Deccan Education Society's
FERGUSSON COLLEGE (AUTONOMOUS), PUNE

Syllabus
for

T. Y. B. Sc. (Physics)

[NEP 1.0]
(B.Sc. Semester-V and VI)

With Effect From
2025-2026

Deccan Education Society's

Fergusson College (Autonomous), Pune-4

Department of PHYSICS

Syllabi NEP 1.0 Implemented from Academic Year 2025-26

T. Y. B. Sc. Semester: V/VI

Program Outcomes (POs) for B.Sc.	
PO1	**Disciplinary Knowledge:** Demonstrate comprehensive knowledge of the disciplines that form a part of a graduate programme. Execute strong theoretical and practical understanding generated from the specific graduate programme in the area of work.
PO2	**Critical Thinking and Problem solving:** Exhibit the skills of analysis, inference, interpretation and problem-solving by observing the situation closely and design the solutions.
PO3	**Social competence:** Display the understanding, behavioural skills needed for successful social adaptation, work in groups, exhibits thoughts and ideas effectively in writing and orally.
PO4	**Research-related skills and Scientific temper:** Develop working knowledge and applications of instrumentation and laboratory techniques. Able to apply skills to design and conduct independent experiments, interpret, establish hypothesis and inquisitiveness towards research.
PO5	**Trans-disciplinary knowledge:** Integrate different disciplines to uplift the domains of cognitive abilities and transcend beyond discipline-specific approaches to address a common problem.
PO6	**Personal and professional competence:** Performing dependently and also collaboratively as a part of team to meet defined objectives and carry out work across interdisciplinary fields. Execute interpersonal relationships, self-motivation and adaptability skills and commit to professional ethics.
PO7	**Effective Citizenship and Ethics:** Demonstrate empathetic social concern and equity centred national development, and ability to act with an informed awareness of moral and ethical issues and commit to professional ethics and responsibility.
PO8	**Environment and Sustainability:** Understand the impact of scientific solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.
PO9	**Self-directed and Life-long learning:** Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

Program Specific Outcomes (PSOs)

PSO No.	Program Specific Outcomes (PSOs) Upon completion of this programme the student will be able to
PSO1	**Academic competence:** 1. **Develop** and **demonstrate** an understanding of the concepts related to heat, thermodynamic laws, electric field due to static charge distribution, Newtonian mechanics, wave properties of light, Newtonian mechanics, inertial and non- inertial frames of reference, radioactivity, elementary particles, quark model, physical systems from nano-scale to macroscopic scale, magnetostatics, Maxwell's equations and plane wave generation and quantum mechanical systems. Associate the fundamental concepts in physics and interpret information. 2. **Demonstrate independent** thinking and scientific temper. **Categorize**, calculate and **solve** problems using concepts of physics.
PSO2	**Personal and Professional Competence:** 1. Carry out laboratory-oriented numerical calculations and be capable in data visualization and interpretation. Perform, demonstrate and analyse experimental work with suitable techniques in physics to study the phenomena related to light, scientific instruments, material processes, electrical and electronics applications. 2. Carry out the calculations in classical mechanics, quantum mechanics, mathematical methods and solids with advanced techniques using computations and C-programming. 3. Analyse experimental results and interpret graphs. 4. Formulation of ideas, scientific writing and authentic reporting, effective presentation and communication skills through group discussion.
PSO3	**Research Competence:** 1. Apply Physics concepts of thermodynamics, mechanics, wave optics, electronics and nuclear physics in day to day life. Integrate core concepts studied in materials science, electronics, and optics during experimentations and projects. 2. Integrate and explore techniques of synthesis, characterization of different materials and techniques of astronomical data analysis. Cultivate concepts of measurement techniques in physics and relate physics concepts in day to day life. 3. Integrate core physics subjects during experimentation and projects. 4. Apply numerical methods to solve various complex physical problems. 5. Identify and interpret research literature, formulate ideas, write reports and review articles related to all subjects in Physics.
PSO4	**Entrepreneurial and Social competence:** Enhance and empower the students with their self-reliance capabilities through the understanding of advance techniques, use of programming language, material processing, mathematical and classical concepts, advancement of electronics ideas with reference to advance techniques with their industrial applications. 1. Employ experimental skills in industrial applications. 2. Develop scientific temperament and social awareness through internships and science popularization. Awareness of ethical issues: emphasis on academic and research ethics. 3. Outline the use of renewable sources for sustainable development of human beings. 4. Execute social competence including effective use of computer languages to meet global competencies in technological world.

T. Y. B. Sc. NEP 1.0						
Semester	Paper	Paper Code	Title	Type	Credits	Exam Type
V	Major	PHY-301	Mathematical Methods in Physics	Theory	2	CE+ESE
		PHY-302	Classical Mechanics	Theory	2	CE+ESE
		PHY-303	Quantum Mechanics	Theory	2	CE+ESE
	Elective	PHY-304	Atomic and Molecular Physics	Theory	2	CE+ESE
			OR			
		PHY-305	Radiation Physics	Theory	2	CE+ESE
	Elective	PHY-306	LASERS	Theory	2	CE+ESE
			OR			
		PHY-307	Numerical Analysis	Theory	2	CE+ESE
			OR			
		PHY-308	Elements of Materials Science	Theory	2	CE+ESE
	Major	PHY-311	Physics Practical - 5	Practical	2	CE+ESE
		PHY-312	Physics Practical - 6	Practical	2	CE+ESE
	VSC	PHY-331	Analog Electronics	Theory	2	CE
		PHY-332	Physics Practical - 7	Practical	2	CE
	Minor	PHY-321	Materials Science	Theory	2	CE+ESE
	FP	PHY-345	Field Project	Theory / Practical	2	CE
VI	Major	PHY-351	Classical Electrodynamics	Theory	2	CE+ESE
		PHY-352	Nuclear Physics	Theory	2	CE+ESE
		PHY-353	Solid State Physics	Theory	2	CE+ESE
	Elective	PHY-354	Thermodynamics and Statistical Mechanics	Theory	2	CE+ESE
			OR			
		PHY-355	Biophysics	Theory	2	CE+ESE
	Elective	PHY-356	C-Programming	Theory	2	CE+ESE
			OR			
		PHY-357	Digital Electronics	Theory	2	CE+ESE
			OR			
		PHY-358	Astronomy and Astrophysics	Theory	2	CE+ESE
	Major	PHY-361	Physics Practical - 8	Practical	2	CE+ESE
		PHY-362	Physics Practical - 9	Practical	2	CE+ESE
	VSC	PHY-382	Physics Practical - 10 (Project)	Practical	2	CE
	Minor	PHY-371	MODERN PHYSICS	Theory	2	CE+ESE
	OJT	PHY-395	OJT	Theory / Practical	4	CE

SEMESTER V

	PHY-301 - Mathematical Methods in Physics Major-Theory	
	Number of Credits: 02 **No. of Hours: 30**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Recall the knowledge of coordinate systems.	1
CO2	Illustrate methods of solving partial differential equations with the examples of important partial differential equations in Physics.	2
CO3	Apply the various methods for solving differential equations in various physical problems such as in quantum mechanics, which they will learn in future courses in detail.	3
CO4	Explain the Fourier analysis of periodic functions and reconstruct physical problems such as vibrating strings etc.	4
CO5	Determine transformation equations and construct various coordinate systems. Compare cartesian, spherical and cylindrical coordinate systems.	5
CO6	Formulate the special functions, such as the Hermite polynomials, the Legendre polynomials and Bessel functions and their differential equations.	6

PHY-301 - Mathematical Methods in Physics
(Major - Theory)

