



Teaching & Examination Scheme for

2-Year M.Sc. (Physics)

(Academic Session: 2026-28)

**SCHOOL OF APPLIED SCIENCES
SURESH GYAN VIHAR UNIVERSITY, JAIPUR
RAJASTHAN-302017**

Program Outcomes (POs) for Master of Science program

PO1	Knowledge & Life-Long Learning: Acquisition of knowledge for the development of comprehensive aptitude and interdisciplinary skill set that are necessary for participating in learning activities throughout life. Professional competence with characteristic knowledge-bank, mind-set and pragmatic wisdom in their chosen fields
PO2	Research Aptitude: Capability to ask relevant/appropriate questions for identifying, formulating and analyzing the research problems and looking for solutions
PO3	Communication: Ability to communicate effectively on general and professional platforms for the dissemination of acquired knowledge
PO4	Individual and Team Work: Capable to learn and work effectively as an individual, and as a member or leader in diverse teams, in trans/multidisciplinary settings
PO5	Investigation of problem & solutions: Ability of critical thinking, analytical reasoning and research based knowledge to find out the problem and capability of applying knowledge to solve scientific and other problems
PO6	Modern Tool usage: Ability to use and learn techniques, and modern tools for general and scientific practices
PO7	Science and Social responsibility: Ability to learn responsibilities relevant to the professional scientific practices and developing the desired sense of being seasoned and exhibit unequivocal spiritedness with excellent qualities of productive contribution to society and nation in the arena of science and technology
PO8	Ethics: Individual grooming in understanding of ethical principles and responsibilities, moral and social values in day-to-day life thereby attaining cultural and civilized personality

Program Specific Outcomes (PSOs)

After successful completion of M. Sc. Physics program, the students will

PSO1	Academic knowledge: Acquire an in-depth understanding and knowledge of the core areas of Physics encompassing mathematical physics, classical mechanics, quantum mechanics, electrodynamics, and statistical mechanics to appreciate how diverse phenomena observed in nature follow from a small set of fundamental laws
PSO2	Research competence: Develop hands-on skills for carrying out elementary as well as advanced experiments in different sub-fields of Physics such as nuclear physics, condensed matter physics, nanoscience, nuclear physics, lasers and electronics
PSO3	Social accomplishment: Cultivate a strong research aptitude and develop job oriented analytical skills on an advanced level needed in industry, consultancy, education, research or public administration

GYAN VIHAR SCHOOL OF APPLIED SCIENCES
Teaching and Examination Scheme for
2-year M.Sc. Physics
EFFECTIVE FROM ACADEMIC SESSION 2026-28

Year: I

Semester: I (AUTUMN/PAVAS)

S. No.	Course Code	Course Name	Course Type	Credits	Contact Hrs/Wk.			Exam Hrs.	Weightage (in%)	
					L	T/S	P		CIE	ESE
A	University Core									
1	SODECA-I	Proficiency and Co-Curricular Activities -I	AECC	2	0	0	0	0	100	0
B	Program Core									
1	PH9001	Classical Mechanics	DCC	4	3	1	0	3	40	60
2	PH9002	Quantum Mechanics	DCC	4	3	1	0	3	40	60
3	PH9003	Mathematical Physics	DCC	4	3	1	0	3	40	60
4	PH9004	Electronics	DCC	4	3	1	0	3	40	60
5	PH9005	Physics Lab –I	SEC	3	0	0	6	3	60	40
C	Program Electives									
D	University Elective									
		Opt from the list of University Electives								
		TOTAL		21						

NOTE: The University Electives are apart from minimum credits required for award of degree.

L= Lecture
S= Seminar

T=Tutorial
P= Practical

CIE=Continuous Internal Evaluation
ESE= End Semester Examination

Signature of Concerned Teacher

Signature of Convener-BOS

Signature of Member Secretary



GYAN VIHAR SCHOOL OF APPLIED SCIENCES
Teaching and Examination Scheme for
2-year M.Sc. Physics
EFFECTIVE FROM ACADEMIC SESSION 2026-28

Year: I
(SPRING/BASANT)

Semester: II

S. No.	Course Code	Course Name	Course Type	Credits	Contact Hrs/Wk.			Exam Hrs.	Weightage (in%)	
					L	T/S	P		CIE	ESE
A	University Core									
1	SODECA-II	Proficiency in Co-Curricular Activity II	AECC	2	0	0	0	0	100	0
B	Program Core									
1	PHX001	Electrodynamics and Electromagnetic Theory	DCC	4	3	1	0	3	40	60
2	PHX002	Condensed Matter Physics	DCC	4	3	1	0	3	40	60
3	PHX003	Atomic and Molecular Physics	DCC	4	3	1	0	3	40	60
4	PHX004	Statistical Mechanics	DCC	4	3	1	0	3	40	60
5	PHX005	Physics Lab –II	SEC	3	0	0	6	3	60	40
6	PHX006	Seminar-I	SEC	1	0	2	0	1	100	0
7	PHX007	Summer Internship	DPR	1	0	1	0		100	0
C	Program Electives									
D	University/Open Elective									
		Opt from the list of University Electives								
		Total		23						

NOTE: The University Electives are apart from minimum credits required for award of degree.

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GYAN VIHAR SCHOOL OF APPLIED SCIENCES
Teaching and Examination Scheme for
2-year M.Sc. Physics
EFFECTIVE FROM ACADEMIC SESSION 2026-28

Year: II
(Autumn/PAVAS)

Semester: III

S. No.	Course Code	Course Name	Course Type	Credits	Contact Hrs/Wk.			Exam Hrs	Weightage (in%)	
					L	T/S	P		CIE	ESE
A	University Core									
1	SODECA-III	Proficiency and Co-Curricular Activities – III	AECC	2	0	2	0	0	100	0
B	Program Core									
1	PHY001	Nuclear and Particle Physics	DCC	4	3	1	0	3	40	60
2	PHY002	Experimental Techniques of Physics	DCC	4	3	0	1	3	40	60
3	PHY003	Research Methodology & Intellectual Property Rights (IPR)	SEC	4	3	1	0	3	40	60
4	PHY004	Physics Lab –III	SEC	3	0	0	6	3	60	40
5	PHY005	Minor project	DPR	3	0	0	3	1	100	0
C	Program elective (Any Two)									
1		Elective I	DSE	3	3	0	0	3	40	60
2		Elective –II	DSE	3	3	0	0	3	40	60
3	PHY006	MOOC (through SWAYAM/ NPTEL etc) Under Credit Transfer Scheme	DSE	3	3	0	0	3	40	60
D	University/Open Elective									
		Opt from the list of University Electives								
		Total		26						

NOTE: The University Electives are apart from minimum credits required for award of degree.

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P= Practical

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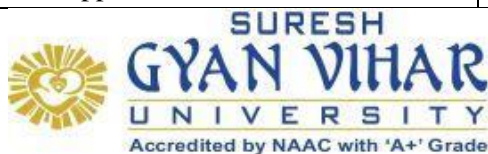
Signature of Convener-

Signature of Member Secretary

Elective paper

1.	Microwave Electronics	PHY007
2.	Computational Physics	PHY008
3.	Nanotechnology	PHY009
4.	Energy Storage Systems	PHY010

5.	Solar Energy and Applications	PHY011
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GYAN VIHAR SCHOOL OF APPLIED SCIENCES
Teaching and Examination Scheme for
2-year M.Sc. Physics
EFFECTIVE FROM ACADEMIC SESSION 2026-28

Year: II
(Spring/BASANT)

Semester: IV

S. No.	Course Code	Course Name	Course Type	Credits	Contact Hrs/Wk.			Exam Hrs	Weightage (in%)	
					L	T/S	P		CIE	ESE
A		University core								
B		Program Core								
1	PHZ001	Dissertation / Major Project	DPR	20	0	0	34	1	0	100
C		Program Elective (Any one)								
D		University/Open elective								
		Opt from the list of University Electives								
		Total		20						

NOTE: The University Electives are apart from minimum credits required for award of degree.

L= Lecture
S= Seminar

T=Tutorial
P= Practical

CIE=Continuous Internal Evaluation
ESE= End Semester Examination

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Total Credit: 90

List of Courses

Abbreviations: DCC-Discipline Core Courses, AECC-Ability Enhancement Compulsory Courses, DPR-Dissertation/Project/Field Study SEC- Skill Enhancement Course DSE - Discipline Specific Elective GE - Generic Elective AECC

Type	Level	Sem.	BoS	Course Code	Course Name	Credits			
						L	T/S	P	Total
SEMESTER I									
AECC	6.5	I	SOA	SODECA9001	Proficiency and Co-Curricular Activities – I	0	0	0	2
DCC	6.5	I	SOA	PH9001	Classical Mechanics	3	1	0	4
DCC	6.5	1	SOA	PH9002	Quantum Mechanics	3	1	0	4
DCC	6.5	1	SOA	PH9003	Mathematical Physics	3	1	0	4
DCC	6.5	1	SOA	PH9004	Electronics	3	1	0	4
DSE	6.5	1	SOA	PH9005	Physics Lab –I	0	0	6	3
SEMESTER II									
AECC	6.5	2	SOA	SODECAX001	Proficiency in Co-Curricular Activity II	0	0	0	2
DCC	6.5	2	SOA	PHX001	Electrodynamics and Electromagnetic Theory	3	1	0	4
DCC	6.5	2	SOA	PHX002	Condensed Matter Physics	3	1	0	4
DCC	6.5	2	SOA	PHX003	Atomic and Molecular Physics	3	1	0	4
DCC	6.5	2	SOA	PHX004	Statistical Mechanics	2	1	0	4
DSE	6.5	2	SOA	PHX005	Physics Lab –II	0	0	6	3
DCC	6.5	2	SOA	PHX006	Seminar-I	0	2	0	1
DCC	6.5	2	SOA	PHX007	Summer Internship	0	0	2	1
SEMESTER III									
AECC	6.5	3	SOA	SODECAY001	Proficiency and Co-Curricular Activities – III	0	0	0	2

DCC	6.5	3	SOA	PHY001	Nuclear and Particle Physics	3	1	0	4
DCC	6.5	3	SOA	PHY002	Experimental Techniques of Physics	3	1	0	4
SEC	6.5	3	SOA	PHY003	Research Methodology & Intellectual Property Rights (IPR)	3	1	0	4
DSE	6.5	3	SOA	PHY004	Physics Lab –III	0	0	6	3
SEC	6.5	3	SOA	PHY005	Minor project	0	6	0	3
DCC	6.5	3	SOA	PHY007	Microwave Electronics	3	0	0	3
DCC	6.5	3	SOA	PHY008	Computational Physics	3	0	0	3
DCC	6.5	3	SOA	PHY009	Nanotechnology	3	0	0	3
DCC	6.5	3	SOA	PHY010	Energy Storage Systems	3	0	0	3
DCC	6.5	3	SOA	PHY011	Solar Energy and Applications	3	0	0	3
DCC	6.5	3	SOA	PHY006	MOOC (through SWAYAM/ NPTEL etc) <i>Under Credit Transfer Scheme</i>	3	0	0	3
SEMESTER IV									
DPR	6.5	4	SOA	BTZ001	Dissertation/ Project work	0	0	34	20

Type of Course	No. of courses in the proposed scheme	No. of credits
AECC	3	6
SEC	2	7
DCC	14	48
DSE	3	9
DPR	1	20
Total Credits		90

