



**Marudhar Kesari Jain College for Women (Autonomous)**  
**Vaniyambadi**

**Regulations 2026-2027**

**PG & Research Department of Physics**

**For**

**Postgraduate Programme**

**Master of Physics**

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# LEARNING OUTCOMES BASED CURRICULUM FRAME WORK FOR UNDERGRADUATE AND POSTGRADUATE EDUCATION

## 1. Preamble

Physics is the most of basic of sciences. It seeks to understand natural phenomena in a quantitative manner, and to answer some of the oldest and deepest questions ever asked by human beings: What are things made of? Is there a limit to the smallest things that we can think of? Did the world have a beginning? Will it have an end? At the same time, it provides the base of much of the technology that we take for granted in the 21st century: computers, artificial satellites, mobile phones, TV, microwave oven. Indeed, it will not be an exaggeration to say that modern human life is shaped by technologies that are largely based on a foundation of physics. Physics as a discipline has existed for three hundred years and has a large 'core' body of knowledge. Our M.Sc. programme lays emphasis on the courses that constitute this core component, while providing students with a bouquet of optional papers covering almost all branches of physics. Those who wish to pursue higher studies in the subject are thereby well equipped to choose their branch of study. The programme also aims at equipping future teachers (at college as well school level) with a thorough grounding in the subject. Since physics is the base of much of modern technology, the programme also gives adequate hands-on experience to students who may go on to work in applied fields. Finally, viewing physics as a training ground for the mind the programme also aims to equip those who go into other fields of work with logical thinking and a critical attitude.

## PROGRAMME OUTCOMES (PO)

<b>Programme</b>	<b>M.Sc., Physics</b>
<b>Programme Code</b>	<b>PS07</b>
<b>Duration</b>	<b>2 Years [PG]</b>
<b>Programme Outcomes</b>	<p><b>PO1:</b> Acquire knowledge in Physics to apply the knowledge in their day-to-day life for betterment of self and society.</p> <p><b>PO2:</b> Develop critical, analytical thinking and problem-solving skills</p> <p><b>PO3:</b> Develop research related skills in defining the problem, formulate and test the hypothesis, analyse, interpret, and draw conclusion from data.</p> <p><b>PO4:</b> Address and develop solutions for societal and environmental needs of local regional and national development.</p> <p><b>PO5:</b> Work independently and engage in lifelong learning and enduring proficient progress.</p> <p><b>PO6:</b> Provoke employability and entrepreneurship among students along with ethics and communication skills.</p> <p><b>PO7:</b> Understand the importance of ethical behavior in business contexts and be able to recognize and address ethical dilemmas they may encounter in their professional careers.</p> <p><b>PO8:</b> Prepared for lifelong learning and professional development, including the ability to adapt to changes in technology, business practices, and economic conditions throughout their careers.</p>
<b>Programme Specific Outcomes:</b>	<p><b>PSO1: Placement:</b> Acquire the ability to critically analyze complex real life problems using the laws of Physics with appropriate mathematical tools and there by preparing the students to face various state/national level competitive exams.</p> <p><b>PSO2: Entrepreneur:</b> Acquire employability and entrepreneurial skills through hands-on training in basic as well as advanced areas of Physics and to develop innovative scientific solutions for industrial and societal needs at local, regional, national and global levels.</p> <p><b>PSO3: Contribution to the Society:</b> Create skills required for identifying socially relevant research problems, collection of data, analyze and interpret data leading to knowledge enhancement in addressing the societal challenges.</p>

### Eligibility for Admission:

Candidates for admission to the first year of the **Master of Physics** course shall be required to have passed the **Bachelor of Physics** by the Government of Tamil Nadu or any equivalent.

## Methods of Evaluation and Assessment

<b>Methods of Evaluation</b>		
Internal Evaluation		25 Marks
External Evaluation	End Semester Examination	75 Marks
	<b>Total</b>	<b>100 Marks</b>
<b>Methods of Assessment</b>		
Recall(K1)	Simple definitions, MCQ, Recall steps, Concept definitions	
Understand/ Comprehend(K2)	MCQ, True/False, Short essays, Concept explanations, short summary or Overview	
Application(K3)	Suggest idea/concept with examples, suggest formulae, solve problems, Observe, Explain	
Analyze(K4)	Problem-solving questions, finish a procedure in many steps, Differentiate Between various ideas, Map knowledge	
Evaluate(K5)	Longer essay/Evaluation essay, Critique or justify with pros and cons	
Create(K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations	

Course Code	Course Category	Title of the Course	Ins. Hrs/Week	Credit	Marks		Total
					CIA	ESE	
<b>Semester – I</b>							
26PPHC11	Core – 1	Classical Mechanics	6	5	25	75	100
26PPHC12	Core – 2	Statistical Mechanics	6	5	25	75	100
26PPHC13P	Core – 3	General Experiments- Practical	5	3	25	75	100
26PPHE11/ 26PPHE12	DCE – 1	1. Mathematical Physics 2. General Relativity and Cosmology	5	3	25	75	100
26PPHE13/ 26PPHE14	DCE – 2	1. Crystal Growth and Thin Films 2. Analysis of Crystal Structure	4	3	25	75	100
26PPHA11	AECC -1	Quantum Computation with Artificial Intelligence	2	2	25	75	100
26PCHR11	HR	Human Rights	2	2	25	75	100
			<b>30</b>	<b>23</b>	<b>175</b>	<b>525</b>	<b>700</b>
<b>Semester – II</b>							
26PPHC21	Core – 4	Quantum Mechanics	6	5	25	75	100
26PPHC22	Core – 5	Linear and Digital Integrated Circuits	6	5	25	75	100
26PPHC23P	Core – 6	Analog and Digital Experiments- Practical	5	3	25	75	100
26PPHE21/ 26PPHE22	DCE – 3	1. Condensed Matter Physics 2. Materials Science	5	3	25	75	100
26PPHE23/ 26PPHE24	DCE – 4	1. Advanced Optics 2. Plasma Physics	5	3	25	75	100
26PPHS21	SEC-1	Renewable Energy and Energy Harvesting	3	2	25	75	100
			<b>30</b>	<b>21</b>	<b>150</b>	<b>450</b>	<b>600</b>
<b>Semester – III</b>							
26PPHC31	Core – 7	Microprocessor 8085 & Microcontroller 8051	6	5	25	75	100
26PPHC32	Core – 8	Numerical methods and Programming in C	6	5	25	75	100
26PPHC33P	Core – 9	Microprocessor and Programming in C	6	4	25	75	100
26PPHE31/ 26PPHE32	DCE – 5	1. Electromagnetic Theory 2. Quantum Field Theory	6	3	25	75	100
26PPHS31	SEC – 2	Electrical Network Skills	3	2	25	75	100
26PPHIK31	IKS*	Ancient Indian Knowledge in Physics	3		25	75	100
26PPHIN31	Internship			2	25	75	100
			<b>30</b>	<b>21</b>	<b>175</b>	<b>525</b>	<b>700</b>
<b>Semester – IV</b>							
26PPHC41	Core – 10	Nuclear and Particle Physics	6	5	25	75	100
26PPHC42	Core – 11	Spectroscopy	6	5	25	75	100
26PPHC43P	Core – 12	Advanced General Experiments	4	3	25	75	100
26PPHC44P	Core – 13	Project	6	6	25	75	100
26PPHE41/ 26PPHE42	DCE – 6	1. Nanoscience and Technology 2. Energy Physics	4	3	25	75	100
26PPHP41	PEC	Sewage and Waste Water Treatment & Reuse	2	2	25	75	100
26PPHL41	SLC	Characterization of Materials	2	2	25	75	100
	MOOC	<b>NPTEL (Online)</b>			25	75	100
			<b>30</b>	<b>26</b>	<b>200</b>	<b>600</b>	<b>800</b>
			<b>120</b>	<b>91</b>	<b>700</b>	<b>2100</b>	<b>2800</b>

Students must complete at least one online course (MOOC) from platforms like SWAYAM, NPTEL, within the third semester. Additionally, engaging in a specified Self-learning Course is mandatory to qualify for the degree, and successful participation will be acknowledged with an extra credit of 2\*.

**CC:** Core Course

**SEC:** Skill Enhancement Course

**SLC:** Self Learning Course

**AECC:** Ability Enhancement Compulsory Course

**DCE:** Discipline Centric Elective

**PEC:** Professional Enhancement Course

**IKS:** Indian Knowledge System (Non- Credit Course)

## SEMESTER I

Department of Physics		L	T	P	Credits	Hours	Marks		
Regulation 2026-27							CIA	ESE	Total
Course Code	Title of the Course								
26PPHC11	Classical Mechanics	6	0	0	5	6	25	75	100
Category	Core Course	Theory 100%							
Learning Objectives									
LO1	To understand constraints, generalized coordinates, configuration space, and apply the principle of virtual work to mechanical systems.								
LO2	To apply D'Alembert's principle and Lagrangian equations to analyze motion of mechanical systems and solve standard problems.								
LO3	To formulate Hamiltonian equations using phase space, cyclic coordinates, and conjugate momentum for various physical systems.								
LO4	To analyze small oscillations, transform to normal coordinates, and determine frequencies of normal modes in multi-particle systems.								
LO5	To apply Lorentz transformations, relativistic dynamics, and four-vector formalism to describe motion in inertial and non-inertial frames.								
Unit	Content								Hours
1	<b>Principles of Classical Mechanics and Lagrangian Formulation:</b> Mechanics of a single particle – mechanics of a system of particles – conservation laws for a system of particles – constraints – holonomic & non-holonomic constraints – generalized coordinates – configuration space – transformation equations – principle of virtual work.- D'Alembert's principle – Lagrangian equations of motion for conservative systems –cyclic coordinate								18
2	<b>Lagrangian Applications, Hamiltonian Formulation:</b> (i) simple pendulum (ii) Atwood's machine (iii) projectile motion, (iv) compound pendulum.- Phase space – Hamiltonian function –Hamilton's canonical equations of motion – cyclic coordinates - conjugate momentum - applications: (i) simple pendulum (ii) one dimensional simple harmonic oscillator (iii) motion of particle in a central force field. Generating functions and their properties; Examples of canonical transformations - Poisson brackets and other canonical invariants								18
3	<b>Hamilton Jacobi Analysis:</b> Equation for Hamilton's principle-function, Application to Harmonic oscillator problem -- Hamilton equation for Hamilton's characteristic function -- Separation of variables and applications to particle motion under central force -- Action angle variables.								18
4	<b>Small Oscillations:</b> Small oscillation – stable and unstable- formulation of the problem – transformation to normal coordinates – frequencies of normal modes – the parallel pendulum- linear triatomic molecule.								18
5	<b>Relativity &amp; Rigid body dynamics:</b> Inertial and non-inertial frames – Lorentz transformation equations – length contraction and time dilation – relativistic addition of velocities – Einstein's								18