Unit No.	Title of Unit and Contents	No. of hours
1	**Orthogonal Curvilinear Coordinates**: Introduction to Cartesian, Spherical polar and cylindrical coordinate systems, transformation equations, General Curvilinear coordinate system: Coordinate surface, co-ordinate lines, length, surfaces and volume elements in curvilinear coordinate system, metric coefficient. Orthogonal Curvilinear coordinate system, Expressions for gradient, divergence, Laplacian and Curl, special case for gradient, divergence, Laplacian and curl in Cartesian, spherical polar and cylindrical coordinate system.	**7**
2	**Partial differential equations**: Frequently occurring partial differential equations, degree, order, linearity and homogeneity (revision), Method of separation of variables, Frobenius method for power series solution of Legendre, Hermite and Bessel differential equations.	**8**
3	**Special Functions:** Generating function for Legendre, Hermite Polynomials, Recurrence relations, their differential equations and orthogonality properties. Bessel function of first kind and their properties. Problems	**8**
4	**Fourier series:** Orthogonality of Sine and Cosine Functions. Fourier Series and Fourier transform. Dirichlet Conditions (Statement only). Kronecker's Method for Computation of Fourier Coefficients. Even and Odd Functions.	**7**

Learning Resources- References

Sr. No.	References
1.	Mathematical methods for physicists - Arfken and Weber, Academic Press New York.
2.	Mathematical Physics - Rajput, Pragati Prakashan
3.	Mathematical methods in the physical sciences - Mary L. Boas, John Willy and sons' publication.
4.	Mathematical Physics - B. D. Gupta, 4th edition. Vikas Publishing House Pvt. Ltd.
5.	Mathematical Physics - H. K. Dass, Rama Verma, S. Chand & Company Pvt. Ltd.

	PHY-302 - Classical Mechanics Major-Theory	
	Number of Credits: 02 **No. of Hours: 30**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Describe methods of solving equations of motions.	1
CO2	Explain necessity of considering constraints.	2
CO3	Apply different techniques to find solutions of problems in Mechanics.	3
CO4	Compare and contrast Newtonian, Lagrangian and Hamiltonian approaches.	4
CO5	Determine the constraint equations and decide the generalized co-ordinates to be used.	5
CO6	Hypothesize rotating frames of references.	6

PHY-302 - Classical Mechanics
(Major - Theory)

Unit No.	Title of Unit and Contents	No. of hours
1	**Mechanics of system of particles:** Revision of Newton's laws of motion. Applications of Newton's laws of motion to solve problems of projectile motion in resistive medium, Rocket motion, Motion of a charged particle in constant electric, magnetic and electromagnetic field, Systems of particles, center of mass, conservation of linear and angular momentum, energy of system of particles	**5**
2	**Motion in Central Force Field:** Central force, equivalent one body problem, Motion in central force field, General features of motion, equation of orbit, Deduction of Kepler's laws of planetary motion and their applications, tidal force field.	**6**
3	**Scattering of particles:** Laboratory and centre of mass system. Scattering, Relation between scattering angles in laboratory and centre of mass system. Differential cross-section, impact Parameter, total cross-section, Rutherford scattering.	**7**
4	**Langrangian and Hamiltonian formulation:** Limitations of Newtonian formulation, Types of constraints, degrees of freedom, generalized coordinates, configuration space, D'Alembert's principle of virtual work, Langrangian equation from D'Alembert's principle, Hamilton's equations.	**7**
5	**Non Inertial frames of systems:** Coordinate systems moving with constant velocity, constant acceleration, uniformly rotating frames of references, Effects of Earths motion on acceleration due to gravity, Effect of Coriolis force, Motion of a particle on the earth.	**5**

Learning Resources- References

Sr. No.	References
1.	Introduction to Classical Mechanics - R. G. Takawale, P. S. Puranik, Tata McGraw Hill Publishing Company Ltd.
2.	Classical Mechanics- N. C. Rana, P. S. Joag, Tata Mc Graw Hill Publishing Company Ltd.
3.	Principles of mechanics, J. L. Synge, B. A. Griffith, Tata McGraw Hill Publishing Company Ltd.
4.	Classical Mechanics - Herbert Goldstein, Narosa Publishing House.
5.	Classical Mechanics - J. C. Upadhyaya, Himalaya Publishing House.
6.	Problem solution of classical mechanics - P. V. Panat, Narosa Publishing House.

	PHY-303 - Quantum Mechanics Major-Theory	
	Number of Credits: 02 **No. of Hours: 30**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Describe and learn theoretical aspects at Quantum Level.	1
CO2	Clarify more about the insight of the microscopic world.	2
CO3	Apply Schrodinger's equation for different cases of potentials.	3
CO4	Explain concept of operators and apply it in Quantum mechanics.	4
CO5	Review Hydrogen atom model and quantum numbers n, l, m_l, m_s and degeneracy.	5
CO6	Write Schrodinger's equation in spherically symmetric polar co-ordinate system.	6

PHY-303 - Quantum Mechanics
(Major - Theory)

Unit No.	Title of Unit and Contents	No. of hours
1	**Historical Background and Initial development:** Black body radiation, photoelectric effect, Compton effect, wave particle duality, Heisenberg's uncertainty principle, problems **Towards Quantum mechanics:** Wave-packets, Schrodinger time dependent and independent equation (Steady state equation), Physical interpretation and requirements of wave function. Probability current density, equation of continuity, and its physical significance, problems	**10**
2	**Operator methods in Quantum Mechanics** Expectation value - Ehrenfest's theorem, Definition of an operator in Quantum mechanics. - Eigen function and Eigen values. Hermitian operator. Position, Momentum operator, angular momentum operator, and total energy operator (Hamiltonian). Commutator brackets- Simultaneous Eigen functions, Commutator algebra. Commutator brackets using position, momentum and angular momentum operator. Raising and lowering angular momentum operator. Concept of parity, parity operator and its eigen values, solved examples	**10**
3	**Applications of Schrodinger wave equation (Steady state):** Free particle. Particle in infinitely deep potential well (one - dimension). Particle in three-dimension rigid box. Step potential. Potential barrier. (Qualitative discussion). Barrier penetration and tunnelling effect. Harmonic oscillator (one-dimension)	**10**

Learning Resources- References

Sr. No.	References
1.	Introduction to Quantum Mechanics. - By D. Griffiths Published by Prentice Hall.
2.	Quantum Mechanics of Atoms, Molecules, Solids, Nuclei and particles. - By Eisberg and R. Resnik Published by Wiley.
3.	Concepts of Modern physics. - By A. Beiser Published by TMH
4.	A textbook of Quantum mechanics: P. M. Mathews and K. Venkatesan, TMH publications
5.	Quantum Mechanics: S L Gupta, Jay Prakash Nath & Co., Meerut, India
6.	Quantum Mechanics: Theory and Applications by Ajay Ghatak & Loknathan

	PHY-304 - Atomic and Molecular Physics Elective-Theory	
	Number of Credits: 02 **No. of Hours: 30**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Recall and recognize the gradual development of the atomic theory and describe various atomic models.	1
CO2	Explain the effect of magnetic field on atomic spectra.	2
CO3	Solve problems in atomic theory.	3
CO4	Relate atomic theory to analyse spectra.	4
CO5	Evaluate spectroscopic data to identify elements using atomic spectra.	5
CO6	Develop mathematical treatment for the Bohr atom, Zeeman effect and Raman spectra.	6

PHY-304 - Atomic and Molecular Physics
(Elective - Theory)

Unit No.	Title of Unit and Contents	No. of hours
1	**Atomic Structure**: Evolution of the vector atom model from Dalton, Atomic excitation and atomic spectra, One and two valence electron systems Pauli Exclusion principle and electron configuration, quantum states, Spectral notations of quantum states. Spin-Orbit Interaction (Single valence electron atom), selection rules, spectra of sodium atom, sodium Doublet., LS and JJ coupling schemes. Lande's Interval rule, Frank-Hertz experiment	**10**
2	**Zeeman Effect:** Early discoveries and developments Experimental arrangement, Normal and anomalous Zeeman Effect Problems, Stark effect (Qualitative discussion)	**4**
3	**X-ray:** Nature of X-rays, Discrete and continuous X-ray spectra, Duane and Hunt's Rule, X-ray emission spectra, Mosley's law and its applications Auger effect, Problems	**4**
4	**Molecular Spectroscopy:** Rotational energy levels Vibrational energy levels Rotational and Vibrational Spectra Electronic spectra of molecules Problems. Raman effect Stokes and Anti-Stokes lines, classical theory of Raman effect, experimental set up.	**6**
5	**Spectroscopic Techniques:** UV-visible spectroscopy, IR spectroscopy, x-ray spectroscopy, Raman spectroscopy, Spectroscopy applications in areas like Astrophysics, Geology, Archaeology, Materials Science, Medical science.	**6**