SEMESTER: I
Core

Program

PH9001	Classical Mechanics	Credits 4 (L:T:P = 3:1:0)	Hrs
Version	1.0		
Pre-requisite:	All students are expected to have a general knowledge of Newton's laws and with basic physics concepts such as mass, moments of inertia, length, force and time		
Objective:	To provide tools and applications of classical mechanics that student can use these in various branches of physics		
Course outcomes (CO)	<p><i>CO1:</i> Demonstrate a basic and advanced knowledge of Lagrangian formulations and solve related problems</p> <p><i>CO2:</i> Identify the cyclic coordinates and understand their importance in Hamiltonian formulation</p> <p><i>CO3:</i> Gain basic idea of variational principles and the use of Hamilton-Jacobi theory for finding the solutions of various Classical systems</p> <p><i>CO4:</i> Acquire knowledge of canonical Transformation and various generating functions for this transformation</p> <p><i>CO5:</i> Demonstrate the concept of motion of a particle under central force and apply advanced methods to deal with central force problems.</p>		
UNIT-I	Lagrangian Dynamics		9
	Newton's Laws; Coordinates system, Degree of freedom; Constraints of motion; Generalized coordinates; principle of Virtual work; D'Alambert's principle and its applications; Lagrange's Equation from D'Alambert's principle; Lagrange's equation for conservative, non-conservative and dissipative systems; Generalized potential; Symmetry properties of space, time and conservation laws.		
UNIT-II	Hamiltonian Dynamics		9
	Hamilton's principle, Lagrange's Equation from Hamilton's principle; Generalized momentum and Cyclic coordinates; Conservation theorems; Hamilton's function, Jacobi's Integral, conservation of energy; Hamilton's equation, Hamilton's equation from D'Alambert's principle; Hamiltonian equation in different coordinate systems, Examples of Hamiltonian Equation; Routh's procedure.		
UNIT-III	Variational Principles & Hamilton-Jacobi Theory		11
	Euler-Lagrange's equation; modified Hamilton's principle, Deduction of Hamilton's equations from modified Hamilton's principle, Extension of Hamilton's Principle for nonconservative and nonholonomic systems; Method of Lagrange's multipliers, Principle of least action; Principle to conservative systems; Hamilton-Jacobi Equation for Hamilton's Principle Function, Kepler's problem as an example of Hamilton-Jacobi Method.		
UNIT-IV	Canonical transformation		10
	Canonical transformation; Legendre transformation; Generating functions; Bilinear invariant conditions; Integral invariant of Poincare; Infinitesimal contact transformation; Poisson brackets, Equation of motion in Poisson bracket, Angular momentum and Poisson bracket relations, Lagrange's and Poisson brackets as canonical invariants; Liouville's theorem.		
UNIT-V	Two body central force problem		9
	Reduction of two body central force problem to the equivalent one body problem; Equations of motion under Central force and first integrals; Differential equation for the orbit Inverse square law of force; The Kepler Problem, Deduction of Kepler's laws; Stability of orbit under central force; Scattering in Central Force Field.		
		Total hours	48
References & Text Books	<ol style="list-style-type: none"> H. Goldstein, C. P. Poole, J. L. Safko, Classical Mechanics, Pearson Education 3rd edition, (2002) S.T. Thornton and J.B. Marion, Classical Dynamics of Particles and Systems (Cengage Learning, Boston/Massachusetts, United State), 5th edition, 2013 J.C. Upadhyaya, Classical Mechanics, Himalaya Publishing House, 3rd edition, (2023) G. Aruldas, Classical mechanics. PHI Learning Pvt. Ltd. (2008) https://nptel.ac.in/courses/115/106/115106123/ https://nptel.ac.in/courses/115/106/115106068/ 		
Mode of Evaluation: (Percent Weightage)	<ol style="list-style-type: none"> Mid-Term (10%); Weekly test (10%); Graded assignment (10%) Written examination (70%) 		
Recommended by BOS on:			
Approved by Academic Council on :			

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)								Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	3	0	3	2	3	2	3	2	3
CO2	3	3	0	0	2	2	1	2	3	1	2
CO3	3	2	1	2	3	3	2	3	3	3	2
CO4	3	3	0	0	3	1	1	1	3	2	3
CO5	3	3	0	0	3	1	3	2	3	2	3

3: High, 2: Medium, 1: Low

SEMESTER: I

Program Core

PH9002	Quantum Mechanics	Credits 4 (L:T:P = 3:1:0)	Hrs
Version	1.0		
Pre-requisite:	All students are expected to have a general knowledge of calculus, linear algebra, and basic classical mechanics		
Objective:	To provide the basic concepts of quantum mechanics and various formalism of quantum mechanics with simple examples		
Course outcomes (CO)	<i>CO1:</i> Explain the theories and phenomena of vector space, operators and Dirac's notations, to solve the various quantum mechanics problems <i>CO2:</i> Analyze the solution of harmonic oscillator problems and recognize the importance of angular momentum <i>CO3:</i> Comprehend on how perturbation can remove the degeneracy, particularly explanation of the Zeeman effect. <i>CO4:</i> Grasp the basics of non-relativistic quantum scattering theory, and learn the partial waves method for deriving scattering cross-sections <i>CO5:</i> Explicate the Klein-Gordon and Dirac equations		
UNIT-I	Formulation of Quantum Mechanics		10
Limitations of Classical Mechanics and foundation of Quantum Mechanics; Linear vector spaces and Hilbert space; Orthonormality, completeness and closure properties; Hermitian operator; Eigenvalues and eigenvectors; Position and momentum space wave function; Generalized Heisenberg uncertainty principle; Dirac notation, Postulates of quantum mechanics, Schrödinger wave equation (time dependent and time independent); Expectation values and Ehrenfest theorem.			
UNIT-II	Harmonic Oscillator & Angular Momentum		10
Solution of harmonic oscillator problem by the operator method, Ladder operators, normalization, Orthonormality; Commutation relations of angular momentum operators; Eigen values and Eigen functions of L^2 and L_z , Ladder operators and their matrix representations; Spin one-half: Spin Eigen functions, Pauli spin matrices; Addition of angular momenta; Clebsch-Gordan coefficients; Coupling of orbital and spin angular momenta; Wigner-Eckart Theorem.			
UNIT-III	Approximation methods for stationary and time-dependent perturbations		10
Stationary systems: Time independent perturbation theory, non-degenerate and degenerate; Application to Zeeman effect; General formulation of WKB method, Application of WKB method. Time dependent problems: Time dependent perturbation theory; Transition to a continuum of final states- Fermi's Golden rule.			
UNIT-IV	Scattering Theory		9
Differential cross-section; Scattering of a wave packet, Integral equation for the scattering amplitude; Born approximation; Method of partial waves; low energy scattering and bound states.			
UNIT-V	Relativistic Quantum Mechanics		9
Klein-Gordon and Dirac equations; Properties of Dirac matrices, Plane wave solutions of Dirac equation; Spin and magnetic moment of the electron; Nonrelativistic reduction of the Dirac equation.			
Total hours			48
References & Text Books	<ol style="list-style-type: none"> 1. N. Zettili, Quantum Mechanics-Concepts and Applications (John Wiley & Sons Ltd., Sussex, U.K.) 2nd edition (2009) 2. D.J. Griffith, Introduction to Quantum Mechanics, Cambridge University Press, 3rd edition (2018) 3. Quantum Physics by H.C. Verma, TBS Publications, 2nd edition (2012) 4. R.Shankar, Principles of Quantum Mechanics, Springer, 2nd edition (2012) 5. L.I. Schiff, Quantum Mechanics, Mc-Graw Hill 6. https://nptel.ac.in/courses/115/104/115104096/ 7. https://nptel.ac.in/courses/115/101/115101107/ 		
Mode of Evaluation: (Percent Weightage)	<ol style="list-style-type: none"> 1. Mid-Term (10%); Weekly test (10%); Graded assignment (10%) 2. Written examination (70%) 		
Recommended by BOS on:			
Approved by Academic Council on :			

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)								Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	2	3	0	2	3	1	3	3	2	3
CO2	3	3	0	0	2	3	3	2	3	3	2
CO3	3	3	0	3	3	3	2	3	3	3	3
CO4	3	3	0	2	3	3	3	3	3	2	2
CO5	3	2	0	0	2	2	2	2	3	2	3

3: High, 2: Medium, 1: Low

SEMESTER: I

Program Core

PH9003	Mathematical Physics	Credits 4 (L:T:P = 3:1:0)	Hrs
Version	1.0		
Pre-requisite:	All students are expected to have a general knowledge of vector spaces, matrix algebra, differential equations, integral equations and integral transforms		
Objective:	To familiarize the students with the idea about tensors, group theory, special functions and complex functions		
Course outcomes (CO)	<p><i>CO1:</i> Learning about vectors and understanding basics of Tensors and group theory</p> <p><i>CO2:</i> Find explicit expressions of Legendre, Bessel, Hermite and Laguerre polynomials using the corresponding generating functions and derive various recurrence relations among these special functions</p> <p><i>CO3:</i> Derive Cauchy integral theorem and Cauchy integral formula and find Taylor and Laurent series expansion of functions of complex variable</p> <p><i>CO4:</i> Find the Fourier series expansion and develop Fourier integrals with various applications</p> <p><i>CO5:</i> Learn properties of Fourier and Laplace transforms and evaluate the Fourier and Laplace transforms of functions and derivatives</p>		
UNIT-I	Tensors & Group Theory		10
Tensors: Coordinate transformations, scalars, contravariant and covariant vectors; Definition of contra variant, mixed and covariant tensor of second rank, Addition, subtraction and contraction of tensors; Quotient rule; Christoffel symbols, Transformation of Christoffel symbols; Covariant differentiation; Ricci's theorem; divergence, Curl and Laplacian tensor form; Stress and strain tensors, Hook's law in tensor form. Group theory: Group postulates; Lie group and generators; Representation; Commutation relations, SU(2), O(3).			
UNIT-II	Special Functions		9
Legendre, Bessel, Hermite and Laguerre functions: recurrence relations, parity, orthogonality and special properties; Spherical harmonics and associated Legendre functions; Green's function; Sturm-Liouville systems and orthogonal polynomials.			
UNIT-III	Complex Variables		10
Functions of complex variable; Analytical function; Properties of analytical functions; Derivatives of analytical functions; Cauchy-Riemann equations, Cauchy Integral theorem; Power series Taylor's and Laurent's series; Calculus of residues: Poles, Essential singularities and branch points, Residue theorem, Singularities on contours of integration; Evaluation of definite integrals; Cauchy residue theorem and applications of the residue theorem.			
UNIT-IV	Fourier Transforms		10
Development of the Fourier integral from the Fourier Series; Fourier and inverse transform, Fourier transform simple applications: Finite wave train, Wave train with Gaussian amplitude; Fourier transform of derivatives; Solution of wave equation as an application; Convolution theorem; Intensity in terms of spectral density for quasi monochromic EM Waves, Momentum representation; Application of Fourier transform to diffraction theory: diffraction pattern of one and two slits.			
UNIT-V	Laplace transforms and Numerical Techniques		9
Laplace transforms and their properties, derivatives and integral of Laplace transform; Convolution theorem; Impulsive function; Application of Laplace transform in solving linear, differential equations with constant coefficient, with variable coefficient and linear partial differential equation. Elements of computational techniques: root of functions, interpolation, extrapolation, integration by trapezoid and Simpson's rule, Solution of first order differential equation using RungeKutta method. Finite difference methods.			
Total hours			48
References & Text Books	<ol style="list-style-type: none"> 1. G. Arfken, H. Weber and F. Harris, Mathematical Methods for Physicists (Elsevier Academic Press, Massachusetts, USA) 2012. 2. P K Chattopadhyay, Mathematical Physics, Wiley Eastern Lit., Mumbai (2000) 3. Mathematical Physics by Satya Prakash, S Chand and Sons, New Delhi, 7th edition (2021) 4. https://nptel.ac.in/courses/115/106/115106086/ 5. https://nptel.ac.in/courses/115/105/115105097/ 		
Mode of Evaluation: (Percent Weightage)	<ol style="list-style-type: none"> 1. Mid-Term (10%); Weekly test (10%); Graded assignment (10%) 2. Written examination (70%) 		
Recommended by BOS on:			
Approved by Academic Council on :			

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)								Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	2	2	0	3	3	1	3	3	2	3
CO2	3	2	0	0	3	3	2	3	3	2	2
CO3	3	3	0	0	3	3	3	3	3	2	3
CO4	3	2	0	0	3	3	2	3	3	2	3
CO5	3	3	0	3	3	3	3	3	3	2	3

