amplifier.
7. To study the characteristics of a junction transition and determination of FET parameters.
8. FET and MOSFET characterization and application as an amplifier.
9. Uni-junction Transistor and its application.
10. Bridge Rectifier using SCR with DC and AC Gate
11. Characteristics and applications of Silicon Controller Rectifier.

Note: Out of the list as above, a student has to perform atleast 08 (eight) practicals in the semester

Semester - VIII

Name of Program	B.Sc. (Physical Sciences)	**Program Code**	UMPS4
Name of the Course	Practical: Electronics-II	**Course Code**	24PHY202SE01
Hours per Week	08	**Credits**	04
Components			**Marks Distribution**
Regular assessment through observation and Class discussion			15
Lab work (Practical File)/Field Work (Report)/ Portfolio			30
Case Study/ Mini Project/ (2×15 = 30)			30
Assignment/Seminar/Presentation (2×10 = 20)			20
Attendance			05
Total			100

Course Learning Outcomes (CLO):

CLO1: Students will be able to design circuits and verify truth table of different logic gates, flip flops, adders and Subtractor

CLO2: Students will be able to design integrating and differentiating circuits using passive components

CLO3: Students will be able to practically verify the frequency response of single and multistage amplifiers

CLO4: Measurement of various analog circuits and comparison of experimental results with Theoretical analysis enables the student for problem solving.

List of Experiments

1. Digital I: Basic Logic Gates, NAND and NOR and Flip flops
2. Astable, Monostable and Bistable Multivibraters.
3. Study of Emitter follower/Darlington Pair Amplifier model-C024.
4. To study the characteristics and frequency response of a push- pull amplifier.
5. To study the characteristics and frequency response of a Chopper Amplifier.
6. Wein Bridge and Phase shift oscillator.
7. To study analog voltage comparator circuit.
8. To study the frequency response of a two stages Transformer coupled amplifier
9. To study the frequency response of a two stages Choke coupled amplifier.
10. To study the Integrating & Differentiating Circuits.
11. To study the Working of Half & Full Adders.
12. To study the working of Half & Full Subtractor.
13. To design a Common Emitter Transistor Amplifier.
14. To study the Transistor Biasing and Stability.

Note: Out of the list as above, a student has to perform atleast 08 (eight) practicals in the semester

REVISED SYLLABI AND SCHEME OF EXAMINATIONS FOR MULTIDISCIPLINARY COURSES FOR UNDER GRADUATE PROGRAMS (SINGLE MAJOR / MULTIDISCIPLINARY PROGRAMS)

B.Sc. (Physical Sciences) Physics

(Based on Curriculum and Credit Framework and formative assessment guidelines for UG Programs under NEP 2020)

MAHARSHI DAYANAND UNIVERSITY ROHTAK (HARYANA)

To be applicable on the students w.e.f. session 2024-25 (3rd Semester onwards) and on the students w.e.f. session 2025-26 (1st semester onwards)

Credit structure for multidisciplinary courses for

Under graduate single major/multidisciplinary programs/ single major program after 2nd semester of multidisciplinary program

Name of the Department	Nomenclature of Multidisciplinary Course (MDC) @ 3 credits	Course Code	Credits Distribution			Total Credits	Workload			Total Workload	Marks
			L	T	P		L	T	P	Contact Hours /Per Week	Internal
Physics	Physics Fundamentals-I	24PHYX01MD01	02	0	01	03	02	0	02	04	75
Physics	Physics Fundamentals – II	24PHYX02MD01	02	0	01	03	02	0	02	04	75
Physics	Physics Fundamentals – III OR Installation and Maintenance of Solar Panels	25PHYX03MD01 OR 25PHYX03MD02	02	0	01	03	02	0	02	04	75

L: Lecture; T: Tutorial; P: Practical

Note:

A student has to opt for three Multidisciplinary Courses in first three semesters from the pool of the courses offered in the disciplines other than those of Major disciplines and Minor disciplines and the one not studied at 10+2 or equivalent level.