	mass-energy relation – Minkowski’s space – four vectors – position, velocity, momentum, acceleration and force in for vector notation and their transformations. <b>Rigid body dynamics:</b> Euler angles, the Euler equations of motion for rigid bodies - body and space reference systems - angular momentum and inertia tensor, Principle axes - Principle moments of inertia, spinning tops, infinitesimal rotations.	
<b>CO</b>	<b>Course Outcomes</b> <b>The student will able to</b>	<b>Knowledge Level</b>
1	Apply principles of single particle and system mechanics using constraints and virtual work.	K1, K2, K3
2	Analyze dynamical systems using Lagrangian formulation and solve standard mechanical problems.	K1, K2, K3, K4
3	Formulate and solve problems using Hamiltonian mechanics and phase space concepts.	K1, K2, K3
4	Evaluate small oscillation systems and determine normal modes and frequencies.	K1, K2, K3
5	Understand relativistic mechanics and apply Lorentz transformations and four-vector formalism.	K1, K2, K3

#### Textbooks:

1	Goldstein, Herbert, Charles P. Poole Jr., and John L. Safko. Classical Mechanics. 3rd ed., Pearson Education, 2002.
2	Upadhyaya, J. C. Classical Mechanics. Himalaya Publishing House, 2010.
3	Gupta, S. P., and G. S. Kumar. Classical Mechanics. Kedar Nath Ram Nath & Co., 2014.

#### Reference Books:

1	Symon, Keith R. Mechanics. 3rd ed., Addison-Wesley, 1971
2	Biswas, S. N. Classical Mechanics. Books and Allied (P) Ltd., 1999.

#### Web-resources:

1	<a href="https://www.britannica.com/science/relativistic-mechanics">https://www.britannica.com/science/relativistic-mechanics</a>
2	<a href="https://nptel.ac.in/courses/122/106/122106027">https://nptel.ac.in/courses/122/106/122106027</a>
3	<a href="https://www.scribd.com/document/741294195/Classical-Mechanics-Gupta-Kumar-Sharma">https://www.scribd.com/document/741294195/Classical-Mechanics-Gupta-Kumar-Sharma</a>

#### Mapping with Programme Outcomes and Programme Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
<b>CO1</b>	2	3	3	3	2	2	2	3	3	3	3
<b>CO2</b>	2	3	3	3	2	2	2	3	2	3	3
<b>CO3</b>	2	3	3	3	2	2	2	3	3	3	3
<b>CO4</b>	2	3	3	3	2	2	2	3	3	3	3
<b>CO5</b>	2	3	3	3	2	2	2	3	3	2	3
<b>Total</b>	<b>10</b>	<b>15</b>	<b>15</b>	<b>15</b>	<b>10</b>	<b>10</b>	<b>10</b>	<b>15</b>	<b>14</b>	<b>14</b>	<b>15</b>
<b>Average</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>3</b>	<b>2.8</b>	<b>2.8</b>	<b>3</b>

3 – Strong, 2- Medium, 1- Low

Department of Physics		L	T	P	Credits	Hours	Marks		
Regulation 2026-27							CIA	ESE	Total
Course Code	Title of the Course								
26PPHC21	Statistical Mechanics	6	0	0	5	6	25	75	100
Category	Core Course	Theory 100%							
Learning Objectives									
LO1	To acquire the knowledge of thermodynamic potentials and to understand phase transition in thermodynamics								
LO2	To identify the relationship between statistic and thermodynamic quantities								
LO3	To understand the concept of partition function, canonical and grand canonical ensembles								
LO4	To explain the fluctuation dissipation theorem and physical significance								
LO5	Understand the statistical behavior of bosons and fermions.								
Unit	Content								Hours
1	<b>Thermodynamic &amp; Phase Transitions:</b> Thermodynamic laws Thermodynamic potentials, Maxwell's relations, chemical potential, Conditions for phase equilibrium -Phase transitions and its classifications - Ehrenfest's classification - Gibbs Phase rule - Landau's theory of phase transition order parameters.								18
2	<b>Statistical Mechanics and Thermodynamics:</b> Foundations of statistical mechanics -- micro and macro states of a system - Micro canonical ensemble - Phase space – Entropy - Connection between statistics and thermodynamics – Entropy of an ideal gas using the micro canonical ensemble - Entropy of mixing and Gibb's paradox.								18
3	<b>Canonical and Grand Canonical Ensembles:</b> Trajectories and density of states - Liouville's theorem – Canonical and grand canonical ensembles - canonical distribution - Partition function - Calculation of statistical quantities - Energy and density fluctuations.								18
4	<b>Classical Statistics:</b> Brownian motion - Langevin's theory – Fluctuation dissipation theorem - The Fokker-Planck equation- Ising model – definition - Mean-field theories of the Ising model in three, two and one dimensions - Statistics of indistinguishable particles - Postulates of classical Statistics - Maxwell-Boltzmann statistics - Density matrix.								18
5	<b>Quantum Statistics:</b> Postulates of quantum statistics Bose-Einstein and Fermi-Dirac statistics – Ideal Fermi gas – Degeneracy - Bose-Einstein statistics – Plank radiation formula - Ideal Bose gas - Bose-Einstein condensation.								18

CO	Course Outcomes Students will able to	Knowledge Level
1	To examine and elaborate the effect of changes in thermodynamic quantities on the states of matter during phase transition	K1, K2, K3
2	To analyze the macroscopic microscopic.	K1, K2, K3, K4
3	Differentiate the ensembles and to interpret the relation of thermodynamic quantities	K1, K2, K3
4	Analysis the magnetic system using ising model and the concept of brownian motion	K1, K2, K3, K4
5	Apply the principles of quantum statistics to analyze systems of identical particles.	K1, K2, K3, K4

**Text Books:**

1	Sathya Prakash and J.P Agarwal, Statistical Mechanics, 7th Edition, Kedar Nath and Ram Nath& Co, Meerut, 1994
2	Agarwal, B. K., and Melvin Eisner. Statistical Mechanics. 2nd ed., New Age International Publishers, 2012.

**Reference Books:**

1	Pathria, R. K., and Paul D. Beale. Statistical Mechanics. 3rd ed., Elsevier, 2011.
2	Landau, L. D., and E. M. Lifshitz. Statistical Physics, Part 1. 3rd ed., Butterworth-Heinemann, 1980.
3	Huang, Kerson. Statistical Mechanics. 2nd ed., Wiley India / Taylor & Francis reprint, 2010.

**Web Resources:**

1	<a href="https://byjus.com/chemistry/third-law-of-thermodynamics/">https://byjus.com/chemistry/third-law-of-thermodynamics/</a>
2	<a href="https://web.stanford.edu/~peastman/statmech/thermodynamics">https://web.stanford.edu/~peastman/statmech/thermodynamics</a>

**Mapping with Programme Outcomes and Programme Specific Outcomes**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	3	2	1	2	3	1	3	3	3
CO2	3	3	3	2	1	2	3	1	3	3	3
CO3	3	3	3	2	1	2	3	2	3	3	3
CO4	3	3	3	2	1	2	3	2	3	3	3
CO5	3	3	3	2	1	2	3	1	3	3	3
<b>Total</b>	<b>15</b>	<b>15</b>	<b>15</b>	<b>10</b>	<b>5</b>	<b>10</b>	<b>15</b>	<b>7</b>	<b>15</b>	<b>15</b>	<b>15</b>
<b>Average</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>1.4</b>	<b>3</b>	<b>3</b>	<b>3</b>

3 – Strong, 2- Medium, 1- Low

Department of Physics		L	T	P	Credits	Hours	Marks		
Regulation 2026-27							CIA	ESE	Total
Course Code	Title of the Course								
26PPHC23P	General Experiments-Practical	0	0	5	3	5	25	75	100
Category	Core Course	Practical 100%							
Learning Objectives									
LO1	To learn the general physics experiments and interpret experimental data using appropriate techniques and instruments.								
Unit	Content								Hours
1	<ol style="list-style-type: none"> <li>1. Determination of Young's modulus by Hyperbolic fringes-Cornu's Method</li> <li>2. Determination of Young's modulus by Elliptical fringes - Cornu's Method</li> <li>3. Determination of Viscosity of the given liquid – Meyer's disc</li> <li>4. Measurement of Coefficient of linear expansion- Air wedge Method</li> <li>5. Determination of Rydberg's Constant - Hydrogen Spectrum</li> <li>6. Thickness of air film - FP Etalon</li> <li>7. Measurement of Band gap energy- Thermistor</li> <li>8. Determination of Specific charge of an electron – Thomson's method.</li> <li>9. Measurement of Resistivity/Conductivity - Four probe method.</li> <li>10. Determination of Numerical Apertures and Acceptance angle of optical fibers using Laser Source.</li> <li>11. Measurement of wavelength of Diode Laser / He – Ne Laser using Diffraction grating</li> </ol>								75
CO	Course Outcomes								Knowledge Level
	<b>Students will able to</b>								
1	Apply theoretical concepts to perform, analyze, and report results of general physics experiments with accuracy and scientific reasoning.								K1, K2, K3, K4

**Textbooks:**

1	Gupta, S. L., and V. Kumar. Practical Physics. 2nd ed., Pragati Prakashan, 2018.
2	Srinivasan, R., and K. R. Priolkar. Kit Developed for Doing Experiments in Physics: Instruction Manual. Indian Academy of Sciences, 2012.