Learning Resources- References

Sr. No.	References
1.	Atomic physics - J. B. Rajam, S. Chand publisher
2.	Concepts of Modern Physics 4th edition - Arthur Beiser (McGraw Hill International edition)
3.	Modern Physics - J. B. Rajam, S. Chand publisher
4.	Introduction to Atomic spectra - White. H. E. (McGraw Hill International edition)
5.	Fundamentals of Molecular spectroscopy - C. N. Banwell and E. M. Mc Cash, McGraw Hill International edition)

	PHY-305 - Radiation Physics Elective-Theory	
	Number of Credits: 02 **No. of Hours: 30**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Describe interaction of radiations with matter.	1
CO2	Discuss radiation sources and radiation shielding.	2
CO3	Classify different radiation detectors and specify their application.	3
CO4	Explain different radiation units for measurement of radiation exposure.	4
CO5	Evaluate safety protocols for radiation protection.	5
CO6	Specify application of radiation sources in different area.	6

PHY-305 - Radiation Physics
(Elective - Theory)

Unit No.	Title of Unit and Contents	No. of hours
1	**Interaction of Radiation with Matter** Interaction of different types of radiation with Matter-Ionizing & Non ionizing radiations, excitation, ionization, radioactive losses- Energy loss by collision, range energy relation, Bethe-Bloch formula collision stopping power, radiation stopping power, Straggling. Energy classification, Photoelectric effect, Compton scattering, Pair production, Rayleigh scattering, Neutron interactions, Neutron sources, elastic and inelastic scattering, nuclear reaction, neutron activation and induced activity, radioisotope production, Nuclear fission.	**8**
2	**Radiation Detectors** Characteristic curve of Gas-filled detectors. Ionization chamber, Proportional counter, Gas filled detectors (G. M. counter), Characteristics of organic and inorganic scintillation detectors, Scintillator detector, Semiconductor detector.	**5**
3	**Radiation units and Measurement of radiation exposure** Units for radiation exposure- Roentgen, Becquerel, Gray, Sievert, RAD, REM, KERMA. Radiation exposure, Absorbed Dose, Equivalent Dose, Effective Dose, Ambient and directional equivalent dose, Relative biological effective dose, Quality factor, Personal dosimeters, Film badge dosimeters, Thermoluminescent dosimeter. Calibration of dosimeters. Measurement of dose delivered by an electron accelerator and high strength Cobalt -60 source.	**5**
4	**Radiation Sources and Radiation Shielding** Natural & Artificial radioactive sources, Alpha, Beta, Gamma Sources, Neutron sources and accelerator based radiation sources. Basic concept of radiation shielding, linear and mass absorption coefficient, stopping power, materials for shielding of gamma and neutron, shielding interaction cross section, concept of the mean free path for shielding.	**4**

5	**Radiation Protection:** Time, Distance, Shielding, Radiation Protection and Safety rules as per the regulatory guidelines of the Government of India, Safety codes for handling radioactive sources. Monitoring of radiation levels around an open radioactive source, ICRP, NCRP, AERB recommended limit.	**4**
6	**Radiation Applications:** Production of radioactive nuclides in nuclear reactors and by charged particle beams from accelerators. Radioactive pharmaceuticals and labelled compounds. Radioactive nuclei used in diagnostic applications. Applications of gamma-rays in sterilization of medical instruments, medication items and preservation of food.	**4**

Learning Resources- References

Sr. No.	References
1.	Nuclear and Radiation Physics in Medicine. Tony Key. World Scientific. 2014
2.	Introduction to Radiological Physics and Radiation dosimetry. Frank H. Attix. Wiley. 1986
3.	Medical Physics by Glasser O, Vol 1, 2, 3 Year Book Publisher Inc Chicago.
4.	Radiation Protection and Health Science. Marilyn E. Noz. World Scientific. 2007.
5.	Introduction to Radiation Protection. Grupen C. Springer. 2008.
6.	Radiation Physics for Medical Physicists. Podgorsak Ervin B. Springer. 2005.
7.	Techniques for Nuclear and Particle Physics experiments. Leo. W. R. Springer. 2005.

	PHY-306 - LASERS Elective -Theory	
	Number of Credits: 02 **No. of Hours: 30**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Describe the requirements for a system to act as a laser.	1
CO2	Explain concept of Laser fundamentals, pumping mechanism pumping schemes.	2
CO3	Demonstrate potential applications of Lasers.	3
CO4	Differentiate the various types of Lasers and their means of excitation.	4
CO5	Compare three level and four level Laser systems.	5
CO6	Design and development of different laser systems.	6

PHY-306 - LASERS
(Elective - Theory)

Unit No.	Title of Unit and Contents	No. of hours
1	**LASER fundamentals I:** Ordinary light and Lasers, Brief history of Lasers, Interaction of radiation with matter, Energy levels, Population density, Boltzmann distribution, Transition Lifetimes, Allowed and Forbidden Transitions, Metastable states Stimulated Absorption, Spontaneous Emission and Stimulated Emission, Einstein's Coefficients, Einstein's relations Condition for large stimulated emission, Population inversion	**6**
2	**LASER fundamentals II:** Condition for light amplification, Gain coefficient Active medium, Optical feedback, round trip gain, threshold gain, critical population inversion, Optical resonator, condition for steady state oscillations, cavity resonance frequencies. Pumping schemes: three level and four level.	**8**
3	**Types of LASERs:** Solid State Lasers – Ruby Laser, Diode Laser, Nd: YAG laser, Gas Lasers – He-Ne Laser, CO_2 Laser Liquid Lasers: Tunable dye laser	**8**
4	**Applications of LASERs:** Nuclear Science – laser isotope separation, laser fusion Defence Applications Medical – Introduction to nonthermal Lasers for medical applications, Eye surgery, Photodynamic therapy Optical - Holography, supermarket scanners, compact discs, Nonlinear Optics, SHG	**8**

Learning Resources- References

Sr. No.	References
1.	Lasers, Fundamentals and Applications, K. Thyagarajan and, Ajoy Ghatak, Springer
2.	Laser Fundamentals, William T. Silfvast, Cambridge
3.	An introduction to Lasers – Theory and applications, M. N. Avadhanulu, S. Chand and Co. New Delhi.

	PHY-307 - Numerical Analysis Elective-Theory	
	Number of Credits: 02 **No. of Hours: 30**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Identify modern numerical methods and describe the extent and limitations of computational methods in physics,	1
CO2	Discuss the characteristics of various numerical methods.	2
CO3	Solve the problem using numerical methods techniques and computationally solve a selection of problems in physics.	3
CO4	Explain and solve the physics problem using numerical methods, write a program for it using leading-edge tools,	4
CO5	Compare the tools, methodologies, language to test various physics problems.	5
CO6	Design the physics system and solve it, collect the result and discuss, justify and communicate ideas and explanations.	6

PHY-307 - Numerical Analysis
(Elective - Theory)

Unit No.	Title of Unit and Contents	No. of hours
1	**Iterative Methods:** Beginning an iterative method, The method of successive bisection, The method of false position, Newton-Raphson iterative method, The secant method, The Gauss elimination method, Comparison of direct and iterative methods	**7**
2	**Interpolation:** Lagrange interpolation, Difference tables, Truncation error in interpolation, Linear regression, Algorithm for Linear regression, Polynomial regression, Fitting exponential and trigonometric functions.	**8**
3	**Integration:** Numerical integration, Simpson's rule, Trapezoidal Rule, Errors in integration formulae, Algorithms for integration of tabulated function, Algorithms for integration a known function, Comparison of integration formulae	**7**
4	**Solving Differential equations:** Euler's method, Taylor series method, Runge-Kutta methods, Runge-Kutta fourth order formula	**8**