3: High, 2: Medium, 1: Low

SEMESTER: I**Program Core**

PH9004	Electronics	Credits 4 (L:T:P = 3:0:0)	Hrs
Version	1.0		
Pre-requisite:	All students are expected to have a fundamental level knowledge of linear and non-linear analog electronics		
Objective:	To familiarize the students with the idea of electronic devices, circuits, operations, signal processing and their applications.		
Course outcomes (CO)	<p><i>CO1:</i> Design and analyze reactive networks, two-port networks with employing relevant theorems and parameters effectively</p> <p><i>CO2:</i> Obtain a fair understanding of the steps involved in the fabrication of electronic devices like p-n junctions, transistors, BJT, MOSFET, FET, Schottky diodes</p> <p><i>CO3:</i> Design and comprehend a host of OPAMP</p> <p><i>CO4:</i> Gain a fair understanding of the operation and applications of digital electronics</p> <p><i>CO5:</i> Understand the electronics instruments essential for practical applications in electronics</p>		
UNIT-1	Introduction to Network		8
	Network analysis: Kirchhoff's Laws and Star-Delta networks. Network theorems: Superposition, Thevenin, Norton, & Maximum Power Transfer. Two port networks: z, y, h, and t parameters.		
UNIT-II	Electronic Devices		10
	Review of p-n junction, Schottky diode, metal-semiconductor and metal-oxide semiconductor junctions, Field effect transistor and its small signal model, CS and CD amplifiers at low frequencies, Biasing the FET, CS and CD amplifiers at high frequencies. Characteristics of some semiconductor devices- BJT, JFET, & MOSFET		
UNIT-III	Operational Amplifiers		10
	Op-Amp Circuits: Characteristics of ideal and practical op-amp, Amplification, Applications of operational amplifiers: Inverting and non-inverting amplifiers, Summing, difference, integrating, differentiating amplifiers.		
UNIT-IV	Digital Electronics		10
	Boolean algebra; Demorgan's theorems; standard forms of Boolean expressions, K-map, number systems and codes, Half and Full Adders; Flip-Flops, Shift registers, counter.		
UNIT-V	Electronic Instruments		10
	A/D and D/A converter, photodiode, solar cell, photo detectors, LEDs, Transducers, 8085 microprocessor, Regulated Power supplies, phase shift and Wien bridge oscillators, digital oscilloscopes, phase-sensitive detectors.		
		Total hours	48
References & Text Books	<ol style="list-style-type: none"> 1. J. Millman, C. Halkias and C. Parikh, Integrated Electronics: Analog and Digital Circuits and Systems (Tata McGraw - Hill Education, Noida, India) 2009. 2. R.L. Boylestad and L. Nashelsky, Electronic Devices and Circuit Theory (Pearson, New Delhi, India) 2009. 3. D. Chattopadhyay and P. C. Rakshit, Electronics: Fundamentals and Applications (New Age International, New Delhi, India) 2008. 4. B. L. Theraja, Basic Electronics: Solid State (S. Chand & Company Ltd., New Delhi, India) 2010. 5. P. Malvino and J.A. Brown, Digital Computer Electronics (Tata McGraw - Hill Education, Noida, India) 2011. 		
Mode of Evaluation: (Percent Weightage)	<ol style="list-style-type: none"> 1. Mid-Term (10%); Weekly test (10%); Graded assignment (10%) 2. Written examination (70%) 		
Recommended by BOS on:			
Approved by Academic Council on :			

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)								Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	2	3	3	3	2	0	3	3	3
CO2	3	3	2	3	3	3	3	0	3	3	3
CO3	3	3	3	3	3	3	2	0	3	3	3
CO4	3	3	3	3	3	3	3	0	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3

3: High, 2: Medium, 1: Low

SEMESTER: II
Program Core

PHX001	Electrodynamics and Electromagnetic Theory Credits 4 (L:T:P = 3:1:0)	Hrs
Version	1.0	
Pre-requisite:	All students are expected to have a a strong foundation in thermodynamics and calculus	
Objective:	To explains the phenomena associated with charged particles in motion and changing electric and magnetic fields with understanding of basic principle of electrical and electronic circuits	
Course outcomes (CO)	<p><i>CO1:</i> To understand the basics of electrostatics and <i>CO2:</i> Enhance skills for solving Boundary value problems especially using Method of images</p> <p><i>CO2:</i> Analyze electrostatics in diverse media, multipole expansions and boundary value problems</p> <p><i>CO3:</i> Understand the basic concepts of magnetostatics</p> <p><i>CO4:</i> To use of Maxwell equations conservation laws, gauge transformations, and Green functions in analyzing the electromagnetic phenomena</p> <p><i>CO5:</i> Would be able to apply Lorentz transformations, covariant forms of Maxwell's equations, and relativistic electrodynamics principles</p>	
UNIT-I	Electrostatics	9
Electric field, Gauss Law, Differential form of Gaussian law; Surface distribution of charges and dipoles and discontinuities in the electric field and potential; Poisson and Laplace equations; Green's Theorem; Formal Solutions of electrostatic boundary value problem with Green's function, Electrostatic potential energy and energy density; capacitance. Boundary Value Problems: Methods of Images, Green function for the sphere, General solution for the potential; conducting sphere with hemispheres at a different potentials; orthogonal functions and expansion.		
UNIT-II	Multipoles and Dielectrics	9
Multipole expansion, Multipole expansion of the energy of a charge distribution in an external field; Elementary treatment of electrostatics with permeable media; Boundary value problems with dielectrics, Molar polarizability and electric susceptibility; Models for molecular polarizability, electrostatic energy in dielectric media.		
UNIT-III	Magnetostatics	10
Biot-Savart law and Ampere's theorem; Electromagnetic induction, Vector potential and magnetic induction for a circular current loop; Magnetic fields of a localized current distribution; Boundary condition on B and H; Uniformly magnetized sphere; Magnetic Fields in Matter: Magnetization, dia-, para- and ferro-magnetic materials, Magnetic susceptibility and permeability.		
UNIT-IV	Time Varying Fields and Conservation Laws	8
Maxwell's equations; Vector and scalar potentials; Gauge transformations, Lorentz gauge, coulomb gauge; Poynting's Theorem and conservation of energy and momentum for a system of charged particles and EM fields.		
UNIT-V	Relativistic Electrodynamics	12
Lorentz' transformations law for the electromagnetic fields, Fields due to a point charge in uniform motion; Group symmetries of Lorentz' transformations; Electromagnetic field tensor; Relativistic electrodynamics using potential, Four vector formalism, Relativistic energy and momentum, transformation of four potentials and four currents, Relativistic transformations of electro-magnetic fields; Maxwell's equations in covariant form, Invariance of electric charge, covariance of electrodynamics.		
Total hours		48
References & Text Books	1. J.D. Jackson: Classical Electrodynamics, Wiley India (2004) 2. David J. Griffiths: Introduction to Electrodynamics, Benjamin Cummings (2012) 3. L.D. Landau and E.M. Lifshitz, Classical Theory of Electrodynamics, Addison-Wesley 4. Electricity And Magnetism Purcell 3rd Edition (2018) 5. https://nptel.ac.in/courses/115/106/115106122/	
Mode of Evaluation: (Percent Weightage)	1. Mid-Term (10%); Weekly test (10%); Graded assignment (10%) 2. Written examination (70%)	
Recommended by BOS on:		
Approved by Academic Council on :		

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)								Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	3	0	3	2	3	2	3	3	3
CO2	3	3	0	0	3	3	3	3	3	3	3
CO3	3	2	1	0	2	2	2	2	3	2	3
CO4	3	3	0	0	2	3	3	3	3	3	3
CO5	3	2	0	2	3	3	2	3	3	3	3

3: High, 2: Medium, 1: Low

SEMESTER: II

Program Core

PHX002	Condensed Matter Physics	Credits 4 (L:T:P = 3:1:0)	Hrs
Version	1.0		
Pre-requisite:	All students are expected to have a strong foundation in quantum mechanics, statistical mechanics, vector algebra & calculus, and simple geometry		
Objective:	To provide the student with a clear and logical presentation of the basic and advanced concepts and principles of solid state physics		
Course outcomes (CO)	<p><i>CO1:</i> Will understand the crystal structures, diffraction techniques, and methods for determining crystallographic properties in various materials</p> <p><i>CO2:</i> Comprehend various bonding types in crystals and defects</p> <p><i>CO3:</i> Have an understanding of thermal conductivity in solids, lattice vibrations, phonon concepts</p> <p><i>CO4:</i> Develop a semi-classical description of electrical and thermal transport in metals using the Boltzmann approach, with basic physical concepts (like band gap, holes, effective mass, etc.) related to semiconductors</p> <p><i>CO5:</i> Grasp principles of superconductivity, including critical temperatures, types, and the Meissner effect</p>		
UNIT-I	Crystal Structure		9
Crystal solids, unit cells, two- and three-dimensional Bravais lattices; Crystal systems, Crystal planes and Miller indices; Close packed structures; Symmetry elements in crystals, Point groups and space groups; Ewald construction; X-ray diffraction - bragg's law, methods; Reciprocal lattices and its applications to diffraction techniques; Brillouin zones; Atomic and geometric structure factor.			
UNIT-II	Bonding & Defects in Crystals		9
Bonding in crystal: Interatomic forces and types of bonding, Van der Waals bond, Cohesive energy of inert gas solids, Ionic bond, cohesive energy and bulk modulus of ionic crystals, Madelung constant. Defects in crystals: Point defects (Frenkel and Schottky), Line defects (Edge and Screw dislocation), Burger's vector, Dislocation density, Surface defects (Grain boundaries and stacking faults), Volume defects, Strength of Alloy, Role of dislocation in crystal growth.			
UNIT-III	Thermal Conductivity of Solids		10
Elastic properties of solids; Vibrations of linear monatomic and diatomic lattices: Acoustical and optical modes, Dispersion relation, Long wavelength limits; Optical properties of ionic crystal in the infrared region, Normal modes and phonons; Inelastic scattering of neutron by phonon; Einstein and Debye theories of specific heat.			
UNIT-IV	Free, Nearly-free and Tight Binding Approximations		11
Free electron theory, Boltzmann transport equation (Response and relaxation phenomena), Drude model of electrical and thermal conductivity and Sommerfeld theory, Density of states, Hall effect in metal, Band theory of solids; Nearly free electron theory, Electrons motion in periodic potentials, Bloch theorem, Kronig Penny model, Number of states in a band; Effective mass of an electron in a band; Classification of metal, Semiconductor (Direct and Indirect) and insulator, Carrier concentration in extrinsic and intrinsic semiconductors; Tight binding method			
UNIT-V	Magnetic Properties of Materials and Superconductivity		9
<p>Magnetic Properties of Materials : Classification of Magnetic Materials, Origin of Atomic Magnetism, Classical Langevin Theory of dia- and Paramagnetic Domains. Quantum theory of Paramagnetism. Curie's law. Weiss' Theory of Ferromagnetism. Concept of Domain Wall. Magnetostriction, Heisenberg's Exchange Interaction, Relation between Exchange Integral and Weiss Constant.</p> <p>Superconductivity: Superconductivity and its historical perspective, critical temperature, type-I and type II superconductors, persistent current, effect of magnetic field, Meissner effect, thermodynamics of superconductors.</p>			
Total hours			48
References & Text Books	<ol style="list-style-type: none"> 1. M.L. Cohen, Fundamentals of Condensed Matter Physics. 2. A. Aharony, Introduction to Solid State Physics, World Scientific. 3. P. M. Chaikin, Principles of Condensed Matter Physics, Cambridge University Press. 4. Charles Kittel, Introduction to Solid State Physics, Wiley India (2007) 5. https://archive.nptel.ac.in/courses/115/106/115106061/ 		
Mode of Evaluation: (Percent Weightage)	<ol style="list-style-type: none"> 1. Mid-Term (10%); Weekly test (10%); Graded assignment (10%) 2. Written examination (70%) 		
Recommended by BOS on:			
Approved by			