Department of Physics		L	T	P	Credits	Hours	Marks		
Regulation 2026-27							CIA	ESE	Total
Course Code	Title of the Course								
24PPHE11	Mathematical Physics	5	0	0	3	5	25	75	100
Category	Core-Elective	Theory 75% & Problem 25%							
<b>Learning Objectives</b>									
LO1	To understand vector space concepts, linear operators, Orthogonality, and eigenvalue problems in abstract spaces.								
LO2	To apply analytic function theory, contour integration, and residue theorem to evaluate complex integrals.								
LO3	To analyze matrices, compute eigenvectors, and apply diagonalization techniques.								
LO4	To apply Fourier and Laplace transforms to solve differential equations and physical applications.								
LO5	To solve differential equations using special functions, orthogonal polynomials, and Green's function methods.								
Unit	Content								Hours
1	<b>Linear Vector Space:</b> Basic concepts – Definitions- examples of vector space – Linear independence - Scalar product- Orthogonality – Gram-Schmidt orthogonalization procedure linear operators – Dual space- ket and bra notation – orthogonal basis – change of basis – Isomorphism of vector space – projection operator – Direct sum and invariant subspace – orthogonal transformations and rotation.								15
2	<b>Complex Analysis:</b> Review of Complex Numbers -de Moivre's theorem- Functions of a Complex Variable- Differentiability -Analytic functions- Harmonic Functions- Complex Integration- Contour Integration, Cauchy – Riemann conditions – Singular points –Cauchy's Integral Theorem and integral Formula -Taylor's Series - Zeros and poles – Residue theorem								15
3	<b>Matrices:</b> Types of Matrices and their properties, Rank of a Matrix -Conjugate of a matrix - Adjoint of a matrix - Inverse of a matrix - Hermitian and Unitary Matrices -Trace of a matrix- Transformation of matrices - Characteristic equation - Eigen values and Eigen vectors - Cayley–Hamilton theorem – Diagonalization-Tensor Basics								15
4	<b>Fourier &amp; Laplace Transforms:</b> Definitions -Fourier transform and its inverse - Transform of Gaussian function Fourier transform of derivatives - Cosine and sine transforms - Convolution theorem. Application: Diffusion equation: Flow of heat in an infinite and in a semi - infinite medium - Laplace transform and its inverse - Transforms of derivatives and integrals – Differentiation and integration of transforms - Dirac delta functions – Application.								15
5	<b>Differential Equations:</b> Second order differential equation- Sturm-Liouville's theorem- Hermite polynomials – General Solution- Generating function - Orthogonality properties - Recurrence relations – Legendre polynomials - General Solution- (any 2 Problems ) Generating function - Rodrigue formula – Orthogonality properties (any 2 Problems) - One-dimensional Green's function and Reciprocity theorem								15

CO	Course Outcomes Students will be able to	Knowledge Level
1	Apply concepts of linear vector spaces, operators, and transformations in physical systems.	K1, K2, K3
2	Analyze complex functions and apply contour integration and residue theorem to solve problems.	K1, K2, K3
3	Use matrix methods to solve systems of equations and eigenvalue problems.	K1, K2
4	Apply Fourier and Laplace transforms to solve physical problems such as heat flow and wave motion.	K1, K2, K3, K4
5	Solve differential equations using special functions and Green's function methods.	K1, K2, K3, K4

#### Textbooks:

1 Satyaprakash, Mathematical Physics. 4th ed., Sultan Chand & Sons, 2016.

2 Gupta, B. D. Mathematical Physics. 4th ed., Vikas Publishing House, 2009.

#### Reference Books:

1 Zill, Dennis G., and Michael R. Cullen. Advanced Engineering Mathematics. 3rd ed., Narosa Publishing House, 2006.

2 Wylie, Clarence R., and Louis C. Barrett. Advanced Engineering Mathematics. 6th ed., McGraw-Hill, 1995.

3 Dass, H. K., and Rama Verma. Mathematical Physics. S. Chand Publishing, 2011.

#### Web Resources:

1 [https://books.google.co.in/books?id=IzJdPqEn6VYC&printsec=copyright&redir\\_esc=y#v=onepage&q&f=false](https://books.google.co.in/books?id=IzJdPqEn6VYC&printsec=copyright&redir_esc=y#v=onepage&q&f=false)

2 <https://www.youtube.com/watch?v=vvHG0V9dqW0>

3 <https://www.youtube.com/watch?v=IIKwbPfmRTQ>

### Mapping with Programme Outcomes and Programme Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	2	2	2	1	2	1	1	3	2	1
CO2	3	3	2	2	1	1	1	1	3	2	1
CO3	3	3	2	2	1	1	1	2	3	3	1
CO4	3	2	3	3	2	1	2	1	3	3	2
CO5	3	2	2	3	2	1	2	2	3	3	2
<b>Total</b>	<b>15</b>	<b>12</b>	<b>11</b>	<b>12</b>	<b>7</b>	<b>6</b>	<b>7</b>	<b>7</b>	<b>15</b>	<b>13</b>	<b>7</b>
<b>Average</b>	<b>3</b>	<b>2.4</b>	<b>2.2</b>	<b>2.4</b>	<b>1.4</b>	<b>1.2</b>	<b>1.4</b>	<b>1.4</b>	<b>3</b>	<b>2.6</b>	<b>1.4</b>

3 – Strong, 2- Medium, 1- Low

Department of Physics		L	T	P	Credits	Hours	Marks		
Regulation 2026-27							CIA	ESE	Total
Course Code	Title of the Course								
26PPHE12	General Relativity and Cosmology	5	0	0	3	5	25	75	100
Category	Core Elective	Theory 100%							
Learning Objectives									
LO1	To understand and perform tensor operations such as contraction, tensor products, and transformations between covariant and contravariant forms.								
LO2	To understand the fundamentals of vector and tensor fields, their transformation properties, and the use of gradient, Laplacian, and covariant derivatives in general coordinates								
LO3	To understand the concepts of space-time and Lorentz transformations, and to study the motion of particles using world-lines and proper time.								
LO4	To understand the role of tensors in describing space-time curvature and to study the principles of equivalence, gravitation, and curved space-time physics.								
LO5	To understand the expansion and evolution of the Universe, including its thermal history and the standard cosmological model.								
Unit	Content								Hours
1	<b>Tensors:</b> Tensors in index notation - inner and outer products - contraction - symmetric and antisymmetric tensors - quotient law - metric tensors - covariant and contravariant tensors - vectors - the tangent space - dual vectors - tensors - tensor products - the Levi-Civita tensor – tensors, curvature, and symmetry in Riemann spaces.								15
2	<b>Tensors Field:</b> Vector-fields, tensor-fields, transformation of tensors - gradient and Laplace operator in general coordinates - covariant derivatives and Christoffel connection - Elasticity: Field tensor - field energy tensor - strain tensor - tensor of elasticity- curvature tensor								15
3	<b>General Relativity:</b> The space-time interval - the metric - Lorentz transformations - space-time diagrams - world-lines - proper time - energy-momentum vector – energy momentum tensor - perfect fluids - energy-momentum conservation - parallel transport - the parallel propagator – geodesics.								15
4	<b>Tensor in Relativity:</b> Ricci and Einstein tensors - Weyl tensor - Killing vectors - the Principle of Equivalence - gravitational red shift - gravitation as space-time curvature - the Newtonian limit - physics in curved space-time - Einstein's equations - the Weak Energy Condition - perihelion precession								15
5	<b>Cosmology:</b> The standard cosmological model-Friedmann-Robertson - the theory of cosmological fluctuations - Theory and observations of the cosmic microwave background -Expansion of the Universe -scale structure of the Universe-Walker type models of the Universe - Dark matter and dark energy-origin of galaxies.								15

CO	Course Outcomes Students will able to	Knowledge Level
1	Apply index notation and perform tensor algebra.	K1, K2, K3
2	Analysis vector and tensor fields in curved spaces	K1, K2, K3
3	Interpret world lines and space time diagrams	K1, K2, K3
4	Apply the equivalence principle and interpret gravity as space time curvature	K1, K2, K3, K4
5	Understand large scale structure formation and origin of galaxies	K1, K2

#### Textbooks:

1	Satyaprakash, Mathematical Physics. 4th ed., Sultan Chand & Sons, 2016.
2	Gupta, B. D., and Kumar. Mathematical Physics. 4th ed., Vikas Publishing House, 2009.
3	Plebanski, Jerzy, and Andrzej Krasinski. An Introduction to General Relativity and Cosmology. Cambridge University Press, 2006.