Learning Resources- References

Sr. No.	References
1.	Computer Oriented Numerical Methods, by V. Rajaraman (PHI Learning Publications)
2.	Numerical methods for scientists and engineers, by H. M. Antia (Hindustan Book Agency)
3.	Computational Physics, by N. J. Giordano and Hisao Nakanishi (Pearson Education India

	PHY-308 - Elements of Materials Science Elective-Theory	
	Number of Credits: 02 **No. of Hours: 30**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Describe types of materials, their properties and identify types of defects.	1
CO2	Explain functional properties of ceramic bulk materials and different nanomaterials.	2
CO3	Apply knowledge of mathematics and advanced science and engineering principles to materials systems.	3
CO4	Explain applications of Polymers for research and industrial applications. Determine concentration, purity of material and molecular weight.	4
CO5	Select materials for design and construction. Test materials using different characterization methods with the fundamental principles underlying and connecting the structure and properties.	5
CO6	Design and construct different Phase Diagrams under different combination and thermodynamic states.	6

PHY-308 - Elements of Materials Science
(Elective - Theory)

Unit No.	Title of Unit and Contents	No. of hours
1	**Materials and their properties:** Types of materials: Conductors, Semiconductors and Insulators, Materials properties: Mechanical, Electrical and thermal, Impurities in solids. Defects in solids: Point, Line, Surface and Volume. Deformation: Elastic deformation and Plastic deformation. Mechanism of Plastic deformation by slip, Critical resolved shear stress (CRSS)	**8**
2	**Phase Diagrams; Molecular Phases:** Basic terms: System, Surrounding, Component, Coordinates, Phase, Equilibrium. Solid solutions in metals, Rules of solid solubility. Phase Diagram: definition, importance and objective, Lever rule, Gibb's phase rule. Phase diagram of a) Sugar water b) NaCl water. Types of phase diagrams with construction - Type-I Lens type Cu-Ni phase diagram, Type-II Only introduction	**8**
3	**Ceramic Materials and Introduction to nanomaterials:** Ceramic Phases, Classification of ceramic materials, Ceramic crystals (AX), Mechanical behavior of ceramics, Electric properties: dielectrics, semiconductors, piezoelectric, Nano-sized structures and materials, classification of nanomaterials (0D, 1D, 2D and shape effects, surface to volume ratio), properties and applications of nano materials	**8**
4	**Characterization Techniques:** Introduction and basic principle only, Introduction to X-Ray diffraction, UV-Visible spectroscopy, Photoluminescence, Thermal gravimetric analysis (TGA), X-Ray photoelectron spectroscopy.	**6**

Learning Resources- References

Sr. No.	References
1.	Materials Science and Engineering - V. Raghavan (5th Edition)
2.	Elements of Materials Science and Engineering - L. H. Van Vlack (6th Edition)
3.	Elements of X-Ray diffraction - B. D. Cullity.
4.	Fundamentals of Molecular spectroscopy - C. N. Banwell and E. M. McCash
5.	Solid State Physics - A. J. Dekker

	PHY-311 - Physics Practical-5 Major-Practical	
	Number of Credits: 02 **No. of Hours: 60**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Describe different experimental techniques to determine values of various constants, coefficients, parameters.	1
CO2	Arrange the apparatus as per the requirements of the aims and objectives of the experiment.	2
CO3	Demonstrate the procedure to perform the experiments and the skills required for the experiment.	3
CO4	Explain the theory behind the formulae used and validate the hypotheses.	4
CO5	Standardize the entire procedure to obtain reliable, repeatable results.	5
CO6	Perform the experiment, tabulate the data, identify the sources of errors, and show how to minimize the errors.	6

PHY-311 - Physics Practical-5
(Major - Practical)

Experiment No.	Title of Experiment
1	Viscosity of Oil by Rotating Cylinder Method
2	Study of X – ray diffractograms of various materials
3	Michelson interferometer
4	Surface tension of liquids using Fergusson Method
5	Study of Hall Effect
6	Energy Gap of Semiconductor
7	Four Probe Method
8	Platinum Resistance Thermometer
9	Determination of diameter of the Sun
10	Magneto Resistance

Learning Resources- References

Sr. No.	References
1.	Advanced Practical Physics Worsnop and Flint, B. L. Worsnop, H. T. Flint, Littlehampton Book Services Ltd.
2.	Advanced Practical Physics, S. P. Singh, Pragati Prakashan
3.	A Course of Experiments with He-Ne Lasers, Rajpal S. Sirohi, New Age International

	PHY-312 - Physics Practical-6 (Major-Practical)	
	Number of Credits: 02 **No. of Hours: 60**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Describe different experimental techniques to determine values of various constants, coefficients, parameters.	1
CO2	Arrange the apparatus as per the requirements of the aims and objectives of the experiment.	2
CO3	Demonstrate the procedure to perform the experiments and the skills required for the experiment.	3
CO4	Explain the theory behind the formulae used and validate the hypotheses.	4
CO5	Standardize the entire procedure to obtain reliable, repeatable results.	5
CO6	Perform the experiment, tabulate the data, identify the sources of errors, and show how to minimize the errors.	6

PHY-312 - Physics Practical-6
(Major - Practical)

Experiment No.	Title of Experiment
1	Refractive index of liquids using hollow prism
2	Lloyd's Mirror
3	Forbe's Method
4	Thermal Conductivity of Rubber Tube
5	e/m by Thomson's Method
6	Plank Constant
7	Self-Inductance by Anderson Bridge
8	Magnetic Properties of material using Hysteresis Loop Tracer
9	Fraunhofer Lines in Solar spectrum
10	Frequency response of Human Ear

Learning Resources- References

Sr. No.	References
1.	Advanced Practical Physics Worsnop and Flint, B. L. Worsnop, H. T. Flint, Littlehampton Book Services Ltd.
2.	Advanced Practical Physics, S. P. Singh, Pragati Prakashan
3.	A Course of Experiments with He-Ne Lasers, Rajpal S. Sirohi, New Age International

	PHY-331 - Analog Electronics VSC-Theory	
	Number of Credits: 02 **No. of Hours: 30**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Recall basic knowledge of physical and electrical conducting properties of semiconductors.	1
CO2	Explain the effect of negative feedback on different parameters of an Amplifier and different types of negative feedback topologies.	2
CO3	Apply the knowledge to build, and troubleshoot Analog circuits using IC555, VCO, etc.	3
CO4	Explain the effect of positive feedback and design and working of different Oscillators using BJTS and operational amplifier.	4
CO5	Evaluate the working of BJT / FET amplifiers.	5
CO6	Design amplifier circuits using BJT's and FET's and observe the amplitude and frequency responses of common amplifier circuits.	6

PHY-331 - Analog Electronics
(VSC - Theory)

Unit No.	Title of Unit and Contents	No. of hours
1	**Circuit Theorems and Power Supplies:** Statements of Thevenin's Theorem, Norton's Theorem, Superposition Theorem and Maximum Power Transformer Theorem (Without proofs) and solutions of numerical problems based on these theorems. Zener diode as a voltage regulator. Series and shunt regulators, short circuit protection.	**7**
2	**Basic Electronic devices and circuits:** BJT: Construction, study of I-V characteristics and transfer characteristics in CE, CB and CC configurations. Different methods of transistor biasing and thermal stability. Frequency response of transistor amplifier. Concept of feedback and study of phase shift, Wein bridge, Hartley and Colpitt's oscillators. Construction, working, characteristics and applications of UJT and SCR.	**8**
3	**Operational Amplifiers:** Differential amplifier. Block diagram of Op-amp. Study of parameters of op-amp. Inverting and Non-Inverting amplifiers, adder, subtractor using op-amp. Applications of op-amp as Integrator, Differentiator, exponential and logarithmic amplifiers, multiplier, divider, I to V convertor, high impedance voltmeter, comparator, Schmitt trigger, oscillators, astable and monostable multivibrator, square wave, triangular wave generator.	**7**