Semester-I

Name of Program	Not to be filled	**Program Code**	Not be filled
Name of the Course	Physics Fundamentals – I	**Course Code**	24PHYX01MD01
Hours per Week	04(2+2)	**Credits**	03
Components			**Marks Distribution**
Written Test (2×10 = 20)			20
Lab work (Practical File)/Field Work (Report)/Portfolio			20
Assignments/ Case Study/ Mini Project (2×10 = 20)			20
Seminar/Presentation			10
Attendance			05
Total			75

Course Learning Outcomes (CLO):

After completing this course, the learner will be able to

CLO1: Apply the concept of force and its role in describing interactions between objects and motion and gravity

CLO2: Use principles of energy conservation, work, and power in daily life events

CLO3: derive relations connecting physical quantities and check the correctness of physical relation

CLO4: Understand motion, velocity, acceleration, and their mathematical representations

Unit 1:

Physics-Nature, scope & excitement, Major discoveries in physics, major contribution by Indian Physicists, Fundamental physical constants, Physics in relation to other sciences, impact of physics on society and on latest development in science & technology. System of Measuring Units-Need for measurement, measuring process, concept of mass, length, time; Fundamental and derive units, system of units, concepts of error, types of error (only definition), Accuracy and precision in measurement, least count and applications of measuring instruments -Vernier calliper, Screw Gauge.

Unit 2:

Motion of objects in one dimension- position of the object, origin/reference point, frame of reference, definitions and examples of motion in one, two and three dimension, Scalar and Vector quantities, description of motion along a straight line- distance and displacement, uniform motion and non-uniform motion, average and instantaneous speed, average and instantaneous velocity, acceleration; graphical analysis of straight line motion- distance- time graph, velocity-time graph, equation of motions and their applications.

Unit 3:

Causes of motion- concept of force, I^{st} law of motion, inertia and mass; Newton's 2nd law of motion, momentum and force; Newton's 3rd law of motion, daily life applications of Newton's laws of motion. Universal law of gravitation and its importance, acceleration due to gravity and free fall of a body; mass and weight of an object on earth and moon, concept of thrust and pressure and importance in daily life, buoyancy and Archimedes principle-the physics behind floating of objects on water.

Unit 4:

Work, energy, types of energy-Kinetic energy and Potential energy, P.E. of an object at a height; law of conservation of energy and its applications. Conservation of linear and angular momentum, collision (elastic and inelastic) and conservation laws in collisions- importance in daily life; concepts of centre of mass-Physics behind cycling, rock climbing and skating.

Practicals:

1. To measure the diameter of a small spherical / cylindrical body.
2. To measure the length, width and height of the given rectangular block.
3. To measure the internal diameter and depth of a given beaker/calorimeter and hence find its volume.
4. Use of screw gauge:(i) to measure diameter of a given wire and (ii) to measure thickness of a given sheet
5. To determine radius of curvature of a given spherical surface by a spherometer.
6. To find the downward force, along an inclined plane, acting on a roller due to gravitational pull of the earth and study its relationship with the angle of inclination by plotting graph between force and $\sin\theta$.
7. To find the weight of a given body using parallelogram law of vectors.
8. Verification of Archimedes principle.
9. Verification of Work-energy theorem.
10. Acceleration due to gravity (g) by bar pendulum.
11. To determine the moment of Inertia of a fly-wheel.
12. Study of law of conservation of linear momentum and Kinetic Energy.

Note: A student has to perform **at least eight (08)** experiments from the above list.