#### Reference Books:

1	Wald, Robert M. Space, Time, and Gravity: The Theory of the Big Bang and Black Holes. University of Chicago Press, 1992.
2	Narlikar, J. V. Introduction to Cosmology. 2nd ed., Cambridge University Press, 2002

#### Web Resources:

1	<a href="https://link.springer.com/book/9780387406282">https://link.springer.com/book/9780387406282</a>
2	<a href="https://www.youtube.com/watch?v=w6zi95SknZw">https://www.youtube.com/watch?v=w6zi95SknZw</a>
3	<a href="https://www.youtube.com/watch?v=tzQC3uYL67U">https://www.youtube.com/watch?v=tzQC3uYL67U</a>

### Mapping with Programme Outcomes and Programme Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	3	2	3	3	3	3	3	3	3
CO2	3	3	3	2	3	3	3	3	3	3	3
CO3	3	3	3	2	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3
Total	15	15	15	12	15	15	15	15	15	15	15
Average	3	3	3	2.4	3	3	3	3	3	3	3

3 – Strong, 2- Medium, 1- Low

Department of Physics		L	T	P	Credits	Hours	Marks		
Regulation 2026-27							CIA	ESE	Total
Course Code	Title of the Course								
24PPHE13	Crystal Growth and Thin Films	4	0	0	3	4	25	75	100
Category	Core Elective	Theory 100%							
Learning Objectives									
LO1	To acquire the knowledge on Nucleation and Kinetics of crystal growth.								
LO2	To understand the Crystallization Principles and Growth techniques								
LO3	To study the basic of crystal analysis								
LO4	To understand the thin film deposition methods.								
LO5	To understand the different characterization techniques.								
Unit	Content								Hours
1	<b>Crystal Growth Kinetics:</b> Introduction to crystal growth – Solubility diagram – Unsaturation - Saturation – Supersaturation –Metastable Zone width – Nucleation – homogeneous and heterogeneous nucleation – Classical theory of nucleation: Gibbs Thomson equation for Vapour - Gibbs Thomson equation for solution – Energy of formation of a nucleus and its types – Spherical nucleus - BCF theory.								12
2	<b>Crystal Structures:</b> Symmetry operations, elements – Combination of symmetry elements (Point group) –Symmetry properties of the energy function – Common crystal structures –Voids in close packing - Pauling’s rule - Defects in crystals – Polycrystalline Amorphous - Polymorphism.								12
3	<b>Crystallization:</b> Solid phase – Liquid Phase-Vapour Phase crystal-Gel growth - Bridgman technique - Czochralski method – zone melting - Skull Melting process - Verneuil technique Slow cooling method – Slow evaporation method – Temperature gradient method - Gel Preparation, growth –Vapour growth: PVD – CVD								12
4	<b>Thin Film:</b> Formation- Theory of Thin films- Growth and Structure of Films- Thickness measurement -Mechanical, structural and optical characterization of thin films-Surface and interface characterization of films and heterostructures								12
5	<b>Thin Film Deposition Methods:</b> Thin Films – Basic of Thin films - Chemical deposition – Spin coating – Electron beam gun - Spray pyrolysis - Sputtering – RF Sputtering - Cathodic arc deposition - Pulsed Laser Deposition Technique - Ion implantation.								12

CO	Course Outcomes Students will be able to	Knowledge Level
1	Acquire the Basic Concepts, Nucleation and Kinetics of crystal growth.	K1, K2, K3
2	Understand the Crystallization Principles and Growth techniques.	K1, K2
3	Understand the Crystallization Principles and Crystal Growth techniques.	K1, K2
4	Identify the symmetry operations and elements in crystals	K1, K2, K3
5	Understand the characterization of materials	K1, K2

Textbooks:	
1	Markov, Ivan V. Crystal Growth for Beginners: Fundamentals of Nucleation, Crystal Growth, and Epitaxy. 2nd ed., World Scientific, 2004.
2	Goswami. A, Thin Film Fundamentals, New Age International Publisher, 2008
Reference Books:	
1	Brice, J. C. Crystal Growth Processes. Wiley, 1986.
2	Ramasamy, P., and F. D. Gnanam. UGC Summer School Notes on Crystal Growth. 1983.
3	Santharaghavan, P., and P. Ramasamy. Crystal Growth Processes. KRU Publications, 2010.
Web Resources:	
1	<a href="https://onlinecourses.nptel.ac.in/noc24_ge56/preview">https://onlinecourses.nptel.ac.in/noc24_ge56/preview</a>
2	<a href="https://openaccesspub.org/3d-printing-and-applications/article/1804">https://openaccesspub.org/3d-printing-and-applications/article/1804</a>
3	<a href="https://measurlabs.com/blog/characterization-of-thin-films/">https://measurlabs.com/blog/characterization-of-thin-films/</a>

### Mapping with Programme Outcomes and Programme Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	2	1	2	1	1	1	1	2	1	1
CO2	3	3	2	2	1	1	1	1	3	2	2
CO3	3	3	2	2	2	1	2	2	3	2	1
CO4	3	2	3	3	2	1	1	2	3	3	2
CO5	3	3	2	3	3	2	1	1	3	3	2
<b>Total</b>	<b>15</b>	<b>13</b>	<b>10</b>	<b>12</b>	<b>9</b>	<b>6</b>	<b>6</b>	<b>7</b>	<b>14</b>	<b>11</b>	<b>8</b>
<b>Average</b>	<b>3</b>	<b>2.6</b>	<b>2</b>	<b>2.4</b>	<b>1.8</b>	<b>1.2</b>	<b>1.2</b>	<b>1.4</b>	<b>2.8</b>	<b>2.2</b>	<b>1.6</b>

3 – Strong, 2- Medium, 1- Low

Department of Physics		L	T	P	Credits	Hours	Marks		
Regulation 2026-27							CIA	ESE	Total
Course Code	Title of the Course								
26PPHE14	Analysis of Crystal Structures	4	0	0	3	4	25	75	100
Category	Core Elective	Theory 100%							
Learning Objectives									
LO1	To understand the basic concept of crystal structures, and diffraction theory.								
LO2	To provide students with a background to X-ray generation, scattering theory and experimental diffraction from single crystals.								
LO3	To provide instruction on the methods and basis for determining low-molecular weight crystal structures using X-ray Crystallography.								
LO4	To give the students a background to the instrumentation used for powder diffraction and structure refinement using Rietveld method.								
LO5	To teach the different levels of structure exhibited by proteins and nucleic acids and methods used in protein crystallography.								
Unit	Content								Hours
1	<b>Crystal Lattice:</b> Unit cell and Bravais lattices - crystal planes and directions - basic symmetry elements operations - translational Understand crystal symmetry and reciprocal lattice concept for X-ray diffraction symmetries - point groups - space groups - equivalent positions - Bragg's law-Laue conditions - Laue groups.								12
2	<b>X-Ray Diffraction:</b> X-ray generation, properties - sealed tube, rotating anode, synchrotron radiation - absorption - filters and monochromators atomic scattering factor - Fourier transformation and structure factor - anomalous dispersion - Laue, rotation/oscillation, moving film methods- interpretation of diffraction patterns - cell parameter determination - systematic absences - space group determination.								12
3	<b>Structure Analysis:</b> Single crystal diffractometers - geometries - scan modes - scintillation and area detectors -intensity data collection - data reduction - factors affecting X-ray intensities - temperature and scale factor - electron density - direct method fundamentals and procedures - structure refinement - least squares method - Fourier and difference Fourier synthesis - R factor - structure interpretation - geometric calculations - conformational studies - computer program packages.								12
4	<b>Powder XRD Analysis:</b> Fundamentals of powder diffraction - Debye Scherrer method - diffractometer geometries - use of monochromators and Soller slits - sample preparation and data collection - identification of unknowns - powder diffraction files (ICDD) - Rietveld refinement fundamentals - profile analysis - peak shapes - whole pattern fitting - structure refinement procedures – auto-indexing – structure determination from powder data - new developments. Energy dispersive X-ray analysis – texture studies - crystallite size determination - residual stress analysis - high and low temperature and high pressure crystallography (basics only).								12

5	<b>Macromolecules:</b> Globular and fibrous proteins, nucleic acids - primary, secondary, tertiary and quaternary structures - helical and sheet structures - Ramachandran map and its significance – crystallization methods for proteins - factors affecting protein crystallization – methods used to solve protein structures - Structure Validation,	12
<b>CO</b>	<b>Course Outcomes</b> <b>Students will be able to</b>	<b>Knowledge Level</b>
1	Understand crystal symmetry and reciprocal lattice concept for X-ray diffraction	K2
2	Gain a working knowledge of X-ray generation, X-ray photography with Laue, oscillation and moving film methods, and space group determination.	K1, K3
3	Get an exposure to crystal structure determination using program packages.	K1, K4
4	Understand the instrumentation used for powder diffraction, data collection, data interpretation, and structure refinement using Rietveld method.	K2, K4
5	Get an insight into the structural aspects of proteins and nucleic acids, crystallization of proteins and methods to solve protein structures.	K4

<b>Textbooks:</b>	
1	Blundell, T.L. and Johnson, L., "Protein Crystallography", Academic Press, New York, 1986.
2	H.L. Bhat, Introduction to Crystal Growth Principles and Practice CRC Press, Taylor & Francis Group, Boca Raton, Florida, 2015.
<b>Reference Books:</b>	
1	Glusker, J.P. and Trueblood, K.N. Crystal Structure Analysis: A Primer", Oxford University, Press, New York, 1994.
2	Ladd, M.F.C. and Palmer, R.A., "Structure Determination by X-ray Crystallography", Plenum Press, New York, 3rd Edition, 1993.
3	Stout, G.H. and Jensen, L."X-ray Structure Determination, A Practical Guide", Macmillan: New York, 1989.
4	Woolfson, M.M. "An Introduction to X-ray Crystallography" Cambridge University Press, New York, 1997.
5	Sam Zhang, Lin Ki, Ashok Kumar, Materials Characterization Techniques, CRC Press, Taylor & Francis Group, Boca Raton, Florida, 2009
<b>Web Resources:</b>	
1	<a href="https://www.youtube.com/watch?v=WovxKZpNrTQ">https://www.youtube.com/watch?v=WovxKZpNrTQ</a>
2	<a href="https://ocw.mit.edu/courses/5-069-crystal-structure-analysis-spring-2010/pages/lecture-notes/">https://ocw.mit.edu/courses/5-069-crystal-structure-analysis-spring-2010/pages/lecture-notes/</a>