Academic Council on
:

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)								Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	3	0	3	3	3	3	3	3	3
CO2	3	2	0	0	2	3	2	3	3	3	3
CO3	3	3	0	3	2	2	3	2	3	2	3
CO4	3	3	0	2	3	3	3	3	3	3	3
CO5	3	3	0	0	2	3	3	3	3	3	3

3: High, 2: Medium, 1: Low

SEMESTER: II

Program Core

PHX004	Statistical Mechanics	Credits 4 (L:T:P = 3:1:0)	Hrs
Version	1.0		
Pre-requisite:	All students are expected to have a a strong foundation in thermodynamics and calculus		
Objective:	To evaluate the laws of classical thermodynamics for macroscopic systems using the properties of its atomic particles		
Course outcomes (CO)	<i>CO1:</i> Explain the laws of thermodynamic quantities with Maxwell's relations <i>CO2:</i> Learn the ensemble formulation of statistical mechanics, and apply these to calculate important thermodynamical quantities for microcanonical & canonical systems <i>CO3:</i> Formulate the quantum mechanical ensemble theory for grand canonical systems <i>CO4:</i> Illustrate the fundamental concepts of Bose-Einstein and Fermi-Dirac Statistics <i>CO5:</i> Construct and solve the Ising model, along with the Landau theory of phase transitions		
UNIT-I	Probability Theory and Brief Review of Thermal Physics		11
Elementary probability theory: Preliminary concepts; Random walk problem; Binomial distribution, Mean values, Standard deviation, Various moments; Gaussian distribution, Poisson distribution, Mean values; Probability density, Probability for continuous variables. Laws of thermodynamics and their consequences; Thermodynamic potential; Maxwell relations and their applications; Micro- and macro- states; Postulate of equal a priori probability; Contact between statistics and thermodynamics; Classical ideal gas; Entropy of mixing; Gibbs' paradox and its solution.			
UNIT-II	Elements of Ensemble Theory		10
Phase space and Liouville's theorem; Microcanonical ensemble theory and its application to classical ideal gas and simple harmonic oscillator; System in contact with a heat reservoir; Thermodynamics of canonical ensemble, Partition function; Classical ideal gas in canonical ensemble; Energy fluctuation.			
UNIT-III	Grand Canonical Ensemble		10
System in contact with a particle reservoir; Chemical potential; Grand canonical partition function; Physical significance of various statistical quantities; Classical ideal gas in grand canonical ensemble theory; Density and energy fluctuations; Clausius-Clapeyron equation.			
UNIT-IV	Quantum Statistical Mechanics		11
Bosons: occupation number, Bose-Einstein statistics, Thermodynamics of black body radiations specific heat of solids (Einstein model and Debye theory), Bose-Einstein condensation; Fermions: occupation number, Fermi-Dirac statistics, degenerate Fermi gas; Heat capacity of ideal Fermi gas at finite temperature, Pauli paramagnetism, Landau diamagnetism.			
UNIT-V	Phase Transitions		6
Thermodynamic phase diagrams, Super-fluidity in liquid He II, First and second order phase transitions, Dynamic model of phase transition, Ising model.			
Total hours			48
References & Text Books	1. F. Reif, Fundamentals of Statistical and Thermal Physics, McGraw Hill (2009) 2. R. K. Pathria, Statistical Mechanics, Elsevier, USA (2011) 3. B. B. Laud Fundamentals of Statistical Mechanics, New Age publication (2012) 4. https://nptel.ac.in/courses/115/103/115103113/ 5. https://nptel.ac.in/courses/115/106/115106111/		
Mode of Evaluation: (Percent Weightage)	1. Mid-Term (10%); Weekly test (10%); Graded assignment (10%) 2. Written examination (70%)		
Recommended by BOS on:			
Approved by Academic Council on :			

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)								Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	3	0	3	3	3	3	3	2	3
CO2	3	3	0	3	3	2	2	2	3	3	3
CO3	3	2	0	1	2	2	2	2	3	2	3
CO4	3	3	3	0	2	3	3	3	3	3	3
CO5	3	3	0	3	2	3	3	3	3	3	2

3: High, 2: Medium, 1: Low

SEMESTER: II
Program Core

PHX003	Atomic and Molecular Physics 3:0:0)	Credits 4 (L:T:P =	Hrs
Version	1.0		
Pre-requisite:	All students are expected to have a fundamental level knowledge of atoms and molecules		
Objective:	To provide atomic, molecular and spin resonance spectroscopy		
Course outcomes (CO)	<p><i>CO1:</i> Capable to understand atomic structure, spectra, and associated models</p> <p><i>CO2:</i> Understand of the energy spectrum of hydrogen, apply nondegenerate and degenerate perturbation methods, and understand Stark effects</p> <p><i>CO3:</i> Capable to understand the change in behavior of atoms in external applied electric field on atomic spectral lines, their selection rule</p> <p><i>CO4:</i> Comprehend various bonding theories and apply them to understand molecular bonding mechanisms in hydrocarbons</p> <p><i>CO5:</i> Description of the diatomic molecules and analysis the rotational, vibrational and Raman spectra of molecules</p>		
UNIT-I			9
Atomic Structure and Atomic Spectra Rutherford's Model and concept of stability of atom, Bohr's model, Sommerfeld's model, Stern-Gerlach experiment for electron spin, Revision of quantum numbers, exclusion principle, electron configuration, Hund's rule etc.			
UNIT-II			10
Gross structure of energy spectrum of hydrogen atom. Nondegenerate first order perturbation method, relativistic correction to energy levels of an atom, atom in a weak uniform external electric field – first and second order Stark effect, calculation of the polarizability of the ground state of hydrogen atom and of an isotropic harmonic oscillator; degenerate stationary state perturbation theory, linear Stark effect for hydrogen atom levels.			
UNIT-III			10
Orbital magnetic dipole moment, spin-orbit interaction energy, Hartree theory, LS coupling, origin of spectral lines, selection rules, some features of one-electron, two-electron spectra and X-ray spectra, fine spectra, hyperfine structure, Zeeman effect. Lamb shift (only qualitative description)			
UNIT-IV			9
The nature of chemical bonds, valence bond approach and molecular orbital approach for molecular bonding (for H ₂ molecule). Bonding and antibonding orbitals, pi- bonds, sigma - bonds, different kinds of bonding mechanism, Madelung constant, hybridization, bonding in hydrocarbons.			
UNIT-V			10
Molecular spectra: Rotational levels in diatomic and polyatomic molecules, vibrational levels in diatomic and polyatomic molecules, diatomic vibrating rotator, Born-Oppenheimer approximation, symmetry of the molecules and vibrational levels, experimental aspects of vibrational and rotational spectroscopy of molecules, polarization of light and Raman effect, Raman Spectroscopy.			
Total hours			48
References & Text Books	<ol style="list-style-type: none"> 1. Robert Eisberg and Robert Resnick, Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles, Wiley. 2. H. E. White, Introduction to Atomic Spectra, McGraw Hill. 3. Arthur Beiser, Perspectives of Modern Physics, McGraw Hill. 4. Gerhard Herzberg Molecular Spectra and Molecular Structure, Krieger Pub Co. 5. C. N. Banwell, Fundamentals of Molecular Spectroscopy, Tata McGraw Hill. 6. https://nptel.ac.in/courses/115/105/115105100/ 		
Mode of Evaluation: (Percent Weightage)	<ol style="list-style-type: none"> 1. Mid-Term (10%); Weekly test (10%); Graded assignment (10%) 2. Written examination (70%) 		
Recommended by BOS on:			
Approved by Academic Council on :			

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)								Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	3	0	2	3	3	3	3	3	3
CO2	3	3	0	3	2	2	3	2	3	3	3
CO3	3	2	0	0	3	2	2	2	3	3	3
CO4	3	2	3	0	2	1	1	1	3	3	3
CO5	3	2	0	3	3	3	2	3	3	3	3

3: High, 2: Medium, 1: Low

SEMESTER: III
Program Core

PHY001	Nuclear and Particle Physics	Credits 4 (L:T:P = 3:1:0)	Hrs
Version	1.0		
Pre-requisite:	All students are expected to have a fundamental level knowledge of bachelor-level knowledge of general physics and atoms		
Objective:	To educate about different forms of nuclear reactions as well as their energy levels		
Course outcomes (CO)	<p>CO1: Understand the nature of nuclear force, nuclear reactions with basic laws of radioactivity and spin dependence of nuclear forces</p> <p>CO2: Understand the phenomenon of radioactive decays and learn about the basic properties and characteristics of Nuclear forces, and their mediating particle</p> <p>CO3: Get knowledge about Nuclear models, Magic numbers, and Collective nuclear model</p> <p>CO4: Differentiate between different type of nuclear reactions, relevant aspects associated with nuclear reactions and kinematics of such reactions</p> <p>CO5: Grasp knowledge about elementary particle physics</p>		
UNIT-I	Basic Nuclear Properties		9
Properties of Nucleus & Nuclear Forces: Shape and size, mass and relative abundances, spin, Isospin, Mirror nuclei, Parity and symmetry; Magnetic dipole moment and electric quadrupole moment; binding energy & nuclear stability, nuclear compositions; Quantum properties of nucleon states; Saturation of nuclear force; properties of nuclear forces; two nucleon systems deuteron with potentials, n-p and p-p/n-n interactions at different energies, exchange forces and tensor forces; Yukawa's hypothesis, meson theory of nuclear force.			
UNIT-II	Radioactive Nuclear Decay		9
Laws of radioactivity, radioactive dating, radioactive series; Theory of alpha, beta & gamma decays and their properties, Electric and magnetic multipole moments and gamma decay probabilities in nuclear system (no derivations); Reduced transition probability, Selection rules; Internal conversion and zero-zero transition; Double beta decay.			
UNIT-III	Nuclear Models		10
Fermi gas model, liquid drop model and Bethe-Weizsacker formula, their applications; shell model and shell structure, extreme single particle shell model with potentials – square well, harmonic oscillator; spin orbit interaction, magic numbers, predictions of the shell model; collective nuclear model; superconductivity model (qualitative idea only), Collective Nuclear Models and characteristics.			
UNIT-IV	Nuclear Reactions & Nuclear detector		10
Types of nuclear reactions and conservation laws, nuclear reaction kinematics, nuclear scattering cross section determinations, compound nucleus disintegration, Breit Wigner dispersion formula (one level), direct reactions, nuclear transmutation reactions, nuclear fission and fusion, partial wave analysis of reaction cross section, compound nucleus formation and breakup, resonance scattering and reaction-Briet –Weigner dispersion formula for s-waves ($l=0$), continuum cross section, statistical theory of nuclear reactions Gas-filled detectors (ionization chambers, proportional counters, Geiger-Muller counters), Semiconductor detectors (silicon detectors, germanium detectors), Scintillation detectors (principles, applications)			
UNIT-V	Elementary Particle Physics		10
Units in high energy physics; Classification of particles- fermions and bosons, particles and antiparticles; Strange particles, Basic idea of different fundamental types of interactions with suitable examples; Quark flavors and their quantum numbers, Quarks as constituents of Hadrons, Qualitative idea of Quark confinement and asymptotic freedom, necessity of introducing the Color quantum no., Quark model, decay of pion and muon, Gell-Mann Nishijima formula, conservation laws.			
Total hours			48
References & Text Books	<ol style="list-style-type: none"> 1. B. Martin, Nuclear & Particle Physics an Introduction, John Wiley & Sons, Inc., New Jersey, USA (2011) 2. K.S. Krane, Introductory Nuclear Physics (John Wiley & Sons, Inc., New Jersey, USA) (2008) 3. D.J. Griffiths, Introduction to Elementary Particles (Wiley-VCH Verlag GmbH, Germany) (2008) 4. https://nptel.ac.in/courses/115/103/115103101/ 		
Mode of Evaluation: (Percent Weightage)	<ol style="list-style-type: none"> 1. Mid-Term (10%); Weekly test (10%); Graded assignment (10%) 2. Written examination (70%) 		
Recommended by BOS on:			
Approved by Academic Council on :			