4	**Special Function ICs:** IC 555 - Block diagram and functions of various pins. Astable operation: Circuit diagram, frequency of oscillations and duty cycle. Monostable Operation and application of one-shot multivibrator in water level control, touch switch and frequency divider. VCO 566 - Block diagram and working. PLL 565 - Block diagram, working and applications.	**8**

Learning Resources- References

Sr. No.	References
1.	OP Amps and Linear Integrated Circuits - Gaikwad - PHI
2.	Integrated Circuits - Botkar PHI

	PHY-332 - Physics Practical-7 VSC-Practical	
	Number of Credits: 02 **No. of Hours: 60**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Describe different experimental techniques to determine values of various constants, coefficients, parameters.	1
CO2	Arrange the apparatus as per the requirements of the aims and objectives of the experiment.	2
CO3	Demonstrate the procedure to perform the experiments and the skills required for the experiment.	3
CO4	Explain the theory behind the formulae used and validate the hypotheses.	4
CO5	Standardize the entire procedure to obtain reliable, repeatable results.	5
CO6	Perform the experiment, tabulate the data, identify the sources of errors, and show how to minimize the errors.	6

PHY-332 - Physics Practical-7
(VSC - Practical)

Experiment No.	Title of Experiment
1	Regulated power supply using IC723
2	Adder and Subtractor using OP-AMP 741
3	Integrator and differentiator using OP-AMP 741
4	Optical Fiber –Loss Measurement
5	Half and Full wave rectifier
6	Study of IV characteristics of transistor (in CE/CB/CC)
7	Wien Bridge Oscillator
8	IC555 Astable Multivibrator
9	IC555 Monostable multivibrator
10	Study of Frequency response using BJT

Learning Resources- References

Sr. No.	References
1.	Electronic Principles, Albert Malvino and David Bates, McGraw Hill
2.	Op-Amps and Linear ICs, R. A. Gayakwad, Pearson Publications
3.	Modern Digital Electronics, R. P. Jain, McGraw Hill
4.	Advanced Practical Physics, S. P. Singh, Pragati Prakashan

	PHY-321 - Materials Science Minor-Theory	
	Number of Credits: 02 No. of Hours: 30	
Course Outcomes (COs) On completion of the course, the students will be able to:		**Bloom's cognitive level**
CO1	Describe types of materials, their properties and identify types of defects.	1
CO2	Explain functional properties of ceramic bulk materials and different nanomaterials.	2
CO3	Apply knowledge of mathematics and advanced science and engineering principles to materials systems.	3
CO4	Explain applications of Polymers for research and industrial applications. Determine concentration, purity of material and molecular weight.	4
CO5	Select materials for design and construction. Test materials using different characterization methods with the fundamental principles underlying and connecting the structure and properties.	5
CO6	Design and construct different Phase Diagrams under different combination and thermodynamic states.	6

PHY-321 - Materials Science
(Minor - Theory)

Unit No.	Title of Unit and Contents	No. of hours
1	**Materials and their properties:** Types of materials: Conductors, Semiconductors and Insulators, Materials properties: Mechanical, Electrical and thermal, Impurities in solids. Defects in solids: Point, Line, Surface and Volume. Deformation: Elastic deformation and Plastic deformation. Mechanism of Plastic deformation by slip, Critical resolved shear stress (CRSS), Introduction to Diffusion in Solids.	**7**
2	**Phase Diagrams; Molecular Phases:** Basic terms: System, Surrounding, Component, Coordinates, Phase, Equilibrium. Solid solutions in metals, Rules of solid solubility. Phase Diagram: definition, importance and objective, Lever rule, Gibb's phase rule. Phase diagram of a) Sugar water b) NaCl water. Types of phase diagrams with construction - Type-I Lens type Cu-Ni phase diagram, Type-II Only introduction, Introduction to Type-III Phase diagram.	**8**
3	**Ceramic Materials and Introduction to nanomaterials:** Ceramic Phases, Classification of ceramic materials, Ceramic crystals (AX), Mechanical behavior of ceramics, Electromagnetic behavior of ceramics - Electric properties: dielectrics, semiconductors, piezoelectric, Magnetic Properties: Magnetic Ceramics, hard and soft ferrites. Nano-sized structures and materials, classification of nanomaterials (0D, 1D, 2D and shape effects, surface to volume ratio), properties and applications of nano materials	**8**

4	**Characterization Techniques:** Introduction and basic principle only, Introduction to X-Ray diffraction, UV-Visible spectroscopy, Photoluminescence, Thermal gravimetric analysis (TGA), Electron microscopy (SEM, TEM), Scanning probe microscopy, X-Ray photoelectron spectroscopy.	**7**

Learning Resources- References

Sr. No.	References
1.	Materials Science and Engineering - V. Raghavan (5th Edition)
2.	Solid State Physics - A. J. Dekker.
3.	Elements of X-Ray diffraction - B. D. Cullity.
4.	Fundamentals of Molecular spectroscopy - C. N. Banwell and E. M. McCash
5.	Elements of Materials Science and Engineering - L. H. Van Vlack (6th Edition)

	PHY-345 – Field Project (FP) **Major** **Theory/Practical**	
	Number of Credits: 02 **No. of Hours: 60**	

SEMESTER VI

	PHY-351 - Classical Electrodynamics Major-Theory	
	Number of Credits: 02 **No. of Hours: 30**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Identify various physical parameters related to Electrodynamics.	1
CO2	Illustrate the mathematical treatment of concepts of classical electrodynamics. Interpret fundamental laws of classical electrodynamics.	2
CO3	Apply the concepts of classical electrodynamics to different numerical problems.	3
CO4	Explain the outcomes of real-world problems.	4
CO5	Validation of system by using phenomena of classical electrodynamics.	5
CO6	Demonstrate concepts of classical electrodynamics through numerical problems, models and experiments.	6

PHY-351 – Classical Electrodynamics
(Major - Theory)

Unit No.	Title of Unit and Contents	No. of hours
1	**Motional emf and Faraday's law:** Electromotive force, Motional emf, Flux rule, Faraday's law, The induced electric field, Energy in magnetic field, Inductance.	**9**
2	**Maxwell's Equation:** Electrodynamics before Maxwell, Maxwell's correction in Ampere's law, Maxwell's equations, magnetic charge, Maxwell's equation in matter, boundary conditions.	**9**
3	**Electromagnetic Waves in vacuum and matter:** Electromagnetic waves in vacuum, Monochromatic plane waves, energy and momentum in Electromagnetic waves, Poynting vector, Propagation of wave in linear media, reflection and transmission at normal incidence, reflection and transmission at oblique incidence.	**12**

Learning Resources- References

Sr. No.	References
1.	Introduction to Electrodynamics, David J Griffiths, 4th edition, Pearson.
2.	Concepts of Physics, Volume II, H. C. Verma, Bharati Bhavan (P & D).
3.	Electricity and magnetism, Reitz, Milford and Christie, Narosa Publishing House.
4.	Feynman Lecture Series, Volume II, The New Millenium Edition.