References:

1. Essential University Physics, Vol.-1 &2 by Richard Wolfson, Pearson Education, Patparganj, Delhi, India.
2. Concept of Physics by H.C. Verma, Bharti Bhawan, Ansari Road, Daryaganj, New Delhi, India.
3. Modern Physics (2nd edition), by S.L. Kakani and Shubhra Kakani, Viva Books, New Delhi.
4. Physics for Scientists and Engineers with Modern Physics, 7th edition, by Raymond A. Serway and John W. Jewett, Jr., Thomson Higher Education 10 Davis Drive Belmont, CA 94002-3098 USA.
5. Physics for You, Fifth Edition, by Keith Johnson, OUP Oxford; 5th edition (23 June 2016).
6. B.Sc. Practical Physics, C. L. Arora, R Chand & Co. New Delhi
7. B.Sc. Practical Physics, Harnam Singh and Dr. P.S. Hemne, S Chand & Company Ltd.

Semester-II

Name of Program	Not to be filled	**Program Code**	Not be filled
Name of the Course	Physics Fundamentals – II	**Course Code**	24PHYX02MD01
Hours per Week	04(2+2)	**Credits**	03
Components			**Marks Distribution**
Written Test (2×10 = 20)			20
Lab work (Practical File)/Field Work (Report)/Portfolio			20
Assignments/ Case Study/ Mini Project (2×10 = 20)			20
Seminar/Presentation			10
Attendance			05
Total			75

Unit 1:

Light and optics-Nature and properties of light, its speed, frequency and wavelength; Reflection of light-types of reflection and their importance in daily life, laws of reflection, multiple reflection by mirrors and their applications. Refraction of light- laws of refraction, refractive index, refraction of light through prism (dispersion of light), formation Rainbow, twinkling of stars, advance Sunrise and delayed Sunset; Scattering of light and blue colour of the sky; apparent depth, total internal reflection and its important applications.

Unit 2:

Image formation through reflection-images formed by plane mirrors, multiple images formed by two flat mirrors and optical illusions; images formed by parabolic mirrors and spherical mirrors- concave and convex mirrors, ray diagrams, mirror equation and magnification; applications of plane and curved mirrors in daily life. Image formation through refraction-images by convex and concave lenses, ray diagrams and lens equation. Optical instruments-Camera, eye, telescope and microscope.

Unit 3:

Electricity- electric charge, types of charges, unit of charge, frictional electricity, electricity by conduction and electric current, units of electric current, measurement of current, conductors and insulators; resistance, resistivity and law, electric potential and potential difference, emf; Electric circuit- resistor, capacitor, battery, ammeter and voltmeter; Series and parallel combinations of resistors.

Unit 4:

Electrical wiring in houses and electrical safety (fuse, hot wire, neutral, ground and short circuit), electric power and electric power transmission; Heating effect of current and its practical applications. Magnetic effect of electric current- Magnetic field and field lines, bar magnet, magnetic field and direction of field due to a current- through straight conductor and through a circular loop; solenoid, electromagnet.

Practicals:

1 To find the focal length of a convex mirror using a convex lens.
2 To find the value of v for different values of u in the case of a concave mirror and to find the focal length
3 To find the focal length of a concave lens using a convex lens.
4 To determine the refractive index of a glass slab.

5. To find the refractive index of a liquid using a convex lens and plane mirror
6. To determine the resistivity of different wires by plotting a graph for potential difference versus current.
7. To verify law for metallic conductor and to determine its resistance.
8. To find the frequency of AC mains with a sonometer.
9. Use of Multimeter for measuring Resistance, A.C. and D.C. Voltage and Current, checking of electrical fuses.
10. Use of Multimeter to check the working condition of diode, an LED, a resistor and a capacitor.

Note: A student has to perform atleast eight (08) experiments from the above list.