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)								Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	2	0	3	3	3	3	3	3	3
CO2	3	3	0	0	3	3	3	3	3	3	3
CO3	3	2	0	1	3	3	1	3	3	3	3
CO4	3	2	0	0	3	2	2	2	3	3	3
CO5	3	3	0	3	3	3	3	3	3	3	3

3: High, 2: Medium, 1: Low

SEMESTER: III
Program Core

PHY002	Experimental Techniques in Physics	Credits 4 (L:T:P = 3:1:0)	Hrs
Version	1.0		
Pre-requisite:	All students are expected to have a fundamental level knowledge of basic solid state physics		
Objective:	To develop an appreciation of the role and significance of experimentation in the field of science		
Course outcomes (CO)	<p><i>CO1:</i> To choose an appropriate microscopy techniques to investigate microstructure of materials at high resolution</p> <p><i>CO2:</i> To determine crystal structure of specimen and estimate its crystallite size and stress</p> <p><i>CO3:</i> To apply thermal analysis techniques to determine thermal stability of and thermodynamic transitions of the specimen.</p> <p><i>CO4:</i> To use appropriate spectroscopic technique to measure vibrational/electronic transitions to estimate parameters like energy band gap</p> <p><i>CO5:</i> To be able to understanding the electrical and magnetic properties of materials in response of electric and magnetic environments</p>		
UNIT-1	Morphological analysis		10
	Field Emission Scanning Electron Microscope (FESEM) – Advantages over SEM, Transmission Electron Microscope (TEM), Selected Area Electron Diffraction (SAED) Probe Microscopy: Principle, Instrumentation and Working of Scanning Tunneling Microscope (STM) and Atomic Force Microscope (AFM).		
UNIT-II	Structural characterizations		9
	X-ray Diffraction: Production of X-rays, Types (continuous and characteristics), Bragg's diffraction condition, XRD principle and working; Techniques used for XRD: Laue's method, Rotating crystal method, Powder (DebyeScherrer) method, Derivation of Scherrer formula for size determination; Neutron Diffraction: Principle, Instrumentation and Working; Applications of XRD in bulk and nano-materials.		
UNIT-III	Thermal Analysis		9
	Principle, Instrumentation and Working: Thermo-gravimetric (TGA), Differential Thermal Analysis (DTA), Differential Scanning Calorimetry (DSC); Graphical analysis affecting various factors; Specific heat capacity measurements.		
UNIT-IV	Spectroscopic Characterization		10
	Principle, instrumentation and working principles: InfraRed (IR), Fourier Transform Infra-Red (FTIR), Raman, Ultraviolet-Visible (UV-VIS), Diffused Reflectance Spectroscopy (DRS), X-ray photoelectron spectroscopy (XPS), Photoluminescence (PL), Electron Spin Resonance (ESR), Nuclear Magnetic Resonance (NMR).		
UNIT-V	Electrical, Dielectric & Magnetic Characterization		10
	Electrical & Dielectric measurements: Measurement of electrical resistance: two probe, three probe and four probe methods, Magnetoresistance; I-V characteristics; electrochemical impedance analyzer. Magnetic Characterization: Principle, Instrumentation and Working of Vibrating Sample Magnetometer (VSM), Analysis of Hysteresis loop, SQUID Technique: Principle, Instrumentation and Working.		
Total hours			48
References & Text Books	<ol style="list-style-type: none"> 1. Elements of X-ray diffraction, Bernard Dennis Cullity, Stuart R. Stock, Pearson, 3rd edition (2014) 2. Instrumental Methods of Chemical Analysis, G.Chatwal & S.Anand, Himalaya Publishing House (2011) 3. https://nptel.ac.in/courses/115/105/115105110/ 4. https://nptel.ac.in/courses/115/105/115105120/ 5. https://nptel.ac.in/courses/115/105/115105121/ 		
Mode of Evaluation: (Percent Weightage)	<ol style="list-style-type: none"> 1. Mid-Term (10%); Weekly test (10%); Graded assignment (10%) 2. Written examination (70%) 		
Recommended by BOS on:			
Approved by Academic Council on :			

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)								Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	3	0	3	2	3	3	3	3	3
CO2	3	3	0	3	3	3	3	3	3	3	3
CO3	3	3	0	0	3	3	3	3	3	3	3
CO4	3	3	3	0	3	3	3	3	3	3	3
CO5	3	3	0	3	3	3	3	3	3	3	3

3: High, 2: Medium, 1: Low

SEMESTER: III

Program Core

PHY003	Research Methodology & Intellectual Property Rights (IPR)	Credits 4 (L:T:P = 3:1:0)	Hrs
Version	1.0		
Pre-requisite:	All students are expected to have a fundamental level knowledge or work experience in a related field		
Objective:	To provide a framework and guidelines for researchers to clearly define research questions, hypotheses, and objectives		
Course outcomes (CO)	<p>CO1: Define and articulate the meaning and importance of research</p> <p>CO2: Develop skills in writing theses, technical papers, reviews, and research papers</p> <p>CO3: Evaluate research quality and Define plagiarism and understand its implications in scientific writing.</p> <p>CO4: Comprehend the fundamental concepts and the need for intellectual property rights.</p> <p>CO5: Examine case studies and real-world examples of intellectual property disputes, litigation, licensing agreements and gain knowledge about various new Govt. schemes</p>		
UNIT-1	General Principles of Research		9
	Meaning and importance of research, Different types and styles of research, Role of serendipity, Critical thinking, Creativity and innovation, Formulating hypothesis and development of research plan, Review of literature, Interpretation of results and discussion.		
UNIT-II	Technical & Scientific writing		10
	<p>Technical & scientific writing- thesis, technical papers, reviews, electronic communication, research papers, etc., Poster, presentation and dissertation preparation, Making R and D proposals, Communication skills–defining communication; type of communication; techniques of communication, etc.</p> <p>Library: Classification systems, e-Library, Reference management using various softwares, Web-based literature search engines such as google scholar, Scopus, web of science, Scifinder etc.;</p>		
UNIT-III	Research Quality Parameters and Plagiarism		10
	Bibliographic index and research quality parameters- citation index, impact factor, h index, i10 index, etc. Plagiarism definition, regulations, policies and documents/thesis/manuscripts checking through softwares, Knowing and Avoiding Plagiarism during documents/thesis/manuscripts/ scientific writing.		
UNIT-IV	Intellectual Property Rights		11
	<p>Introduction and the need for intellectual property right (IPR) – Kinds of Intellectual Property Rights; Patents, Copyright, Trademarks & Design: Introduction and Types, Procedure for registration, Terms, Infringement and legal remedies; Discussion on leading cases</p> <p>Geographical Indication (GI), Plant variety protection Layout Design protection and farmers’rights: Introduction, Procedure for registration, Term of protection meaning; Difference between GI and trademarks.</p>		
UNIT-V	New developments in IPR		8
	India’s New National IP Policy, 2016 – Govt. of India step towards promoting IPR – Govt. Schemes in IPR – Career Opportunities in IP - IPR in current scenario with case studies.		
Total hours			48
References & Text Books	<ol style="list-style-type: none"> 1. S. Gupta, Research Methodology and Statistical techniques (Deep and Deep Publications (P) Ltd. New Delhi, India) 2005. 2. R. Kothari, Research Methodology (New Age International, New Delhi, India) 2008. 3. Web resources: www.sciencedirect.com for journal references, www.aip.org and www.aps.org for reference styles. 4. Nithyananda, K V. (2019). Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited. 5. Ahuja, V K. (2017). Law relating to Intellectual Property Rights. India, IN: Lexis Nexis 		
Mode of Evaluation: (Percent Weightage)	<ol style="list-style-type: none"> 1. Mid-Term (10%); Weekly test (10%); Graded assignment (10%) 2. Written examination (70%) 		
Recommended by BOS on:			
Approved by Academic Council on :			

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)								Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	3	0	3	0	3	0	3	2	3
CO2	3	3	0	0	3	3	3	3	3	2	3
CO3	3	3	0	3	3	3	3	3	3	2	3
CO4	3	0	0	2	0	2	0	2	3	1	3
CO5	3	0	0	0	0	0	0	0	3	1	3

3: High, 2: Medium, 1: Low

SEMESTER: III**Program Elective**

PHY007	Microwave Electronics	Credits 3 (L:T:P = 3:0:0)	Hrs
Version	1.0		
Pre-requisite:	All students are expected to have a fundamental level knowledge of electronics and electromagnetic spectrum		
Objective:	To provide an understanding of microwave waveguides, passive & active devices		
Course outcomes (CO)	<p><i>CO1:</i> Understand the fundamentals of microwaves and their frequency spectrum</p> <p><i>CO2:</i> Understand microwave propagation in ferrites and the phenomenon of Faraday rotation</p> <p><i>CO3:</i> Explore single crystal ferromagnetic resonators and YIG-tuned solid-state resonators</p> <p><i>CO4:</i> Understand the types and construction of magnetrons</p> <p><i>CO5:</i> Explore future trends and potential innovations in microwave components and systems and their applications</p>		
UNIT-I			9
Introduction to microwaves and its frequencies spectrum Application of microwaves. Wave Guides :(a) Rectangular wave guides: Wave equation & its solutions, TE & TM modes. Dominant mode and choice of wave guide Dimensions Methods of excitation of wave guide. (b) Circular wave guide-wave equation & its solutions, TE, TM & TEM modes. (c) Attenuation - Cause of attenuation in wave guides, wall current. & derivation of attenuation constant, Q of the wave guide.			
UNIT-II			5
Ferrites: Microwave propagation in ferrites, Faraday rotation, Devices employing Faraday rotation (isolator, Gyrator, Circulator).			
UNIT-III			5
Introduction to single crystal ferromagnetic resonators, YIG tuned solid state resonators. Microwave tubes: Space.			
UNIT-IV			9
Magnetrons: Types & description, Theoretical relations between Electric & Magnetic field of oscillations. Modes of oscillation & operating characteristics. Traveling wave tubes: O & M type traveling wave tubes. Gyrotrons: Constructions of different Gyrotrons, Field - Particle Interaction in Gyrotron.			
UNIT-V			8
Microwave Detectors: Power, Frequency, Attenuation, Impedance Using smith chart, VSWR, Reflectometer, Directivity, Coupling using direction coupler. Complex permittivity of material & its measurement: definition of complex of solids, liquids and powders using shift of minima method.			
Total hours			36
References & Text Books	<ol style="list-style-type: none"> 1. Electromagnetic Waves & Radiating System-Jorden & Balmain. 2. Theory and Applications of Microwaves A.B. Brownwell & R.E. Beam (Mc Graw Hill). 3. Introduction to Microwave Theory by Atwater (McGraw Hill). 4. Principles of Microwave circuits by G.C. Montogmetry (McGraw Hill). 		
Mode of Evaluation: (Percent Weightage)	<ol style="list-style-type: none"> 1. Mid-Term (10%); Weekly test (10%); Graded assignment (10%) 2. Written examination (70%) 		
Recommended by BOS on:			
Approved by Academic Council on :			

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)								Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	2	2	0	3	2	2	2	3	2	3
CO2	3	3	0	0	3	3	3	3	3	2	3
CO3	3	3	0	1	3	3	3	3	3	3	3
CO4	3	2	0	0	3	2	2	2	3	3	3
CO5	3	3	0	2	3	2	3	2	3	3	3