### Mapping with Programme Outcomes and Programme Specific Outcomes

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	3	3	3	2	3	2	1	2	3	3	3
<b>CO2</b>	3	3	3	2	2	2	1	2	2	2	2
<b>CO3</b>	3	3	2	2	2	2	2	2	2	2	2
<b>CO4</b>	3	2	2	2	2	2	2	2	2	2	2
<b>CO5</b>	3	2	2	2	2	2	2	2	2	2	2
<b>Total</b>	<b>15</b>	<b>13</b>	<b>12</b>	<b>10</b>	<b>11</b>	<b>10</b>	<b>8</b>	<b>10</b>	<b>11</b>	<b>11</b>	<b>11</b>
<b>Average</b>	<b>3</b>	<b>2.6</b>	<b>2.4</b>	<b>2</b>	<b>2.2</b>	<b>2</b>	<b>1.6</b>	<b>2</b>	<b>2.2</b>	<b>2.2</b>	<b>2.2</b>

**3 – Strong, 2- Medium, 1- Low**

Department of Physics		L	T	P	Credits	Hours	Marks		
Regulation 2026-27							CIA	ESE	Total
Course Code	Title of the Course								
26PPHA11	Quantum Computation with Artificial Intelligence	2	0	0	2	2	25	75	100
Category	Ability Enhancement Compulsory Course	Theory 100%							
<b>Learning Objectives</b>									
LO1	To understand the fundamentals of quantum computation and qubits.								
LO2	To study quantum gates and quantum circuits.								
LO3	To learn important quantum algorithms.								
LO4	To introduce artificial intelligence applications in quantum computing.								
LO5	To understand quantum error correction and future quantum technologies.								
Unit	Content								Hours
1	<b>Fundamentals of Quantum Computation:</b> Review of Quantum Mechanics – Linear Algebra – Postulates of Quantum Mechanics – Quantum States and Qubits – Quantum Measurement – Bloch Sphere – Density Matrix – Introduction to Quantum Computing.								6
2	<b>Quantum Computation Models:</b> Classical and Quantum Turing Machines – Deterministic and Probabilistic Models – Reversible Computation – Circuit Model of Quantum Computation – Computational Complexity – Basic Quantum Programming Platforms.								6
3	<b>Quantum Gates and Circuits:</b> Single Qubit Gates: Pauli Gates, Hadamard Gate, Phase Gate – Rotation Gates – Two Qubit Gates: CNOT, Controlled U Gate – Three Qubit Gates: Toffoli Gate – Quantum Circuit Representation – Visualization of Quantum Gates.								6
4	<b>Quantum Algorithms and AI Applications:</b> Deutsch Algorithm – Deutsch Jozsa Algorithm – Simon’s Algorithm – Introduction to Shor’s Algorithm – Quantum Fourier Transform – Basics of Artificial Intelligence – Machine Learning concepts – AI assisted Quantum Optimization.								6
5	<b>Quantum Error Correction and Future Applications:</b> Quantum Errors – Classical vs Quantum Error Correction – Fault Tolerant Quantum Computation – Decoherence – DiVincenzo Criteria – Quantum Machine Learning – Applications in Cryptography, Healthcare and Material Science.								6

CO	Course Outcomes Students will be able to	Knowledge Level
1	Explain the principles of quantum computation and qubits.	K1, K2
2	Describe quantum computational models and complexity classes.	K1, K2
3	Analyze quantum gates and circuit operations.	K1, K4
4	Illustrate quantum algorithms and AI integration.	K2, K4
5	Discuss quantum error correction and emerging applications.	K1, K2, K3

<b>Textbooks:</b>	
1	Michael A. Nielsen and Isaac L. Chuang, Quantum Computation and Quantum Information, Cambridge University Press
2	Chris Bernhardt, Quantum Computing for Everyone, MIT Press.
<b>Reference Books:</b>	
1	Maria Schuld and Francesco Petruccione, Supervised Learning with Quantum Computers.
2	Eleanor Rieffel and Wolfgang Polak, Quantum Computing: A Gentle Introduction.
<b>Web Resources:</b>	
1	<a href="https://www.youtube.com/watch?v=sQSQBYHR0ms">https://www.youtube.com/watch?v=sQSQBYHR0ms</a>
2	<a href="https://www.nature.com/articles/s41467-025-65836-3">https://www.nature.com/articles/s41467-025-65836-3</a>

### Mapping with Programme Outcomes and Programme Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
<b>CO1</b>	3	2	1	1	2	1	1	1	3	2	1
<b>CO2</b>	3	3	2	1	2	1	1	1	3	2	1
<b>CO3</b>	3	3	3	2	3	2	1	2	3	3	2
<b>CO4</b>	2	3	3	3	3	1	2	2	2	3	3
<b>CO5</b>	2	2	2	3	3	2	1	1	2	3	3
<b>Total</b>	<b>13</b>	<b>13</b>	<b>11</b>	<b>10</b>	<b>13</b>	<b>7</b>	<b>6</b>	<b>7</b>	<b>13</b>	<b>13</b>	<b>10</b>
<b>Average</b>	<b>2.6</b>	<b>2.6</b>	<b>2.2</b>	<b>2</b>	<b>2.6</b>	<b>1.4</b>	<b>1.2</b>	<b>1.4</b>	<b>2.6</b>	<b>2.6</b>	<b>2</b>

3 – Strong, 2- Medium, 1- Low

**SEMESTER II**

Department of Physics		L	T	P	Credits	Hours	Marks		
Regulation 2026-27							CIA	ESE	Total
Course Code	Title of the Course								
26PPHC22	Quantum Mechanics	6	0	0	5	6	25	75	100
Category	Core Course	<b>Theory100%</b>							
Learning Objectives									
LO1	To develop the physical principles and the mathematical background important to quantum mechanical descriptions.								
LO2	To derive and apply equations of Motion in quantum Mechanics								
LO3	To analyze both non-degenerate -Degenerate energy levels								
LO4	To Understand and apply angular momentum operators in quantum mechanics.								
LO5	To correlate the relativistic quantum mechanics using Dirac equation								
Unit	Content								Hours
1	<b>Foundation of Quantum Mechanics:</b> Interpretation of the wave function – Time dependent Schrodinger equation – Time independent Schrodinger equation – Stationary states – Ehrenfest’s theorem –Linear vector space – Linear operator – Eigen functions and Eigen Values –Hermitian Operator – Postulates of Quantum Mechanics – Uncertainty relation.								18
2	<b>Operator Formalism &amp; representation:</b> Dirac notation – Equations of motions – Schrodinger representation – Heisenberg representation – Interaction representation – Coordinate representation – Momentum representation – Symmetries and conservation laws – Unitary transformation.								18
3	<b>Approximation Methods:</b> Time independent perturbation theory for non-degenerate energy levels – Degenerate energy levels – Stark effect in Hydrogen atom -Variation method – Helium atom – WKB approximation - Application to simple harmonic oscillator-Ladder operators								18
4	<b>Angular momentum &amp; Quantum Mechanics:</b> Angular momentum operators – The rotation operator and angular momentum –Spin angular momentum – Total angular momentum operator – Commutation relation – Eigenvalue of angular momentum operator – Matrix Representation –Addition of angular momentum – Clebsch-Gordan coefficients.								18
5	<b>Dirac Equation-:</b> Dirac Equation – KG equation - Covariant form of Dirac Equation – Properties of the gamma matrices – Traces – Relativistic invariance of Dirac equation – Probability Density – Current four vector – Bilinear covariant – Feynman’s theory of positron (Elementary ideas only without propagation formalism)								18

CO	Course Outcomes	Knowledge Level
1	Demonstrates a clear understanding of the basic postulates of quantum mechanics which serve to formalize the rules of quantum Mechanics	K1, K2, K3
2	Distinguish between different representation	K1, K2, K3
3	Apply time independent perturbation theory to solve problems	K1, K2, K3
4	Acquire knowledge about angular momentum operators and the algebra in quantum mechanics	K1, K2
5	Derive and analyze KG equation and compare it with the Dirac equations	K1, K2, K3, K4

Textbooks:	
1	SatyaPrakash,. Advanced Quantum Mechanics. Kedar Nath Ram Nath, 2014.
2	Aruldas, G. Quantum Mechanics. 2nd ed., PHI Learning Pvt. Ltd., 2008.
Reference Books:	
1	Mathews, P. M., and K. Venkatesan. Quantum Mechanics. 2nd ed., McGraw Hill Education, 2010.
2	Griffiths, David J., and Darrell F. Schroeter. Introduction to Quantum Mechanics. 3rd ed., Cambridge University Press, 2018.
3	Devanathan, V. Quantum Mechanics. 2nd ed., Alpha Science International Ltd., 2011.
Web Resources:	
1	<a href="https://www.msuniv.ac.in/images/distance%20education/learning%20materials/ug%20pg%202023/pg%202021/Msc%20physics%202023/sy_2324_mscphysics2023_2_QuantumMechanics-I.pdf">https://www.msuniv.ac.in/images/distance%20education/learning%20materials/ug%20pg%202023/pg%202021/Msc%20physics%202023/sy_2324_mscphysics2023_2_QuantumMechanics-I.pdf</a>
2	<a href="http://uou.ac.in/sites/default/files/slm/MSCPH-512.pdf">http://uou.ac.in/sites/default/files/slm/MSCPH-512.pdf</a>

### Mapping with Programme Outcomes and Programme Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	2	3	2	3	3	3
CO2	3	3	3	3	3	3	3	2	3	3	3
CO3	2	3	3	2	3	2	3	2	3	3	3
CO4	3	3	3	3	3	2	3	3	3	3	3
CO5	3	3	3	2	3	3	3	3	3	3	3
<b>Total</b>	<b>14</b>	<b>15</b>	<b>15</b>	<b>13</b>	<b>15</b>	<b>12</b>	<b>15</b>	<b>12</b>	<b>15</b>	<b>15</b>	<b>15</b>
<b>Average</b>	<b>2.8</b>	<b>3</b>	<b>3</b>	<b>2.6</b>	<b>3</b>	<b>2.4</b>	<b>3</b>	<b>2.4</b>	<b>3</b>	<b>3</b>	<b>3</b>