References:

1. Concept of Physics by H.C Verma (Part – I & II)
2. Essential University Physics, Vol-I & II by Richard Wolfson
3. Physics by Resnick, Halliday &Walker

Semester-III

Name of Program	Not to be filled	**Program Code**	Not be filled
Name of the Course	Physics Fundamentals – III	**Course Code**	25PHYX03MD01
Hours per Week	04(2+2)	**Credits**	03

Components	**Marks Distribution**
Written Test (2×10 = 20)	20
Lab work (Practical File)/Field Work (Report)/Portfolio	20
Assignments/ Case Study/ Mini Project (2×10 = 20)	20
Seminar/Presentation	10
Attendance	05
Total	75

Course Learning Outcomes (CLO):

After completing this course, the learner will be able to:

CLO1: develop a deep understanding of key principles, including Coulomb's law, electric and magnetic fields, Gauss's law, Ampere's law,

CLO2: solve problems related to electric and magnetic field calculations, potential, capacitance, and diode characteristics

CLO3: explore current-voltage (I-V) characteristics of a p-n junction diode in forward and reverse bias and rectifier circuit

CLO4: Analyse the behavior of charges in static electric and magnetic fields through

Unit 1:

Electric charge: Properties of charge, comparison of charge and mass, conservation of charge, Quantization of charge, Coulomb's law, Coulomb's law in vector form, Force on a point charge due to multiple charges, Electric field intensity, Electric field due to an isolated point charge, uniformly charged long thin wire and charged ring, Electric dipole and dipole moment. Electric intensity on axial line and equatorial line of an electric dipole, Electric field lines, Electric flux, Gauss's law, Derivation of Coulomb's law from Gauss's law. Capacitance, Capacitance of an isolated spherical conductor, Capacitor and its principle, Capacitance of a parallel plate capacitor, Combination of the capacitor, energy stored in a charged capacitor

Unit 2:

Electric current, Charge carriers in different materials, Ohm's law, resistivity and conductivity. Resistors, types of resistors, Classification of materials based on resistivity, temperature dependence of resistivity, Superconductivity, Combination of resistors, Cell and Battery, the electromotive force of a cell, the internal resistance of a cell, Grouping of cells. Measurement of electric current, Kirchoff's rules, electric energy, electric power, Joules's law of heating, electrical power transmission, electric fuse

Unit 3:

Magnetic field due to current, motion of a charged particle in a magnetic field, Lorentz force, cyclotron, force on a current carrying conductor in a magnetic field, Torque on a rectangular current loop in a uniform magnetic field, Biot-Savart law and its applications, Ampere's circuital law and its applications, Coulomb's law of force between two magnetic poles, Magnetic field lines and magnetic flux, Gauss's law in magnetism, Magnetic dipole and dipole moment, Magnetic field at a point an axial line and equatorial line of a bar magnet, Torque on a bar magnetic in uniform magnetic field. Time period of vibration of a freely suspended magnet in a uniform magnetic field, The earth magnetism, Classification of magnetic materials, Hysteresis, Permanent magnets and electromagnets.

Unit 4:

Dual nature of radiation, Photoelectric effect, Hertz and Lenard's observations; Einstein's photoelectric equation-particle nature of light, Experimental study of photoelectric effect, Matter waves-wave nature of particles, de-Broglie relation, Alpha-particle scattering experiment; Rutherford's model of atom; Bohr model of hydrogen atom, Expression for radius of nth possible orbit, velocity and energy of electron in nth orbit, Energy bands in conductors, semiconductors and insulators (qualitative ideas only) Intrinsic and extrinsic semiconductors- p and n type, p-n junction, Semiconductor diode - I-V characteristics in forward and reverse bias, application of junction diode -diode as a rectifier

Practicals:

1. To study the variation in potential drop with the length of a wire for a steady current.
2. To determine the resistivity of two/three wires by plotting a graph for potential difference versus current.
3. To study the earth's magnetic field using a compass needle-bar magnet by plotting magnetic field lines and tangent galvanometer
4. To measure resistance, voltage (AC/DC), and current (AC) and check the continuity of a given circuit using a multi-meter.
5. To study various factors on which the internal resistance/EMF of a cell depends.
6. To determine the internal resistance of a given primary cell using potentiometer.
7. To draw the I-V characteristic curve of a p-n junction in forward bias and reverse bias.
8. To draw the characteristic curve of a Zener diode and to determine its reverse breakdown voltage.
9. To identify a diode, an LED, a transistor, an IC, a resistor and a capacitor from a mixed collection of such items

Note: A student has to perform atleast eight (08) experiments from the above list.