3: High, 2: Medium, 1: Low

SEMESTER: III

Program Elective

PHY008	Computational Physics	Credits 3 (L:T:P = 3:0:0)	Hrs
Version	1.0		
Pre-requisite:	A solid foundation in quantum mechanics, statistical mechanics, linear algebra, and proficiency in programming languages such as Python or C		
Objective:	Develop proficiency in applying computational tools and programming languages (C or Python) to solve complex problems in physics, including data visualization		
Course outcomes (CO)	<p>CO1: Efficiently use computational tools and programming for solving physics problems</p> <p>CO2: Simulate and analyze stochastic processes, including random walks and Brownian motion</p> <p>CO3: Apply Monte Carlo methods to model physical systems and understand their properties</p> <p>CO4: Utilize numerical methods to solve mathematical problems related to physics accurately</p> <p>CO5: Implement DFT to investigate the electronic structure of systems and apply it in practical scenarios</p>		
UNIT-1	Need & Basics of Computational Tools		7
Example of problems in physics requiring computational approach; Basic computer architecture and latest advancements. Use of C or Python in physics and related problems, Data visualization and related.			
UNIT-II	Stochastic Processes		7
Theory of random walks and simulation of random walks in one, two and three dimensions. Elementary ideas and simulations of self-avoiding walks, additive and multiplicative stochastic processes, Brownian motion and fractional Brownian motion.			
UNIT-III	Monte Carlo Methods		7
Monte Carlo methods; Metropolis algorithm. Introduction to the simulations: (a) Ising model in magnetism (b) Glauber and Kawasaki dynamics.			
UNIT-IV	Numerical Methods and Applications		7
Solution of simultaneous linear equations, Numerical differentiation, Numerical Integration, Trapezoidal, Simpson and Gaussian quadrature methods, Least-square curve fitting, Straight line and polynomial fits, Numerical solution of ordinary differential equations: Euler and Runge-Kutta methods..			
UNIT-V	Density Functional Theory (DFT)		8
Electron density in DFT, Hohenberg-Kohn theorems, Kohn-Sham formulation, Exchange-correlation functional: local density approximation and generalized gradient approximations.			
Total hours			36
References & Text Books	<ol style="list-style-type: none"> 1. June Gunn Lee, Computational Materials Science: An Introduction, (CRC Press 2011) 2. Efthimios Kaxiras, Atomic and Electronic Structure of Solids (Cambridge Unive. Press) 2007. 3. Richard M. Martin, Electronic Structure: Basic Theory and Practical Methods(Cambridge University Press) 2008. 4. David S. Sholl and Janice A. Steckel, Density Functional Theory: A Practical Introduction (John Wiley and Sons, 2009). 5. Feliciano Giustino, Materials Modelling Using Density Functional Theory: Properties and Predictions, Wiley (2009). 6. Rajendra Prasad, Electronic Structure of Materials, Taylor and Francis (2013). 		
Mode of Evaluation: (Percent Weightage)	<ol style="list-style-type: none"> 1. Mid-Term (10%); Weekly test (10%); Graded assignment (10%) 2. Written examination (70%) 		
Recommended by BOS on:			
Approved by Academic Council on:			

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)								Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	3	3	1	3	3	3	3	3	3
CO2	3	3	3	0	3	3	3	0	3	3	0
CO3	3	3	3	0	3	3	3	0	3	3	0
CO4	3	3	3	0	3	3	3	0	3	3	0
CO5	3	3	3	0	3	3	3	0	3	3	0

3: High, 2: Medium, 1: Low

SEMESTER: III
Program Elective

PHY009	Nanotechnology	Credits 3 (L:T:P = 3:0:0)	Hrs
Version	1.0		
Pre-requisite:	All students are expected to have a strong foundation in physics, chemistry, and materials science		
Objective:	To understand, manipulate, and apply materials and devices at the nanoscale to create innovative solutions across various fields		
Course outcomes (CO)	<p><i>CO1:</i> Basic understanding of nanotechnology with the knowledge of different types of nanomaterials.</p> <p><i>CO2:</i> To comprehend basic knowledge on the synthesise of nanomaterials by different methods</p> <p><i>CO3:</i> Qualitatively describe how the nanoparticle size can affect the morphology, crystal structure, reactivity, and mechanical properties</p> <p><i>CO4:</i> Understand some specific materials like graphene and carbon nanotubes for various applications</p> <p><i>CO5:</i> Have understanding of industrial applications of nanomaterials in various fields.</p>		
UNIT-I	Background of Nanotechnology		7
History of Nanotechnology; Definition and Overview: Why and How; Types of nanomaterials (i.e. Zero (0), One (1), Two (2), and Three (3) dimensional), Quantum dots, Nanowires and Nanotubes, 2D films; Some examples: Graphene, Fullerenes, Single and Multi wall Carbon Nanotube (MWCNT), and Porous Silicon: Synthesis, Properties and Applications; Nano sized effects: surface to volume ratio.			
UNIT-II	Synthesis of Nanomaterials		8
Key issue in the synthesis of Nanomaterials; Different approaches of synthesis i.e. top-down and bottom-up approach: Thermal and e-beam evaporation, chemical vapor deposition (CVD), Ball Milling, Sol-Gel method, Colloidal Method, Hydrothermal, Sonochemical, Biological Methods Using Plant Leaf and Microorganism, Micro Emulsion Method, Core-shell particles, Self-Assembly and Lithography			
UNIT-III	Properties of Nanomaterials		8
Structural, electrical, optical, mechanical, chemical, and magnetic properties at nanoscale. size dependent comparison of these properties from bulk materials			
UNIT-IV	Recent Special Nanomaterials		9
Basic structures & applications: Carbon based nanomaterials, CNT, core-shell structures micro and mesopores Materials, Organic inorganic Hybrids, ZnO, DNA- RNA- Nanoproducts, MXenes.			
UNIT-V	Industrial Applications of Nanomaterials		5
Nano-materials in bone substitutes & Dentistry, Food and Cosmetic applications, Textiles, Paints, Drug delivery and its applications, Biochips- analytical devices, Nano-sensors, Nano-capacitors, Nano-lubricants, Nano-composites and Nano-catalysts			
Total hours			36
References & Text Books	<ol style="list-style-type: none"> 1. "Nanostructures & Nanomaterials: Synthesis, Properties & Applications" G. Cao, Imperial College Press (2004) 2. Fundamentals of Nanotechnology, Hornyak, G. Louis, Tibbals, H. F., Dutta, Joydeep, CRC Press (2009) 3. Nanomaterials: An introduction to synthesis, properties and application, Dieter Vollath, WILE-VCH (2008) 4. An Introduction to Nanoscience and Nanotechnology, Alain Nouailhat (2007) 5. https://nptel.ac.in/courses/118102003 		
Mode of Evaluation: (Percent Weightage)	<ol style="list-style-type: none"> 1. Mid-Term (10%); Weekly test (10%); Graded assignment (10%) 2. Written examination (70%) 		
Recommended by BOS on:			
Approved by Academic Council on :			

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)								Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	3	0	3	0	3	0	3	3	3
CO2	3	2	0	0	3	3	2	3	3	3	3
CO3	3	2	0	3	3	0	2	0	3	3	3
CO4	3	3	0	0	3	2	3	2	3	3	3
CO5	3	3	0	0	3	2	3	2	3	2	3

3: High, 2: Medium, 1: Low

SEMESTER: III

Program Elective

PHY010	Energy Storage Systems	Credits 3 (L:T:P = 3:0:0)	Hrs
Version	1.0		
Pre-requisite:	All students are expected to have a basic understanding of electrochemistry and materials science		
Objective:	Provide a comprehensive understanding of various energy storage technologies, including thermal, chemical, electromagnetic, and electrochemical systems, their applications, efficiencies, and future prospects		
Course outcomes (CO)	<p>CO1: Understand the scope, technology overview, and applications of energy storage systems in various sectors</p> <p>CO2: Analyze and evaluate thermal energy storage systems, including their principles, efficiencies, and economic implications</p> <p>CO3: Develop expertise in chemical energy storage, focusing on hydrogen storage and its future potential</p> <p>CO4: Gain insights into electromagnetic energy storage systems and assess their advantages, limitations, and future prospects</p> <p>CO5: Achieve proficiency in electrochemical energy storage systems, including batteries, supercapacitors, and fuel cells, and understand their hybrid configurations</p>		
UNIT-1	Energy Storage Systems Overview		8
	Scope of energy storage, needs and opportunities in energy storage, Technology overview and key disciplines, comparison of time scale of storages and applications, Energy storage in the power and transportation sectors. Importance of energy storage systems in electric vehicles, Current electric vehicle market		
UNIT-II	Thermal Storage System		6
	Heat pumps, hot water storage tank, solar thermal collector, application of phase change materials for heat storage-organic and inorganic materials, efficiencies, and economic evaluation of thermal energy storage systems		
UNIT-III	Chemical Storage System		6
	H₂ storage- Compressed storage, liquid/solid state storage, materials for H ₂ storage, application of chemical energy storage system, advantages and limitations of chemical energy storage, challenges, and future prospects of chemical storage systems.		
UNIT-IV	Electromagnetic Storage Systems		7
	Double layer capacitors with electrostatically charge storage, superconducting magnetic energy storage (SMES), concepts, advantages and limitations of electromagnetic energy storage systems, and future prospects of electrochemical storage systems		
UNIT-V	Electrochemical storage system		9
	<p>Batteries-Working principle of battery, battery classification, recent trends in batteries.</p> <p>Supercapacitors- Working principle of supercapacitor, types of supercapacitors, cycling and performance characteristics, Introduction to Hybrid electrochemical supercapacitors</p> <p>Fuel cell- Operational principle of a fuel cell, types of fuel cells, hybrid fuel cell-battery systems, hybrid fuel cell-supercapacitor systems.</p>		
Total hours			36
References & Text Books	<ol style="list-style-type: none"> Sandeep A. Arote, Electrochemical Energy Storage Devices and Supercapacitors: An overview, Institute of Physics Publishing (2021) Subramanian Srinivasan, Fuel Cells from fundamentals to applications, Springer, (2006). Electric Vehicle Battery Systems Sandeep Dhameja, Pub Newnes (2001) Frank S. Barnes and Jonah G. Levine, Large Energy Storage Systems Handbook (Mechanical and Aerospace Engineering Series), CRC press (2011) Ralph Zito, Energy storage: A new approach, Wiley (2010) 		
Mode of Evaluation: (Percent Weightage)	<ol style="list-style-type: none"> Mid-Term (10%); Weekly test (10%); Graded assignment (10%) Written examination (70%) 		
Recommended by			

BOS on:	
Approved by Academic Council on :	

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)								Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	2	3	3	0	3	0	3	3	3
CO2	3	3	0	0	3	3	3	3	3	3	3
CO3	3	3	0	3	3	3	3	3	3	3	3
CO4	3	3	0	0	3	3	2	0	3	3	3
CO5	3	3	0	3	3	3	3	3	3	3	3