	PHY-352 - Nuclear Physics Major-Theory	
	Number of Credits: 02 No. of Hours: 30	
Course Outcomes (COs) On completion of the course, the students will be able to:		**Bloom's cognitive level**
CO1	Define and describe basic properties of nucleus.	1
CO2	Explain the concept of radioactivity. Classify different radiation detectors and nuclear models.	2
CO3	Solve problems related to nuclear and particle physics.	3
CO4	Explain nuclear reaction dynamics, nuclear reactors and accelerators.	4
CO5	Compare the nuclear energy with other energy sources.	5
CO6	Specify applications of accelerators and detectors. Compile knowledge of elementary particles to understand nuclear phenomena.	6

PHY-352 - Nuclear Physics
(Major - Theory)

Unit No.	Title of Unit and Contents	No. of hours
1	**Basic Properties of Nucleus:** Composition, charge, size, density of nucleus, Mass defect and Binding energy, packing fraction, Nuclear Angular momentum, Nuclear magnetic dipole moment, Electric quadrupole moment, parity and symmetry, classification of nuclei, stability of nuclei (N vs Z curve).	**6**
2	**Radioactivity:** Radioactivity disintegration (concept of natural and artificial radioactivity, Properties of α, β, γ rays, laws of radioactive decay, activity, half-life, mean life, specific activity and its units, Beta decay, successive disintegration, radioactive equilibriums, radioisotopes. Application of radioactivity (Agricultural, Medical, Industrial, Archaeological).	**7**
3	**Nuclear forces:** Properties of nuclear forces, Meson theory of nuclear forces, properties of deuteron system, Elementary particles, Quarks model for elementary particles.	**5**
4	**Particle Accelerator and Detectors:** Introduction to particle accelerators, Linear accelerator (LINAC), Cyclotron. Applications of accelerators, Classification of Nuclear detector, Gas filled detectors (G. M. counter) Solid state detectors (NaI scintillation counter)	**6**

5	**Nuclear Reactions & Nuclear Energy:** Introduction to Nuclear reactions, Compound nucleus, Conservation laws in nuclear reactions, Q value equation, Exothermic and Endothermic reactions, Threshold energy, Nuclear cross-section, Nuclear fission, chain reaction and critical mass, nuclear reactor and its basic components, homogeneous and heterogeneous reactors, power reactor, fast breeder reactor, nuclear fusion, stellar energy.	**6**

Learning Resources- References

Sr. No.	References
1.	Introduction to Nuclear Physics H. A. Enge (Addition Wesley Co.)
2.	The Atomic Nucleus R. D. Evans (Tata McGraw Hill Co.)
3.	Concepts of Nuclear Physics – B. L. Cohen (Tata McGraw Hill Co.)
4.	Schaum's Outline Series Modern Physics R. Gautrearu (McGraw Hill Co.)
5.	Nuclear Physics, D. C. Tayal, Himalaya Publishing House.
6.	Atomic and Nuclear Physics, Shatendra Sharma (Pearson Education, 1st Edition)
7.	Nuclear Physics an Introduction, 2nd edition, S. B. Patel, New Age International Publishers

	PHY-353 - Solid State Physics Major-Theory	
	Number of Credits: 02 **No. of Hours: 30**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	List seven crystal systems.	1
CO2	Explain free electron theory and band theory.	2
CO3	Calculate lattice parameter from given XRD pattern.	3
CO4	Identify the structure of materials.	4
CO5	Evaluate the density of state equation in 3D.	5
CO6	Specify the importance of magnetic materials.	6

PHY-353 - Solid State Physics
(Major - Theory)

Unit No.	Title of Unit and Contents	No. of hours
1	**Crystal Physics:** Introduction, lattice, basis, crystal structure, unit cell & primitive cell, Translational vectors, Symmetry operations, crystal classes & crystal systems in 2D and 3D, Bravais lattices, atomic packing fraction in cubic systems SC, FCC, BCC. Miller indices, Interplanar spacing. Brillouin zones, Concept of reciprocal lattice and its properties. Crystal structures of diamond, ZnS, NaCl, CsCl, HCP, Structure determination using X-ray Diffraction: Bragg's law and Bragg's Diffraction condition indirect and reciprocal lattice, Ewald's construction.	**12**
2	**Free Electron and Band Theory of Metals:** Free Electron model, Energy levels and Density of orbital in 1D and 3D, Bloch theorem (statement only), Nearly free electron model, Fermi energy, Fermi level, Hall Effect, Origin of energy gap, Energy bands in Solids, Effective mass of electron (with derivation), Distinction between metal, semiconductor and insulator.	**6**
3	**Solid state devices:** Semiconductors, intrinsic, extrinsic, temp dependence, doping, conductivity, Hall effect, Hall coefficient, semiconductor devices. e.g. metal semiconductor junction, p-n junction diodes, Zener and tunnel diodes, LED's transistor, solar cells.	**5**
4	**Magnetism:** Diamagnetism, Langevin theory of Diamagnetism, Application of diamagnetic material: (Superconductor), concept, Occurrence of Superconductivity, Critical magnetic field and Meissner effect achievement at low temp, attempts at room temp. Examples, Paramagnetism, Langevin theory of Paramagnetism, ferromagnetism, ferromagnetic domains, Hysteresis, Curie temperature. Ferromagnetism, Ferrites and its applications, antiferromagnetism, Neel temperature.	**7**

Learning Resources- References

Sr. No.	References
1.	Solid State Physics - S. O. Pillai, 3rd Edition, New Age International (P.) Ltd., Publisher (1999)
2.	Introduction to Solid State Physics - Charles Kittel, John Wiley and Sons, 7th Edition.
3.	Solid State Physics - Kakani and Hemrajani, S. Chand Publication.
4.	Solid State Physics - Saxena, Gupta and Saxena, Pragati Prakashan.
5.	Solid State Physics - A. J. Dekker, Macmillan India Ltd., (1998).
6.	Solid State Physics - R. K. Puri, V. K. Babbar, S. Chand Publication.
7.	Problems in Solid State Physics - S. O. Pillai, New Age International (P.) Ltd.
8.	Solid State Physics - Palanisamy.
9.	Solid State Physics - David, Snoke, Pearson Publication.

	PHY-354 - Thermodynamics and Statistical Mechanics Elective-Theory	
	Number of Credits: 02 **No. of Hours: 30**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Define thermodynamic quantities and functions.	1
CO2	Estimate the probabilities in statistical processes.	2
CO3	Apply the knowledge of Entropy and density of states to understand the concept of temperature.	3
CO4	Explain the quantum statistics and differentiate between classical and quantum statistics.	4
CO5	Compare the MB, BE and FD statistics and classify particles according to them.	5
CO6	Design statistical tools to study thermodynamical interactions in ensembles.	6

PHY-354 - Thermodynamics and Statistical Mechanics
(Elective - Theory)

Unit No.	Title of Unit and Contents	No. of hours
1	**Transport Phenomena and Thermodynamics:** Mean free path, Transport Phenomenon, Viscosity, Thermal conductivity, Diffusion, First and Second TdS Equations, Specific heat and latent heat Equations, Joule Thomson Effect.	**5**
2	**Basic Concepts of the Theory of Probability:** Random events, Probability, Probability and frequency, Probability from an ensemble, Some basic rules of probability theory, Mean value of a discrete variable, Variance: Dispersion, Probability distribution, Binominal distribution, Mean value when the distribution is binominal, Fluctuations, Stirling approximation, Poisson distribution, Mean value and standard deviation in the case of Poisson distribution, Gaussian distribution, Standard deviation in the case of Gaussian distribution, Random walk problem.	**10**
3	**Macroscopic states and Microscopic states (Statistical Description of System of Particles) Statistical Ensembles:** Macroscopic states, Microscopic states, Phase space, μ-space, Γ-space, Postulate of equal a priori probabilities, Behaviour of the density of states, quasi static processes, Thermal interaction, Mechanical interaction, General interaction, Distribution of energy between systems in equilibrium, The approach to thermal equilibrium. Microcanonical ensemble, Canonical ensemble, Mean value and fluctuations	**10**
4	**Quantum Statistics of Ideal gases:** Identical particles and symmetry requirements, Formulation of the statistical problem, the quantum distribution functions, Maxwell-Boltzmann statistics, Bose-Einstein statistics, Fermi-Dirac statistics,	**5**

Learning Resources- References

Sr. No.	References
1.	Fundamentals of Statistical and Thermal Physics - F. Reif - McGraw Hill Publications
2.	Fundamentals of Statistical Mechanics - B. B. Laud - New Age International Publishers
3.	Perspectives of Modern Physics- A. Beiser - McGraw Hill Publications
4.	Statistical Mechanics - Gupta, Kumar - Pragati Prakashan