3– Strong, 2- Medium, 1- Low

Department of Physics		L	T	P	Credits	Hours	Marks		
Regulation 2026-27							CIA	ESE	Total
Course Code	Title of the Course								
26PPHC12	Linear and Digital Integrated Circuits	6	0	0	5	6	25	75	100
Category	Core Course	Theory 100%							
<b>Learning Objectives</b>									
LO1	To introduce the basic building blocks of linear integrated circuits.								
LO2	To understand the concept of linear and non-linear applications of operational amplifiers.								
LO3	To analyze, active filter circuits, IC 555 timer configurations, and phase-locked loop systems.								
LO4	To design voltage regulator circuits and the performance of DAC and ADC systems.								
LO5	To implement CMOS logic circuits, combinational and sequential digital systems using TTL 74xx ICs								
Unit	Content								Hours
1	<b>Integrated Circuits and Operational Amplifier:</b> Classification of ICs – Based on functions - analog and Digital ICs, basic information of Op-Amp 741, Op-Amp internal circuit – block diagram. Characteristics and parameters, Inverting and Non-inverting amplifier, adder, subtraction, differentiator and Integrator.								18
2	<b>Linear Applications of Op-Amp:</b> Solution to simultaneous equations, Instrumentation amplifiers, V to I and I to V converters. <b>Non-Linear Applications of Op-Amp:</b> Sample and Hold circuit, Log and Antilog amplifier, Comparators, Schmitt trigger, Multivibrators, Triangular and Square waveform generators.								18
3	<b>Active Filters:</b> Butterworth filters – 1 <sup>st</sup> order, 2 <sup>nd</sup> order low pass, high pass and band pass filters. <b>Timer And Phase Locked Loops:</b> Introduction to IC 555 timer, description of functional diagram, monostable and astable operations and applications, Schmitt trigger, PLL - introduction, basic principle, voltage-controlled oscillator (IC 566), applications of PLL								18
4	<b>Voltage Regulator:</b> Series Op-Amp regulator, IC Voltage Regulators, Switching Regulator. <b>D To A and A To D Converters:</b> Introduction, basic DAC techniques -weighted resistor DAC, R-2R ladder DAC, A to D converters - counter type ADC, successive approximation ADC and dual slope ADC.								18
5	<b>CMOS Logic:</b> CMOS logic levels, MOS transistors, Basic CMOS Inverter, NAND and NOR gates. <b>Combinational Circuits Using TTL ICs:</b> Study of logic gates using 7400 ICs, Four-bit parallel adder (IC 7483), Comparator (IC 7485), Decoder (IC 74138, IC 74154), BCD to 7-segment decoder (IC7447), Encoder (IC74147), Multiplexer (IC74151), Demultiplexer (IC 74154). <b>Sequential Circuits Using TTL ICs:</b> Flip Flops (IC 7474), Shift Registers(IC74164), Universal Shift Register (IC 74194), 4-bit asynchronous binary counter (IC 7493).								18

CO	Course Outcomes Students will able to	Knowledge Level
1	Learn about the basic concepts for the circuit configuration for the design of linear integrated circuits and develops skill to solve problems.	K1, K2, K3
2	Develop skills to design linear and non-linear applications circuits using Op-Amp and design the active filters circuits.	K1, K2, K3, K4
3	Design, and apply active filter circuits, IC 555 timer configurations, and phase locked loop systems for signal processing and timing applications in electronic circuits	K1, K2, K3
4	Analyze and design voltage regulator circuits and evaluate the operation and performance of DAC and ADC systems for efficient signal conversion in electronic applications.	K1, K2, K3, K4
5	Design, and implement CMOS logic circuits, combinational and sequential digital systems using TTL 74xx ICs for practical digital applications.	K1, K2, K3, K4

Textbooks:	
1	Vijayendra, V. Introduction to Integrated Electronics (Digital and Analog). S. Viswanathan Printers & Publishers Pvt. Ltd., 2008.
2	Mehta, V. K., and Rohit Mehta. Principles of Electronics. 12th ed., S. Chand & Company Ltd., 2008.
Reference Books:	
1	Roy Choudhury, D., and Shail B. Jain. Linear Integrated Circuits. 4th ed., New Age International Pvt. Ltd., 2012.
2	Theraja, B. L., and A. K. Theraja. A Textbook of Electrical Technology. Vol. 1, S. Chand & Company Ltd., 2005.
3	Malvino, Albert Paul, and Donald P. Leach. Digital Principles and Applications. 7th ed., McGraw-Hill Education, 2011.
Web Resources:	
1	<a href="https://nptel.ac.in/course.html/electronics/operational%20amplifier/">https://nptel.ac.in/course.html/electronics/operational amplifier/</a>
2	<a href="https://www.geeksforgeeks.org/digital-electronics-logic-design-tutorials/">https://www.geeksforgeeks.org/digital-electronics-logic-design-tutorials/</a>
3	<a href="https://www.electrical4u.com/applications-of-op-amp/">https://www.electrical4u.com/applications-of-op-amp/</a>

### Mapping with Programme Outcomes and Programme Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	2	3	3	3	3	3
CO2	3	3	3	3	1	3	3	3	2	3	3
CO3	3	3	3	3	1	3	3	3	3	3	3
CO4	3	3	3	3	1	3	3	3	3	3	3
CO5	3	3	3	2	1	1	2	3	3	2	2
<b>Total</b>	<b>15</b>	<b>15</b>	<b>15</b>	<b>14</b>	<b>6</b>	<b>12</b>	<b>14</b>	<b>15</b>	<b>14</b>	<b>14</b>	<b>14</b>
<b>Average</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2.8</b>	<b>1.2</b>	<b>2.4</b>	<b>2.8</b>	<b>3</b>	<b>2.8</b>	<b>2.8</b>	<b>2.8</b>

3 – Strong, 2- Medium, 1- Low

Department of Physics		L	T	P	Credits	Hours	Marks		
Regulation 2026-27							CIA	ESE	Total
Course Code	Title of the Course								
26PPHC13P	Analog and Digital Experiments-Practical	0	0	5	3	5	25	75	100
Category	Core Course	Practical 100%							
<b>Learning Objectives</b>									
LO1	To perform and analyze basic analog and digital electronic circuits using laboratory instruments.								
Unit	Content								Hours
1	<p style="text-align: center;"><b>(any 8 experiments)</b></p> <ol style="list-style-type: none"> <li>Construction of (a) Relaxation oscillator using UJT (2N2646), (b) FET as amplifier using (BFW10/BFW11) - Frequency response curve.</li> <li>Study of attenuation characteristics of Wien's bridge network and design of Wien's bridge oscillator using Op-Amp.</li> <li>Construction of square wave and triangular wave generator using IC741</li> <li>IC 7490 - Modulus counter and seven segment display using IC7447 / IC 7448</li> <li>Solving simultaneous equations – IC 741/ IC LM 324</li> <li>Op-Amp–Active filters: Low pass, High pass and Butter worth filter</li> <li>Construction of Op-Amp-4-bit D/A converter - Binary weighted and R-2R Ladder type</li> <li>Construction of square wave generator using IC 555</li> <li>Construction of multiplexer and demultiplexer using ICs.</li> <li>Study of asynchronous parallel 4-bit binary Up/Down counter using IC7493</li> <li>Construction of current to voltage and voltage to current conversion using IC741.</li> </ol>								75
CO	Course Outcomes								Knowledge Level
	<b>Students will able to</b>								
1	Design, test, and interpret the performance of analog and digital circuits through hands-on experiments.								K1, K2, K3, K4

<b>Textbooks:</b>	
1	Srinivasan, R., and K. R. Priolkar. Kit Developed for Doing Experiments in Physics: Instruction Manual. Indian Academy of Sciences, 2012.
2	Navas, K. A. Electronic Lab Manual, Vol. II. PHI Learning Pvt. Ltd., 2015.

Department of Physics		L	T	P	Credits	Hours	Marks		
Regulation 2026-27							CIA	ESE	Total
Course Code	Title of the Course								
26PPHE21	Condensed Matter Physics	5	0	0	3	5	25	75	100
Category	Core Elective	Theory 100%							
<b>Learning Objectives</b>									
LO1	To understand crystal structures, diffraction, and lattice concepts.								
LO2	To analyze lattice vibrations and phonon behavior.								
LO3	To Analyze semiconductor properties and carrier transport and to interpret the hall effect.								
LO4	To explore different types of magnetic materials and their properties.								
LO5	To understand superconducting phenomena and properties.								
Unit	Content								Hours
1	<b>Crystal Physics:</b> Introduction to crystals, Types of lattices - Miller indices – Symmetry elements and allowed rotations - Simple crystal structures – Diamond, CsCl -Diffraction Conditions - Bragg's law – Laue equations- Scattered Wave Amplitude - Structure factor- Reciprocal Lattice (sc, bcc, fcc), Brillouin zone. Structure and properties of liquid crystals. Inert gas crystals - Cohesive energy of ionic crystals - Madelung constant.								15
2	<b>Lattice Dynamics:</b> Lattice with two atoms per primitive cell - First Brillouin zone - Group and phase velocities - Quantization of lattice vibrations - Phonon momentum - Inelastic scattering by phonons – specific heat capacity, Einstein and Debye's theory of lattice heat capacity - Umklapp processes.								15
3	<b>Free Electron Theory of Metals and Semiconductors:</b> Drude – Lorentz theory of electrical conduction-Electrical conductivity- Thermal conductivity - Wiedemann-Franz law - Free electron gas in three dimensions - Band theory of metals and semiconductors - Kronig-Penney model - Semiconductors - Intrinsic carrier concentration - Mobility - Impurity conductivity – Impurity states - Hall effect – Fermi surfaces and construction - Experimental methods in Fermi surface studies.								15
4	<b>Magnetism:</b> Magnetic materials and their types - Quantum theory of paramagnetism - Rare earth ion- Hund's rule- Adiabatic demagnetization - Domain theory of ferromagnetic theory - Heisenberg's interpretation of Weiss field Ferromagnetic domains - Spin waves - Thermal excitation of magnons - Curie temperature.								15
5	<b>Superconductivity:</b> Effect of magnetic fields - Meissner effect – Critical field – Critical current – Thermodynamic properties of Entropy and heat capacity - Energy gap - Type I and II Superconductors. Thermodynamics of super conducting transition - London equation - Coherence length - Cooper pairs – Bardeen Cooper Schrieffer (BCS) Theory - Josephson tunneling - High temperature Superconductors – SQUIDS.								15