3: High, 2: Medium, 1: Low

SEMESTER: III**Program Elective**

PHY011	Solar Energy and Applications	Credits 3 (L:T:P = 3:0:0)	Hrs
Version	1.0		
Pre-requisite:	No graduate courses are required as prerequisite		
Objective:	To get knowledge of solar energy systems and their applications in the field of renewable energy engineering, conduct laboratory experiments, and pursue research in advancing the PV technologies.		
Course outcomes (CO)	<i>CO1:</i> Understand the global and Indian energy scenarios, including the challenges and opportunities posed by solar energy in meeting future energy demands <i>CO2:</i> Apply techniques for the measurement of solar radiation <i>CO3:</i> Be able to understand the photo voltaic effect and charge carrier dynamics within solar cells <i>CO4:</i> To understand the solar cell performance under different operating conditions <i>CO5:</i> Get the knowledge of constructions of various types of solar cells		
UNIT-1	Solar Energy		6
	Introduction to solar energy origin: overview of global and Indian energy scenario, need of solar energy, spectral distribution of solar radiation, absorption of solar radiation in the atmosphere, global and diffused radiation, seasonal and daily variation of solar radiation,		
UNIT-II	Solar Radiation Measurements		6
	Measurement of solar radiation, photo thermal conversion, types of solar energy collectors, concentrating/non-concentrating solar collectors, collector efficiency and its dependence on various parameters, solar fuels: electrolysis of water, photoelectrochemical splitting of water.		
UNIT-III	Fundamentals-I of Solar Cells		8
	photo voltaic effect, p-n junction photodiodes, depletion region, electron and holes transports, absorption of photons, excitons and photoemission of electrons, band engineering, charge carrier generation, charge separation, recombination and other losses,		
UNIT-IV	Fundamentals-II of Solar Cells		6
	I-V characteristics, output power, efficiency, fill factor and optimization for maximum power, metal-semiconductor heterojunctions, surface structures for maximum light absorption, operating temperature vs conversion efficiency.		
UNIT-V	Solar Cell Device		10
	Device physics, device structures, device construction, solar cell properties and design, materials for solar cells, silicon based solar cells: single crystal, polycrystalline and amorphous silicon solar cells, organic solar cells, organic-inorganic hybrid solar cells, advanced concepts in photovoltaic research, nanotechnology applications.		
		Total hours	36
References & Text Books	<ol style="list-style-type: none"> Nelson, J. The Physics of Solar Cells. Imperial College Press, 2003. ISBN: 9781860943409. Solar Engineering of Thermal Process: Duffie and Beckman, John Wiley, 2013. ISBN: 9780470873663 Principles of Solar Engineering, D. Yogi Goswami, Taylor and Francis, 2015. ISBN: 9781138569478 Wenham, S., M. Green, et al., eds. Applied Photovoltaics. 2nd Ed. Routledge, 2006. ISBN: 9781844074013. Luque, A., and S. Hegedus, eds. Handbook of Photovoltaic Science and Engineering. John Wiley & Sons, Ltd, 2003. ISBN: 9780471491965 		
Mode of Evaluation: (Percent Weightage)	<ol style="list-style-type: none"> Mid-Term (10%); Weekly test (10%); Graded assignment (10%) Written examination (70%) 		
Recommended by BOS on:			
Approved by Academic Council on:			

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)								Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	3	0	2	0	3	3	3	0	3
CO2	3	3	1	3	0	3	0	0	3	3	3
CO3	3	3	3	3	0	0	0	0	3	0	3
CO4	3	3	3	0	0	0	0	0	3	0	3
CO5	3	3	3	0	3	3	0	0	3	0	3

3: High, 2: Medium, 1: Low

SEMESTER: IV

Program Elective

SC 822	Optoelectronics	Credits 3 (L:T:P = 3:0:0)	Hrs
Version	1.0		
Pre-requisite:	All students are expected to have a fundamental level knowledge of electronics		
Objective:	To providedesign and production of electronic devices		
Course outcomes (CO)	<p><i>CO1:</i> Explain the construction, operation, characteristics and important technological applications of various photonic devices</p> <p><i>CO2:</i> Explain the principle of spontaneous emission and its role in LED operation</p> <p><i>CO3:</i> Comprehend the principles underlying optical detectors, focusing on the absorption coefficient.</p> <p><i>CO4:</i> Understand the basic structure and components of optical fibers</p> <p><i>CO5:</i> Explain the basic principles of optical fiber communication systems</p>		
UNIT-1			8
Semiconducting materials and Heterostructures; Electronic, transport and optical properties of semiconductors: Direct and Indirect bands; Degenerate and non-degenerate semiconductors, Doping and degeneracy; Allowed, forbidden and phonon assisted optical transitions; Switching; Colour centres; Photoconductivity; Internal quantum efficiency, External quantum efficiency; Double heterojunction, Fabrication of heterojunction, Quantum wells and superlattices.			
UNIT-II			8
LEDs (spontaneous emission, LED structure-surface emitting, Edge emitting-Injection efficiency, recombination efficiency, LED characteristics, spectral response, modulation, Band width, Laser diodes, Basic principle, condition for gain-Laser action-population inversion-stimulated emission, Injection Laser diode, structure, temperature effects, modulation, comparison between LED and ILDs.			
UNIT-III			7
Optical detectors-optical detector principle, absorption coefficient, detector, characteristics, Quantum efficiency, responsivity, response time-bias voltage, Noise in detectors P-N junction-photo diode, characteristics, P-I-N-photo diode, response, Avalanche photo diode (APD) multiplication process-B,W-Noise photo transistor.			
UNIT-IV			7
Optical Fibre, structure, advantages, Types-propagation-wave equation, phase and group velocity, transmission characteristics, attenuation-absorption, scattering losses-dispersion, fibre bend losses, source coupling, splices and connectors-wave length division multiplexing.			
UNIT-V			6
Optical fibre system, system design consideration, power budget, line coding, system rise time, maximum bit rate, channel width, electro-optic effect and applications, acousto-optic effect and applications, nonlinear effect and applications			
Total hours			36
References & Text Books	<ol style="list-style-type: none"> 1. John P. Dakin, Robert G. W. Brown, Handbook of Optoelectronics Vol. 2, 2nd edition, CRC Press (2019) 2. M. A. Parker, Physics of Optoelectronics, CRC Press, 1st edition (2005) 3. Optoelectronic Devices and Systems; S. C. Gupta, Prentice Hall India, 2005. 4. Semiconductor optoelectronic devices; P. Bhattacharya, Prentice Hall India, 2006. 5. https://nptel.ac.in/courses/115/102/115102103/ 		
Mode of Evaluation: (Percent Weightage)	<ol style="list-style-type: none"> 1. Mid-Term (10%); Weekly test (10%); Graded assignment (10%) 2. Written examination (70%) 		
Recommended by BOS on:			
Approved by Academic Council on :			

Mapping of COs with POs & PSOs

Course	Program Outcomes (POs)	Program Specific Outcomes (PSOs)

Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	3	0	3	3	3	3	3	3	3
CO2	3	3	0	3	3	3	3	3	3	3	3
CO3	3	3	0	2	3	3	3	3	3	3	3
CO4	3	2	3	0	3	3	1	3	3	3	3
CO5	3	3	0	3	3	3	3	3	3	3	3

3: High, 2: Medium, 1: Low

SEMESTER: IV
Elective

Program

SC 824	Density Functional Theory Methods	Credits 3 (L:T:P = 3:0:0)	Hrs
Version	1.0		
Pre-requisite:	All students are expected to have proficiency in programming languages (e.g., Python, Fortran, C++) and using computational tools for simulations.		
Objective:	This course provides an in-depth exploration of Density Functional Theory (DFT), a fundamental tool for studying the electronic structure of many-body systems		
Course outcomes (CO)	<p><i>CO1:</i> Understand and apply fundamental quantum mechanical principles to many-electron systems</p> <p><i>CO2:</i> Develop and utilize functionals and functional derivatives in the context of electron density and energy functionals</p> <p><i>CO3:</i> Apply various approximations for exchange-correlation energy, including LDA, LSDA, GGA, and hybrid functionals</p> <p><i>CO4:</i> Formulate and solve Kohn-Sham equations using computational methods, and evaluate the strengths and limitations of DFT</p> <p><i>CO5:</i> Utilize Time-Dependent DFT to analyze dynamic properties of electronic systems under external fields</p>		
UNIT-1	Introduction to DFT & Mathematical representation		7
	The many-electron problem: Schrodinger equation, Interacting and non-interacting wavefunctions, Hartree theory, Identical particles and spin, Hartree-Fock theory, Antisymmetric wavefunctions and Slater determinant, Koopmans' theorem		
UNIT-II	Functional		7
	Idea of functional, Functional derivatives, one and two-body operators and expectation values, Density operators, Reduced density matrices, Variational principle, Electron density, Thomas Fermi model, Hohenberg-Kohn theorems, Kinetic energy functional		
UNIT-III	Density Gradient		8
	Approximations for exchange-correlation: Local density approximation (LDA) and local spin density approximation (LSDA), Gradient expansion and generalized gradient approximation (GGA), Hybrid functionals and meta-GGA approaches		
UNIT-IV	Kohn-Sham Formulation:		7
	Plane waves and pseudopotentials, Janak's theorem, Ionization potential theorem, Self consistent field (SCF) methods, Strengths and weaknesses of DFT		
UNIT-V	Time-dependent density functional theory		7
	Time-dependent density functional theory, Runge-Gross theorem, Linear response and excitation spectra, Real-time TDDFT: Atoms/molecules under strong electric/magnetic field		
		Total hours	36
References & Text Books	<ol style="list-style-type: none"> 1. "Density-Functional Theory of Atoms and Molecules" by Parr and Yang. 2. "The ABC of DFT", by Kieron Burke, http://dft.uci.edu/doc/g1.pdf 3. "Challenges for Density Functional Theory", Cohen et al., Chemical Review 112, pp 289 (2012). 4. "Random-phase approximation and its applications in computational chemistry and materials science", Ren et al., Journal of Materials Science 47, pp 7447 (2012). 5. David S. Sholl and Janice A. Steckel, (2009). Density Functional Theory: A Practical Introduction, John Wiley and Sons. 		
Mode of Evaluation: (Percent Weightage)	<ol style="list-style-type: none"> 1. Mid-Term (10%); Weekly test (10%); Graded assignment (10%) 2. Written examination (70%) 		
Recommended by BOS on:			
Approved by Academic Council on:			

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)								Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	3	3	3	3	3	2
CO2	3	3	0	0	3	3	3	0	3	3	3
CO3	3	3	0	0	3	3	3	0	3	3	0
CO4	3	3	0	0	3	3	3	0	3	3	0
CO5	3	3	0	0	3	3	3	0	3	3	0

3: High, 2: Medium, 1: Low

SEMESTER: IV
Program Elective

SC 826	Renewable Energy	Credits 3 (L:T:P = 3:0:0)	Hrs
Version	1.0		
Pre-requisite:	All students are expected to have a fundamental level knowledge of natural energy sources		
Objective:	To provide the basic knowledge about the development and deployment of renewable energy technologies		
Course outcomes (CO)	<i>CO1:</i> Comprehend the awareness about non-conventional sources of energy technologies <i>CO2:</i> Learn the basic concept about solar energy <i>CO3:</i> Will creates awareness about wind and geothermal energy technologies <i>CO4:</i> Understand an idea about different biomass as energy source and Ocean energies <i>CO5:</i> Teach fundamentals of hydrogen energy and fuel cell as energy systems		
UNIT-1	Introduction of Renewable Energy Sources		7
	Overview of global energy consumption and trends, Importance of renewable energy in mitigating climate change and reducing dependence on fossil fuels; Conventional, non-conventional, renewable, non-renewable sources of energy, Prospects, Perspectives & advantages, Energy challenge in the 21st century		
UNIT-II	Solar Energy		7
	Solar energy, Solar radiation geometry, Local solar time, Day length, Solar radiation measurement, Radiation on inclined surface, Solar radiation data & solar charts, Environmental aspects of solar energy, Solar energy conversion methods, Applications of solar energy.		
UNIT-III	Wind energy & Biomass energy		8
	Wind energy basics: Properties of wind, availability of wind energy in India, wind velocity and power from wind; major problems associated with wind power, wind energy conversion systems (WECS), aerodynamics of wind turbines, Wind turbine components, Types of wind turbines. Biomass Energy: Introduction; Photosynthesis Process; Biofuels; Biomass Resources; Biomass conversion technologies-fixed dome; Urban waste to energy conversion; Biomass gasification (Downdraft) .		
UNIT-IV	Ocean energy		7
	Tidal energy: tidal range and tidal stream technologies, tidal barrage and tidal stream generators; fundamental characteristics of tidal power, harnessing tidal energy, advantages and limitations; Ocean Energy: Overview of ocean energy resources. Ocean thermal energy conversion (OTEC): Principles of operation, OTEC power stations in the world, problems associated with OTEC.		
UNIT-V	Green energy		7
	Fuel Cells: Design and principle of operation of a Fuel Cell, Classification of Fuel Cells; Hydrogen energy: Operating principle, Hydrogen production (Electrolysis method only), Benefits of Hydrogen energy, Hydrogen technology development, Problem associated with hydrogen energy		
Total hours			36
References & Text Books	1. Kingsley Onyeagusi, The Global Impact of Renewable Energy and Data Analytics, Munich, GRIN Verlag (2023) 2. Godfrey Boyle, Renewable Energy: Power for a Sustainable Future, Oxford University press, 3 rd edition (2012) 3. Arno Samets, Solar Energy: The physics and engineering of photovoltaic conversion, UIT Cambridge LTD (2016)		
Mode of Evaluation: (Percent Weightage)	1. Mid-Term (10%); Weekly test (10%); Graded assignment (10%) 2. Written examination (70%)		
Recommended by BOS on:			
Approved by Academic Council on :			