	PHY-355 - Biophysics Elective-Theory	
	Number of Credits: 02 **No. of Hours: 30**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Recall and identify physical properties related to biological systems.	1
CO2	Discuss types of transducers used for processing bioelectric signals.	2
CO3	Solve qualitative and quantitative problems.	3
CO4	Explain the working of bioinstruments and other techniques used for analysing biological signals.	4
CO5	Evaluate bioelectric signals.	5
CO6	Integrate physics concepts with biological systems for better understanding.	6

PHY-355 - Biophysics
(Elective - Theory)

Unit No.	Title of Unit and Contents	No. of hours
1	**Introduction of Biophysics:** Definition and History of Biophysics [Physical properties applied to biology- Surface tension, Viscosity, adsorption, diffusion, osmosis, dialysis and colloids] Cell: Animal and plant cell, types of cell and composition, Functional aspects of cell membrane, cytoplasm, nucleus, mitochondria, chloroplast (Bioenergetics of mitochondria and chloroplast), Protein structure (Primary, Secondary, Tertiary and Quaternary structure): Amino-acids structure (Specify types), Bond length, Bond angles, peptides, and Bond-Rigid planer peptides. Cis and trans configuration, torsion angle, Ramchandran plot. Photosynthesis Process: - electron transport, Gibbs's free energy, Redox couple. [Redox potential, Oxidation and reduction, Examples of redox potential in biological system.] Genetic code- symmetry, DNA structure	**12**
2	**Bio potentials:** Bioelectric signals: structure of neuron, resting potential, action Potential, Nernst equation, Bio-potential amplifier: input impedance, frequency characteristics, gain, CMRR, Calibration, Noise, Temperature sensitive stability. Compound action potentials of the human body ECG, EEG, ERG, EOG (in brief), Transducers: Definition, types- resistive, capacitive and inductive transducers, LVDT, photo diode, Bio electrodes- Half cell potential, polarizable and non-polarizable electrodes, metal and glass electrodes, types and electric characteristics	**10**

3	**Bio instruments:** Basic principle, Construction and working of colorimeters, spectrophotometer, ECG machine, PH meter, Centrifuge measurement, Electron microscope: SEM, TEM.	**4**
4	**New Fields:** Biostatistics and Biometry, Definition and concept in brief, Mathematical modeling and Computational biology (Concept only)	**4**

Learning Resources- References

Sr. No.	References
1.	Introduction to Biophysics - by P. Narayanan. New Age P.
2.	Medical Instrumentation - by Khandpur, TMH
3.	Laboratory Manuals of Biophysics Instruments - by P.B. Vidyasagar
4.	Biophysics -by Vatsala Piramal, Dominant Publisher and Distributors, New Delhi-110002
5.	Textbook of Biophysics - by R.N. Roy
6.	Textbook Photosynthesis - by Hall and Rao.

	PHY-356 - C-Programming Elective-Theory	
	Number of Credits: 02 **No. of Hours: 30**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Describe the basic structure of C language, concept of Flowchart and Algorithm and define functions and pointers.	1
CO2	Discuss the structure of C language, keywords, operators, constants and variables, control statements, standard I/P functions etc.	2
CO3	Implement C programming to solve the basic problems in Physics and objective oriented tasks.	3
CO4	Explain the basic of graphics in C programming.	4
CO5	Review the use of Arrays.	5
CO6	Write the programs using C language.	6

PHY-356 - C-Programming
(Elective - Theory)

Unit No.	Title of Unit and Contents	No. of hours
1	**Introduction to Programming**: What is programming, how to convert given problem into a pseudo code, writing algorithm, efficiency of algorithms, loops and repetitions, writing algorithms for simple problems, writing flowcharts, flowchart symbols.	**6**
2	**Data types and structures:** Integers, float, real, characters, logical Declaration of variables, Input and Output of data: printf, scanf reading and writing data from files, formatting input and output, operators, writing simple programs using data types, Arrays and pointers: uses, simple programs using arrays	**10**
3	**Basics of C-Programming**: Control statements: if, if-else, nested if, for loop, do while loops, go to statement, continue statement, jump statement, exit and break statement, Functions and Subroutines	**8**
4	**Using graphics in C:** Concept of graphics, simple graphics statements, Programming using graphics libraries in C, Applications of graphics	**6**

Learning Resources- References

Sr. No.	References
1.	C-Programming for Physicists, by W. H. Bell.
2.	Computer Basics and C-Programming, by Y. Rajaraman (PHY Learning Publications).
3.	Let us C, by Yashwant Kanetkar. 16th Edition, BPB publication
4.	Programming in C (Schaum's series) Gottfreid THM

	PHY-357 - Digital Electronics Elective-Theory	
	Number of Credits: 02 **No. of Hours: 30**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Recall the basic digital gates, binary arithmetic, and principles of Boolean algebra.	1
CO2	Explain internal block and detailed diagrams and working of the Digital Integrated circuits.	2
CO3	Illustrate use of encoders, decoders, multiplexers in various circuits.	3
CO4	Explain working of flip flops, counters, and registers.	4
CO5	Compare ADC and DAC techniques.	5
CO6	Design digital circuits for dedicated applications.	6

PHY-357 - Digital Electronics
(Elective – Theory)

Unit No.	Title of Unit and Contents	No. of hours
1	**Number systems, Logic Gates, Boolean Algebra and Combinational Circuits:** Binary, Octal and Hexadecimal number systems and interconversions, Logic gates, Boolean algebra and axioms, De Morgan's Theorems, Karnaugh's maps up to 4 variables for simplification of Boolean expressions. Half, full and parallel adder.	**7**
2	**Sequential Circuits:** R-S, J-K, D and T flip-flops. Counters (Synchronous and asynchronous). Up-down counter. Study of IC 7490. Digital Clock, Shift registers. SISO, SIPO, PISO and PIPO operations of shift registers.	**8**
3	**Data Converters:** Introduction to Analog and Digital Systems. Digital to Analog Converters – Weighted resistor method, Binary Ladder method, 4 – bit D/A converter. D/A accuracy and resolution, Analog to Digital Converters – single slope and dual slope techniques for A/D conversion. Accuracy and resolution of A/D converters.	**7**
4	**Semiconductor Memories:** Use of a simple switch, a capacitor and a flip-flop as a memory element, Study of diode matrix as a ROM. Study of PROM, EPROM and EEPROM. RAMs, Static and Dynamic RAMs.	**8**

Learning Resources- References

Sr. No.	References
1.	Digital Principles and Applications – Leach, Malvino, Saha - Mc Graw Hill
2.	Digital Integrated Electronics – Taub, Schilling – Mc Graw Hill.

	PHY-358 - Astronomy and Astrophysics Elective-Theory	
	Number of Credits: 02 **No. of Hours: 30**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Identify, classify and locate celestial objects, the vastness of Space and familiarize with the components of the Universe. Relate with observational astronomy and tools used for the purpose.	1
CO2	Explain nuclear reactions in stars and synthesis of elements in the universe and various cosmologies.	2
CO3	Apply skills in identifying spectra of celestial objects and data analysis.	3
CO4	Analyze and classify stellar spectra.	4
CO5	Measure stellar distances.	5
CO6	Prepare sky charts and make meteor observation logs.	6

PHY-358 - Astronomy and Astrophysics
(Elective - Theory)