CO	Course Outcomes Students will able to	Knowledge Level
1	Apply concepts of crystal structure, diffraction (Bragg's law), and reciprocal lattice analysis.	K1, K2, K3
2	Analyze lattice dynamics, phonons, and heat capacity models.	K1, K2, K3
3	Apply band theory and Kronig-Penney model to analyze metals and semiconductors.	K1, K2, K3
4	Analyze magnetic behavior using quantum theory and Heisenberg exchange interaction.	K1, K2, K3
5	Understand the superconductivity using BCS theory and related concepts	K1, K2

<b>Textbooks:</b>	
1	Pillai, S. O. Solid State Physics. 8th ed., New Age International Publishers, 2018.
2	Kittel, Charles. Introduction to Solid State Physics. 8th ed., Wiley, 2005.
<b>Reference Books:</b>	
1	Raghavan, V. Materials Science and Engineering: A First Course. 6th ed., PHI Learning, 2015.
2	Singhal, R. L. Solid State Physics. 2nd ed., Kedarnath Ram Nath & Co., 2003.
3	Srivastava, J. P. Elements of Solid State Physics. 2nd ed., Prentice-Hall of India, 2004.
<b>Web Resources:</b>	
1	<a href="https://archive.nptel.ac.in/courses/115/105/115105099/">https://archive.nptel.ac.in/courses/115/105/115105099/</a>
2	<a href="http://www.digimat.in/nptel/courses/video/115105099/L75.html">http://www.digimat.in/nptel/courses/video/115105099/L75.html</a>
3	<a href="http://www.digimat.in/nptel/courses/video/115102026/L01.html">http://www.digimat.in/nptel/courses/video/115102026/L01.html</a>

### Mapping with Programme Outcomes and Programme Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	1	1	1	3	2	1
CO2	3	3	1	1	1	1	1	1	3	2	1
CO3	3	3	2	2	2	1	1	1	3	3	2
CO4	3	2	1	1	1	1	1	1	3	2	1
CO5	3	3	2	2	3	1	1	2	3	3	3
Total	15	13	7	7	8	5	5	6	15	12	8
Average	3	2.6	1.4	1.4	1.6	1	1	1.2	3	2.4	1.6

3 – Strong, 2- Medium, 1- Low

Department of Physics		L	T	P	Credits	Hours	Marks		
Regulation 2026-27							CIA	ESE	Total
Course Code	Title of the Course								
26PPHE22	Materials Science	5	0	0	3	5	25	75	100
Category	Core Elective	Theory 100%							
<b>Learning Objectives</b>									
LO1	To gain knowledge on optoelectronic materials								
LO2	To learn about ceramic processing and advanced ceramics								
LO3	To understand the processing and applications of polymeric materials								
LO4	To gain knowledge on the fabrication of composite materials								
LO5	To learn about shape memory alloys, metallic glasses and nanomaterials								
Unit	Content								Hours
1	<b>Opto Electronic Materials:</b> Importance of optical materials – properties: Band gap and lattice matching– optical absorption and emission – charge injection, quasi-Fermi levels and recombination – optical absorption, loss and gain. Optical processes in quantum structures: Inter-band and intra-band transitions Organic semiconductors. Light propagation in materials – Electro-optic effect and modulation, electro-absorption modulation – exciton quenching								15
2	<b>Ceramic Materials:</b> Ceramic processing: powder processing, milling and sintering – structural ceramics: zirconia, alumina, silicon carbide, tungsten carbide – electronic ceramics – refractories – glass and glass ceramics								15
3	<b>Polymeric Materials:</b> Polymers and copolymers – molecular weight measurement – synthesis: chain growth polymerization – polymerization techniques – glass transition temperature and its measurement – viscoelasticity – polymer processing techniques – applications: conducting polymers, biopolymers and high temperature polymers.								15
4	<b>Composite Materials:</b> Particle reinforced composites – fiber reinforced composites – mechanical behavior – fabrication methods of polymer matrix composites and metal matrix composites – carbon/carbon composites: fabrication and applications.								15
5	<b>New Materials:</b> Shape memory alloys: mechanisms of one-way and two-way shape memory effect, reverse transformation, thermo-elasticity and pseudo-elasticity, examples and applications -bulk metallic glass: criteria for glass formation and stability, examples and mechanical behavior - nanomaterials: classification, size effect on structural and functional properties, processing and properties of Nano crystalline materials, single walled and multi walled carbon nanotubes								15

CO	Course Outcomes Students will able to	Knowledge Level
1	Understand the properties and working principles of optoelectronic materials and quantum structures.	K1, K2,
2	Explain processing, properties, and applications of ceramic materials.	K1, K2
3	Analyze synthesis, properties, and applications of polymeric materials.	K1, K2, K3
4	Evaluate composite materials, their fabrication techniques, and mechanical behavior.	K1, K2, K3, K4
5	Acquire the knowledge of advanced materials such as shape memory alloys, bulk metallic glasses, and nanomaterials.	K1, K2

<b>Textbooks:</b>	
1	Pillai, S. O. Solid State Physics. 8th ed., New Age International Publishers, 2018.
2	Kittel, Charles. Introduction to Solid State Physics. 8th ed., Wiley, 2005.
<b>Reference Books:</b>	
1	Raghavan, V. Materials Science and Engineering: A First Course. 6th ed., PHI Learning, 2015.
2	Singhal, R. L. Solid State Physics. 2nd ed., Kedarnath Ram Nath & Co., 2003.
3	Srivastava, J. P. Elements of Solid State Physics. 2nd ed., Prentice-Hall of India, 2004.
<b>Web Resources:</b>	
1	<a href="https://nptel.ac.in/courses/112104229">https://nptel.ac.in/courses/112104229</a>
2	<a href="https://nptel.ac.in/courses/113/105/113105025/">https://nptel.ac.in/courses/113/105/113105025/</a>
3	<a href="https://archive.nptel.ac.in/courses/113/105/113105081">https://archive.nptel.ac.in/courses/113/105/113105081</a>

### Mapping with Programme Outcomes and Programme Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	2	1	1	3	2	1
CO2	3	2	2	2	1	1	1	1	3	2	2
CO3	3	3	2	2	2	1	1	2	3	3	1
CO4	3	2	3	3	2	1	2	1	3	3	2
CO5	3	3	2	3	3	2	2	2	3	3	3
Total	15	13	11	12	10	7	7	7	15	13	9
Average	3	2.6	2.2	2.4	2	1.4	1.4	1.4	3	2.6	1.8

3 – Strong, 2- Medium, 1- Low

Department of Physics		L	T	P	Credits	Hours	Marks		
Regulation 2026-27							CIA	ESE	Total
Course Code	Title of the Course								
26PPHE23	Advanced Optics	5	0	0	3	5	25	75	100
Category	Core Elective	Theory 100%							
<b>Learning Objectives</b>									
LO1	To know the concepts behind polarization								
LO2	To study the working of different types of LASERS								
LO3	To impart an extensive understanding of fiber and non-linear optics.								
LO4	Identify the properties of nonlinear interactions of light and matter								
LO5	Learn the principles of magneto-optic and electro-optic effects and its applications.								
Unit	Content								Hours
1	<b>Polarization and Double Refraction:</b> Classification of polarization –Polarizer and analyzer – Malus law – Production of polarized light – Polaroid – Polarization by reflection – Polarization by double refraction – Polarization by scattering – The phenomenon of double refraction –Quarter and half wave plates – Analysis of polarized light – Optical activity.								15
2	<b>Lasers:</b> Basic principles –Spontaneous and stimulated emissions –Types of lasers and its applications –Solid state lasers– Ruby laser –Nd:YAG laser –gas lasers – He-Ne laser – CO2 laser – Chemical lasers – HCl laser – Semiconductor laser .								15
3	<b>Fiber Optics:</b> Introduction – Total internal reflection – The optical fiber – Glass fibers – The coherent bundle – The numerical aperture – Attenuation in optical fibers – Single and multi-mode fibers – Pulse dispersion in multimode optical fibers – Ray dispersion in multimode step index fibers – Parabolic-index fibers.								15
4	<b>Non-Linear Optics:</b> Basic principles – Harmonic generation – Second harmonic generation – Phase matching – Optical mixing – Parametric generation of light – Self-focusing of light.								15
5	<b>Magneto optics and Electro-Optics:</b> Magneto-optical effects Zeeman effect– Inverse Zeeman effect–Faraday effect –Voigt effect–Cotton-mouton effect –Kerr magneto-optic effect – Electro-optical effects–Stark effect–Inverse stark effect– Electric double refraction –Kerr electro-optic effect.								15

CO	Course Outcomes Students will able to	Knowledge Level
1	Discuss the transverse character of light waves and different polarization phenomenon.	K1, K2, K3
2	Discriminate the fundamental processes involved in laser devices and to analyze the design and operation of the devices.	K1, K2, K3
3	Demonstrate the basic configuration of a fiber optic – communication system and advantages.	K1, K2, K3
4	To differentiate first and second harmonic generation.	K1, K2, K3
5	Interpret the group of experiments which depend for their action on an applied magnetics and electric field.	K1, K2, K3, K4