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)								Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	3	0	1	1	3	1	3	2	3
CO2	3	2	0	0	1	2	2	2	3	2	3
CO3	3	3	0	3	1	2	3	2	3	2	3
CO4	3	3	0	2	1	1	3	1	3	2	3
CO5	3	3	0	0	1	3	3	3	3	2	3

3: High, 2: Medium, 1: Low

SEMESTER: IV

Program Elective

SC 828	Vacuum Science and Thin Film Technology	Credits 3 (L:T:P = 3:0:0)	Hrs
Version	1.0		
Pre-requisite:	All students are expected to have a solid foundation in materials science, physics, and chemistry		
Objective:	To understand and apply the principles of vacuum science and thin film technology		
Course outcomes (CO)	<i>CO1:</i> Explain the atomistic concept of gas pressure and temperature <i>CO2:</i> Explore the different kinds of pumps <i>CO3:</i> Analyze the performance ranges and applications of various vacuum pumps <i>CO4:</i> Analyze the atomistic aspects of nucleation and its influence on film growth <i>CO5:</i> Evaluate the advantages and limitations of various deposition methods		
UNIT-1			8
Vacuum Science: Kinetic theory of gases: Atomistic concept of gas pressure and temperature, Molecular distribution functions, Impingement rate of molecules on a surface, Free path of gas molecules, Gas viscosity and flow, gas conductance of a vacuum line, gas impedance of a vacuum line, flow of gases through apertures, elbows, tubes etc. for viscous and molecular flow regimes			
UNIT-II			8
Production of Vacuum: Meaning of vacuum and vacuum measuring units, vacuum ranges, pumping speed and pump down time. Vacuum Pumps: Mechanical pumps (Oil sealed rotary pump, Roots Pump, Molecular drag pump), Diffusion pump (Operating principles, back streaming, traps and baffles, performance ranges), Cryosorption pumps, Getter pumps (Chemical cleanup and sublimation pumps, Electrical cleanup and ion pumps, Evapour ion pumps, Sputter ion pumps, Titanium sublimation pump.			
UNIT-III			7
Vacuum Measurements: Measurement of low pressure, Pressure gauges for low to high vacuum, McLeod manometer, Thermal conductivity gauges, Pressure gauges for high to ultrahigh vacuum, Hot cathode ionization gauges, Cold cathode ionization gauges, Operation of High-vacuum gauges. Vacuum Applications: Applications in science, technology, research, space science, medical science, day to day life. Use of vacuum in particle accelerators.			
UNIT-IV			8
Thin Film technology: Nucleation and Growth: Film formation and structure; Thermodynamics of nucleation, Nucleation theories: Capillarity model – homogeneous and heterogeneous nucleations, Atomistic model – Walton-Rhodin theory; post-nucleation growth; Deposition parameters; Epitaxy; Thin film structure; Structural defects and their incorporation. Properties of thin films: Electrical, mechanical, optical and magnetic; Introduction – OTEC power generation.			
UNIT-V			5
Preparation methods: Electrochemical Deposition (ECD); Spin coating; Physical Vapor Deposition (PVD)-thermal evaporation, electron beam evaporation, rf-sputtering; Pulsed Laser deposition (PLD); Chemical Vapor Deposition (CVD), Plasma-Enhanced CVD (PECVD), Atomic Layer Deposition (ALD), Molecular Beam Epitaxy (MBE). Thickness measurement and monitoring: Electrical, mechanical, optical interference, microbalance, quartz crystal methods.			
Total hours			36
References & Text Books	1. Hartmut Frey, Hamid R. Khan, Handbook of Thin Film Technology, Springer (2015) 2. Jianguo Zhu, Thin Film Physics and Devices, World Scientific Publishing Co. Pte. Ltd. (2021) 3. Milton Ohring, Materials Science of Thin Films, Academic Press (2002)		
Mode of Evaluation: (Percent Weightage)	1. Mid-Term (10%); Weekly test (10%); Graded assignment (10%) 2. Written examination (70%)		
Recommended by BOS on:			
Approved by Academic Council on:			

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)								Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	3	0	3	0	1	0	3	3	3
CO2	3	3	0	3	3	3	1	3	3	2	3
CO3	3	3	0	0	3	3	3	2	3	2	3
CO4	3	3	3	0	3	3	3	3	3	3	3
CO5	3	3	0	3	3	3	3	0	3	3	2

3: High, 2: Medium, 1: Low

SEMESTER: IV

Program Elective

SC 830	Soft Materials	Credits 3 (L:T:P = 3:0:0)	Hrs
Version	1.0		
Pre-requisite:	All students are expected to have a basic understanding of physics and chemistry and materials science.		
Objective:	To make students aware of the various classes of soft materials		
Course outcomes (CO)	<p><i>CO1:</i> Develop a fundamental understanding of the various classes of soft materials</p> <p><i>CO2:</i> Evaluate the synthesis techniques and characterize the properties of hard and soft colloids</p> <p><i>CO3:</i> Explore the impact of shape and directional interactions of colloids</p> <p><i>CO4:</i> Design of soft materials and understand the process of self-assembly of soft materials</p> <p><i>CO5:</i> Explore the fundamental properties and applications of liquid crystals</p>		
UNIT-1	Fundamentals of Soft Materials		4
	Introduction to soft materials and soft matter, generic aspects of soft materials, classification in terms of their thermal, mechanical and often unusual physical properties; examples of soft systems: polymers, foams, granular media, colloids, liquid crystals, micelles, vesicles and biological membranes.		
UNIT-II	Colloidal Systems and Soft Matter		8
	From hard to soft building blocks, synthesis of hard and soft colloids, hard systems, softer systems and their characterization, dispersion forces, polymers in solution, gels, emulsions and foams		
UNIT-III	Structured Colloids and Shape Engineering		9
	Shape and directional interaction, crystal structure, effect on maximum packing density, anisotropic and directionally interacting colloids, complex shape particles, deforming and stretching, soft lithography and micro molding.		
UNIT-IV	Self-Assembly of Soft Materials		7
	Building blocks for self-assembled soft materials, learning from small molecules, block copolymers, phase diagram, crystallization, micellization, experimental methods for study of block copolymers.		
UNIT-V	Liquid Crystals		9
	Liquid crystalline phases, order parameter in nematics, Distortions in nematics, Torque transmission by a nematic liquid, Fredericksz transition, optical properties of a nematic liquid and application to LCD		
	Total hours		36
References & Text Books	<ol style="list-style-type: none"> 1. Fundamentals of soft matter science: Linda S. Hirst (CRC). Introduction to soft matter: Ian W. Hamle (Wiley). 2. Polymer surfaces and interfaces: M Stamm (Springer). Soft condensed matter: R.A.L. Jones (Oxford) 3. Soft materials: structure and dynamics: John R. Dutcher, A. G. Marangoni (CRC). 4. https://digitalcommons.uri.edu/soft_matter_physics/ 5. https://nptel.ac.in/courses/112/108/112108289/ 		
Mode of Evaluation: (Percent Weightage)	<ol style="list-style-type: none"> 1. Mid-Term (10%); Weekly test (10%); Graded assignment (10%) 2. Written examination (70%) 		
Recommended by BOS on:			
Approved by Academic Council on :			

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)								Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	2	3	0	3	0	3	3	3	2	2
CO2	3	3	2	3	3	3	3	0	3	3	1
CO3	3	2	0	0	3	0	3	0	3	3	3
CO4	3	3	3	0	3	2	3	0	3	2	3
CO5	3	3	3	3	3	3	3	0	3	3	2

3: High, 2: Medium, 1: Low

List of Lab Experiments:

Physics Lab-I (Any 10)

1. To design a RC coupled two stage amplifier of a given gain and the cut off frequencies.
2. To study Hartley oscillator.
3. To Study Transistor bias Stability.
4. To design a Multivibrator of given frequency and study its wave shape.
5. To study the characteristics of an operational amplifier.
6. To study the addition, integration and differentiation properties of an operational amplifier.
7. To study the characteristics of Zener diode and design a regulated power supply using Zener diode.
8. To study characteristics of transistor in CE/CB mode.
9. To study the percentage regulation and variation of Ripple factor with load for a full wave rectifier.
10. To study analog to digital and digital to analog conversion.
11. To determine the drain resistance and transconductance of a FET.
12. To study adder and subtractor circuits using operational amplifier.
13. To study integrator and differentiator circuits using operational amplifier.
14. To design and study an operational amplifier as comparator.
15. Virtual Lab-I

Physics Lab-II (Any 10)

1. To determine half-life of a radioactive isotope using G.M. counter.
2. To study characteristics of a G.M. counter and to study statistical aspects of radioactive decay.
3. To study Hall effect and to determine Hall coefficient.
4. Determine Planck constant using solar Cell.
5. To determine the coefficient of viscosity of a liquid using Poiseuille's method.
6. To determine the thermal conductivity of a bad conductor using Lee's disc method.
7. To determine the band gap energy of a semiconductor using four probe method.
8. Find the dielectric constant of a given solid (Teflon) for three different lengths by using slotted section.
9. To study a driven mechanical oscillator.
10. Find the dielectric constant of a given liquid (organic) using slotted section of K-band.
11. Verification of Bragg's law using microwaves.
12. Determination of Dielectric Constant of a liquid by lecher wire.
13. Study of Heat Capacity of Solids.
14. Study of lattice dispersion.
15. Virtual Lab-II

Physics Lab-III (Any 10)

1. To determine the wavelength of sodium light using Newton's Rings apparatus.
2. To determine the refractive index of a liquid using Newton's Rings.
3. To determine the wavelength difference between two spectral lines using Michelson Interferometer.
4. To verify Fresnel's formula.
5. To determine the thickness of a thin transparent sheet using Michelson Interferometer.
6. To verify Hartmann's formula using constant deviation spectrograph.
7. To determine the wavelength of spectral lines using a spectrometer.
8. To study the Raman spectrum of a given sample.
9. To study CH bands using spectroscopy.
10. To determine the resolving power of a diffraction grating using spectroscopy.

11. To study absorption spectra using spectrometer.
12. To determine the dispersive power of a prism using spectrometer.
13. To determine ultrasonic velocity in liquids.
14. To study Zeeman effect and determine e/m of electron.
15. Virtual Lab-III

School of Applied Sciences

SUMMARY OF SYLLABUS UPDATION FOR 2025-27 (ANNEXURE I)

1. LIST OF PROGRAMS WHO'S SYLLABUS HAVE BEEN SUBMITTED

M.Sc Physics

2. No. & List of Courses whose syllabus has been updated partially or completely: NA

S.No.	Programme and Semester	Old Course Code	New Course Code if Required	Name of Course	Changes Done	Reason for Change	Updation Percentage
1.	M.Sc. Physics I sem	SC 805	PH9003	Mathematical Physics	Syllabus of Unit V updated	As per Suggestion	
2.	M.Sc. Physics II sem	SC 804	PHX002	Condensed Matter Physics	Syllabus of Unit V updated	As per Suggestion	

3. No. and list of New Courses Being Introduced: NA

4. No. and list of Courses Removed or Shifted from Program Core to University Elective or another Semester): NA

5. Any other Major or Minor Information or Updation:

List of Physics Lab experiments have added at the end of scheme.