Unit No.	Title of Unit and Contents	No. of hours
1	**Fundamentals of Astronomy and Observational Astronomy:** Introduction: Components of the Universe; Stars, Planets, Asteroids, Meteors, Comets, Galaxies, Solar System: Age, Origin Basic measurements: Planetary orbits, distances, physical size, mass, density, temperature, rotation period determination, Kepler's laws, EM Spectrum: radiation from heated objects, Wien's law, radiation curves, Doppler effect. Distance measurements: Parallax. Units of distance-light-years, parsec, Co-ordinate system, Celestial hemisphere, Concept of time, Magnitudes: apparent and absolute, constellations, Optical telescopes, mounts, light gathering power, magnification, and resolution. Spectroscopes, CCD camera, photometer, filters, Radio telescopes, interferometry, Need of telescopes in orbit: HST, Chandra.	**12**
2	**Star and Star Systems:** Sun a typical star: Sun: Hydrostatic Equilibrium, Atmosphere, Solar Cycle, Solar Activity, Butterfly diagram, Coronal Mass ejections and effect on Earth's Atmosphere. Stars life cycle: Energy generation in a star. (Nuclear), Spectral classification of stars, O, B, A, F, G, K, M. HR diagram: Significance. Cepheids /RR Lyrae variables as distance indicators, Neutron stars. Evidence of black holes, Chandrasekhar limit.	**10**
3	**Galaxies and AGNs:** Galaxy types, formation and evolution. Galaxy clusters. Active Galactic Nuclei – AGNs their types. AGN - the central engine.	**4**

4	**Cosmology introduction:** Olbers' Paradox. Big Bang and Expanding Universe. Cosmic Microwave Background. Hubble's law with equation, its significance. Concept of space time, Fate of our universe. Evidence of Dark Matter and Dark Energy.	**4**

Learning Resources- References

Sr. No.	References
1.	Astronomy, A Physical Perspective, Marc Kutner: (Cambridge University Press)
2.	Astrophysics for physicists, Arnab Rai Choudhuri, Cambridge University Press.
3.	Structure of the Universe, J. V. Naralikar.
4.	The physical universe, An Introduction to astronomy, Frank H. Shu, Uni. Sci. Books
5.	Astronomy, A Physical Perspective, Marc Kutner: (Cambridge University Press)
6.	Astrophysics for physicists, Arnab Rai Choudhuri, Cambridge University Press.
7.	An introduction to Cosmology, J. V. Naralikar, Cambridge University Press.

	PHY-361 - Physics Practical-8 Major-Practical	
	Number of Credits: 02 **No. of Hours: 60**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Describe different experimental techniques to determine values of various constants, coefficients, parameters.	1
CO2	Arrange the apparatus as per the requirements of the aims and objectives of the experiment.	2
CO3	Demonstrate the procedure to perform the experiments and the skills required for the experiment.	3
CO4	Explain the theory behind the formulae used and validate the hypotheses.	4
CO5	Standardize the entire procedure to obtain reliable, repeatable results.	5
CO6	Perform the experiment, tabulate the data, identify the sources of errors, and show how to minimize the errors.	6

PHY-361 - Physics Practical-8
(Major - Practical)

Experiment No.	Title of Experiment
1	Wavelength of He-Ne Laser by Reflection Greeting
2	Beam Divergence of Diode Lase
3	Magnetic Susceptibility of $FeCl_3$
4	Specific Heat of Graphite
5	G. M. Tube Characteristics
6	Solar constant
7	Temperature of Sun
8	Solar Cell panels and Fill factor, solar cooker
9	Calorific Value of wood and efficiency of Domestic water Heater
10	Study of Electricity generation using Windmill

Learning Resources- References

Sr. No.	References
1.	Advanced Practical Physics Worsnop and Flint, B. L. Worsnop, H. T. Flint, Littlehampton Book Services Ltd.
2.	Advanced Practical Physics, S. P. Singh, Pragati Prakashan
3.	A Course of Experiments with He-Ne Lasers, Rajpal S. Sirohi, New Age International

	PHY-362 - Physics Practical-9 Major-Practical	
	Number of Credits: 02 No. of Hours: 60	
Course Outcomes (COs) On completion of the course, the students will be able to:		**Bloom's cognitive level**
CO1	Describe different experimental techniques to determine values of various constants, coefficients, parameters.	1
CO2	Arrange the apparatus as per the requirements of the aims and objectives of the experiment.	2
CO3	Demonstrate the procedure to perform the experiments and the skills required for the experiment.	3
CO4	Explain the theory behind the formulae used and validate the hypotheses.	4
CO5	Standardize the entire procedure to obtain reliable, repeatable results.	5
CO6	Perform the experiment, tabulate the data, identify the sources of errors, and show how to minimize the errors.	6

PHY-362 - Physics Practical-9
(Major - Practical)

Experiment No.	Title of Experiment
1	RS and JK flipflop
2	Four-bit Shift Register Using IC 7495
3	Verification of De Morgan's Theorem
4	Study of Diode ROM array using IC 74LS138
5	Study of IC 74LS138 3:8 decoder
6	Matrix Multiplication, Ascending/Descending Numbers Using Arrays
7	Simpson's 1/3 Rule /Trapezoidal Rule
8	Newton-Raphson's Method
9	Use of Pointers, Arrays and Loops
10	Legendre Polynomial/Bessel Recurrence Relation
11	Factorial of a number, first 100 prime numbers
12	Graphics – line, circle, arc, ellipse, rectangle, concentric circles

Learning Resources- References

Sr. No.	References
1.	Advanced Practical Physics Worsnop and Flint, B. L. Worsnop, H. T. Flint, Littlehampton Book Services Ltd.
2.	Advanced Practical Physics, S. P. Singh, Pragati Prakashan
3.	A Course of Experiments with He-Ne Lasers, Rajpal S. Sirohi, New Age International

	PHY-382 - Physics Practical-10 (Project) **VSC-Practical**	
	Number of Credits: 02 **No. of Hours: 60**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Describe the necessity, need, relevance and importance of the project undertaken.	1
CO2	Outline the work into small tasks like reference work, collection of equipment and materials, the apparatus as per the requirements of the aims and objectives of the project, actual performance of experiment, data collection etc.	2
CO3	Carry out the experiments as per the designed procedure to achieve the goals	3
CO4	Explain the theory behind the formulae used, collect and analyze the data and validate the hypotheses.	4
CO5	Standardize the entire procedure to obtain reliable, repeatable results. Compare and contrast, if necessary, with the published data to Justify the results obtained.	5
CO6	Prepare a project report, compile and quote the references properly. Develop an ability to communicate effectively and present project work to a panel of experts.	6

	PHY-371 - Modern Physics Minor-Theory	
	Number of Credits: 02 **No. of Hours: 30**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Understand the concepts of modern physics and their implications.	1
CO2	Illustrate the fundamental concepts of Modern Physics.	2
CO3	Apply the concepts of modern physics to different subjective and numerical problems.	3
CO4	Explain the outcomes of real-world problems.	4
CO5	Justify the role of modern physics in development of potential applications.	5
CO6	Develop an intuition towards realistic applications in the physical world.	6

PHY-371 - Modern Physics
(Minor - Theory)

Unit No.	Title of Unit and Contents	No. of hours
1	**Special theory of Relativity:** Michelson-Morley Experiment and its outcome, Postulates of Special Theory of Relativity, Lorentz Transformation equations (no derivation), Lorentz contraction, Time dilation. Variation of mass with velocity. Mass energy Equivalence.	**8**
2	**Wave particle duality:** Black body radiation, Photo electric effect, Compton effect, Bohr's model of hydrogen atom and De-Broglie matter waves. (Qualitative discussion only)	**7**
3	**Introduction to Lasers:** Ordinary light and Lasers (comparison of properties), Absorption, Spontaneous Emission and Stimulated Emission, Metastable state, population inversion, components of laser, Ruby laser and He-Ne laser, Applications of laser: Industrial and biomedical applications.	**8**
4	**Nanoscience:** What is Nano? How subtle? What is Nanoscience and Nanotechnology? Nanostructures in nature, Man-made Nano Materials One Dimensional, Two-Dimensional, Three-Dimensional Nano Materials, Properties of Nano Materials.	**7**

Learning Resources- References

Sr. No.	References
1.	Concepts of Physics, Volume II, H. C. Verma, Publisher Bharati Bhavan.
2.	Concepts of Modern Physics, Aurther Beiser, Mac-Graw Hill.
3.	Fundamentals of Nanoscience by Sulbha Kulkarni.

	PHY-395 – On Job Training (OJT) **Major** **Theory/Practical**	
	Number of Credits: 04 **No. of Hours: 120**	