References:

1. Concept of Physics by H.C Verma (Part – I & II)
2. Essential University Physics, Vol-I & II by Richard Wolfson
3. Physics by Resnick, Halliday &Walker

OR

Semester-III

Name of Program	Not to be filled	**Program Code**	Not to be filled
Name of the Course	Installation and Maintenance of Solar Panels	**Course Code**	25PHYX03MD02
Hours per Week	04(2+2)	**Credits**	03
Components			**Marks Distribution**
Written Test (2×10 = 20)			20
Lab work (Practical File)/Field Work (Report)/Portfolio			20
Assignments/ Case Study/ Mini Project (2×10 = 20)			20
Seminar/Presentation			10
Attendance			05
Total			75

Course Learning Outcomes (CLO):

After completing this course, learners will be able to:

CLO1: Explain the principles of solar energy and the need for solar energy to electrical energy conversion.

CLO2: Identify the components of SPV systems.

CLO3: Understand the procedure for installing SPV systems.

CLO4: Perform testing and inspection of SPV systems.

CLO5: Develop and implement maintenance schedules.

Unit 1: Introduction to solar energy and solar panels: Solar Energy and its potential, harnessing solar energy, need for Solar energy to electrical energy conversion, Solar photo voltaic (SPV) system, SPV panels and their types, ratings and specifications. Advantages and disadvantages of SPV panels, basics of load calculation and SPV requirement.

Unit 2: SPV Panels systems and their Installation: Solar panel to SPV systems: OFF grid and ON grid solar systems, Areas of applications of SPV systems, components of solar systems; solar panel, inverter (Stand alone and grid tied) , Battery Energy system (BES), Charge controller, Tools and equipments : Digital Multimeter, Clamp Meter, Hydrometer, Sun pathfinder, Thermography Camera , drills and fasteners, sealents, pliers and strippers, Pyranometer, Personal Protective Equipments (PPE), Battery maintenance kit Battery water filler etc. Installation: Site selection criteria, steps and procedure for solar panel array installation, different mounting structures, installation of AC and DC distribution boxes, earthing and grounding pits, optimal cable sizing and cable laying.

Unit 3: Testing and Inspection: Testing methods and techniques, testing of SPV open circuit and load voltage, Battery SOC testing, testing of protective systems and earth resistance, Inspection of connected systems and running a test.

Unit 4: Maintenance and Troubleshooting: Scheduled and unscheduled maintenance, checking dust accumulation, Module Shading Module Mismatch, Physical Integrity, standard trouble shooting procedure.

Practicals:

1. Measure the open-circuit voltage (V_{oc}) and short-circuit current (I_{sc}) of a solar panel under sunlight using multimeter.

2. Analyze how the tilt angle of a solar panel affects voltage and current output using multimeter.
3. Study the effect of partial shading on solar panel output on V_{oc} and I_{sc}.
4. To draw forward and reverse bias characteristics of a semiconductor diode.
5. Plot the current-voltage (I-V) curve of a PV cell under sunlight using variable resistors.
6. Compare the voltage and current output of PV cells connected in series and parallel.
7. To determine energy conversion efficiency of a PV cell using lux meter.
8. Investigate how reflectors / mirrors can increase the output of a PV cell.
9. Examine how different light colours affect the output of a PV cell using colour filters.
10. Examine the impact of dust on panel performance and the improvement after cleaning.

Note: A student has to perform **atleast eight (08)** experiments from the above list.

Recommended Books / resources:

1. Solar Photovoltaic technology PHI 2013, Chetan Singh Solanki.
2. Solar Electrical Handbook 2021, Michael Boxwell.
3. Handbook for rooftop solar panel installation in Asia, 2014 Asian Development Bank (ADB).