Textbooks:	
1	Murugesan, R., and K. Sivaprasath. Optics and Spectroscopy. 6th ed., S. Chand Publishing, 2019.
2	Laud, B. B. Lasers and Nonlinear Optics. 3rd ed., New Age International (P) Ltd., 2017.
3	Silfvast, William T. Laser Fundamentals. 2nd ed., Cambridge University Press, 2004.
Reference Books:	
1	Jenkins, Francis A., and Harvey E. White. Fundamentals of Optics. 4th ed., McGraw-Hill, 1981.
2	Meschede, Dieter. Optics, Light and Lasers: The Practical Approach to Modern Aspects of Photonics and Laser Physics. 2nd ed., Wiley-VCH, 2017.
Web Resources:	
1	<a href="https://www.youtube.com/watch?v=WgzynezPiyc">https://www.youtube.com/watch?v=WgzynezPiyc</a>
2	<a href="https://www.youtube.com/watch?v=ShQWwobpW60">https://www.youtube.com/watch?v=ShQWwobpW60</a>

### Mapping with Programme Outcomes and Programme Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	3	2	3	2	2	1	3	2	2
CO2	3	3	2	2	3	2	1	1	3	2	3
CO3	3	3	3	2	2	1	1	1	3	3	3
CO4	3	3	3	3	2	1	2	1	3	3	3
CO5	3	3	3	3	3	1	1	1	3	3	3
Total	15	15	14	12	13	7	7	5	15	13	14
Average	3	3	2.8	2.4	2.6	1.4	1.4	1	3	2.6	2.8

3 – Strong, 2- Medium, 1- Low

Department of Physics		L	T	P	Credits	Hours	Marks		
Regulation 2026-27							CIA	ESE	Total
Course Code	Title of the Course								
26PPHE24	Plasma Physics	5	0	0	3	5	25	75	100
Category	Core Elective	Theory 100%							
<b>Learning Objectives</b>									
LO1	To analyze the effect of magnetic field on mobility of ions and electrons including reduction in cross-field motion								
LO2	To explain the motion of an electron in a time varying electric and magnetic field								
LO3	To understand the basic concepts of plasma and simple harmonic oscillation in charged particle systems								
LO4	To understand the importance of plasma diagnostics in determining key plasma parameters.								
LO5	To explain the basic theory of MHD including plasma as a conducting fluid interacting with magnetic fields								
Unit	Content								Hours
1	<b>Fundamental Concepts of Plasma:</b> Kinetic pressure in a partially ionized - mean free path and collision cross section - Mobility of charged particles - Effect of magnetic field on the mobility of ions and electrons-Thermal conductivity- Effect of magnetic field- Quasi- neutrality of plasma Debye shielding distance - Basics of plasma and its Optical properties.								15
2	<b>Motion of Charged Particles in Electric and Magnetic Field:</b> Particle description of plasma- Motion of charged particle in electrostatic field- Motion of charged particle in uniform magnetic field - Motion of charged particle in magnetic mirror confinement - motion of an electron in a time varying electric field.								15
3	<b>Plasma Oscillations and Waves:</b> Introduction, theory of simple oscillations - electron oscillation in a plasma – Derivations of plasma oscillations by using Maxwell's equation - Ion oscillation and waves in a magnetic field - thermal effects on plasma oscillations - Landau damping.								15
4	<b>Plasma Diagnostics Techniques:</b> Single probe method - Double probe method - Use of probe technique for measurement of plasma parameters in magnetic field - microwave method - spectroscopic method - laser as a tool for plasma diagnostics-X-ray diagnostics of plasma - acoustic method.								15
5	<b>Applications of Plasma Physics:</b> Principle and working fuel in Magneto hydrodynamic Generator (MHD) - Basic theory - Generation of Microwaves Utilizing High Density Plasma - Plasma Diode.								15

CO	Course Outcomes Students will able to	Knowledge Level
1	Understand the collision, cross section of charged particles and to able to correlate the magnetic effect of ion and electrons in plasma state	K1, K2
2	Investigate particle motion in homogeneous and inhomogeneous electric and magnetic field	K1, K2
3	Explore the oscillations and waves of charged particles and thereby apply the Maxwell's equation to quantitative analysis of plasma.	K1, K3
4	Analyze spectroscopic method for plasma diagnostics.	K2, K5
5	Understand the basic theory of MHD generators.	K1, K2

Textbooks:	
1	Sen, S. N. Plasma Physics: Plasma State of Matter. Pragati Prakashan, 2013.
2	Goldston, Robert J., and Paul H. Rutherford. Introduction to Plasma Physics. CRC Press, 1995.
Reference Books:	
1	Chen, Francis F. Introduction to Plasma Physics and Controlled Fusion. 3rd ed., Springer, 2016.
2	Nicholson, Dwight R. Introduction to Plasma Theory. Wiley, 1983.
3	Shohet, Joseph L. The Plasma State. Academic Press, 1971.
Web Resources:	
1	<a href="https://www.astrosen.unam.mx/~aceves/verano/libros/introPlasma.pdf">https://www.astrosen.unam.mx/~aceves/verano/libros/introPlasma.pdf</a>
2	<a href="https://www.youtube.com/watch?v=E8Fqdg4eI00">https://www.youtube.com/watch?v=E8Fqdg4eI00</a>

#### Mapping with Programme Outcomes and Programme Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	2	1	1	2	1	2	3	3	2
CO2	3	3	2	1	1	2	1	2	3	3	2
CO3	3	3	2	2	1	2	1	3	3	3	2
CO4	3	3	3	2	1	2	1	3	3	3	3
CO5	3	3	3	2	1	2	1	3	3	3	3
Total	15	15	12	8	5	10	5	10	15	15	12
Average	3	3	2.4	1.6	1	2	1	2	3	3	2.4

3 – Strong, 2- Medium, 1- Low

Department of Physics		L	T	P	Credits	Hours	Marks		
Regulation 2026-27							CIA	ESE	Total
Course Code	Title of the Course								
26PPHS21	Renewable Energy and Energy Harvesting	3	0	0	2	3	25	75	100
Category	Skill Enhancement Course	Theory 100%							
<b>Learning Objectives</b>									
LO1	To Learn about alternate sources of energy.								
LO2	To know the ways of effectively utilizing the solar energy.								
LO3	To study the method of harvesting wind energy and ocean energy.								
LO4	To learn the techniques useful for the conversion of hydro energy and piezo energy harvesting.								
LO5	To know about utilization of electromagnetic energy harvesting.								
Unit	Content								Hours
1	<b>Fossil fuels and Alternate Sources of energy</b> -Fossil fuels and nuclear energy, their limitation, need of renewable energy. An overview of developments in off shore Wind Energy, Tidal Energy, Wave energy systems, Thermal Energy Conversion, biomass, biochemical conversion, biogas generation, geo thermal energy.								9
2	<b>Solar energy</b> -Solar energy, its importance, storage of solar energy, solar pond, non-convective solar pond, applications of solar pond and solar energy, solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, solar cell, Need and characteristics of photovoltaic (PV) systems.								9
3	<b>Wind Energy Harvesting:</b> Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces, and grid inter connection topologies. <b>Ocean Energy:</b> Ocean Energy Potential against Wind and Solar, Wave Characteristics, Tide characteristics, Ocean Thermal Energy, Osmotic Power, Ocean Bio-mass								9
4	<b>Hydro Energy:</b> Hydropower resources, hydropower technologies, environmental impact of hydro power sources, <b>Piezoelectric Energy harvesting:</b> Introduction characteristic, parameter of piezoelectric materials, piezoelectric generators, Piezoelectric energy harvesting applications								9
5	<b>Electromagnetic Energy Harvesting:</b> Linear generators, MME generators, Usages -Carbon captured technologies, cell, batteries, power consumption								9

CO	Course Outcomes Students will able to	Knowledge Level
1	Understand fossil fuels, nuclear energy, and the need for renewable energy sources.	K1, K2
2	Explain solar energy systems, storage methods, and applications.	K1, K2
3	Analyze wind and ocean energy systems and their power generation mechanisms.	K1, K2, K3
4	Evaluate hydro energy and piezoelectric energy harvesting techniques.	K1, K2, K3, K4
5	Interpret electromagnetic energy harvesting methods and modern energy technologies.	K1, K2, K3, K4

<b>Textbooks:</b>	
1	Agarwal, M. P. Solar Energy. 2nd ed., S. Chand & Company Ltd., 2019.
2	Jayakumar, P. Solar Energy: Resource Assessment Handbook. TERI Press, 2009.
<b>Reference Books:</b>	
1	Rai, G. D. Non-Conventional Energy Sources. 6th ed., Khanna Publishers, 2017.
2	Balfour, J., et al. Photovoltaics: Fundamentals, Technology and Practice. 2nd ed., Pearson, 2016.
3	Boyle, Godfrey. Renewable Energy: Power for a Sustainable Future. 4th ed., Oxford University Press, 2019.
<b>Web Resources:</b>	
1	<a href="https://www.amrita.edu/course/b-sc-in-physics-mathematics-computer-science-renewable-energy-and-energy-harvesting/">https://www.amrita.edu/course/b-sc-in-physics-mathematics-computer-science-renewable-energy-and-energy-harvesting/</a>
2	<a href="https://www.kharagpurcollege.ac.in/studyMaterial/5435Renewable%20Energy%20and%20Energy%20Harvesting.%20SEC2%20by%20Jyotirmoy%20Pramanik.pdf">https://www.kharagpurcollege.ac.in/studyMaterial/5435Renewable%20Energy%20and%20Energy%20Harvesting.%20SEC2%20by%20Jyotirmoy%20Pramanik.pdf</a>

### Mapping with Programme Outcomes and Programme Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	2	3	2	2	1	1
CO2	3	3	2	2	2	2	3	2	3	2	1
CO3	3	3	3	2	2	2	3	2	3	3	1
CO4	3	2	2	3	2	2	3	2	3	3	2
CO5	3	3	2	3	3	2	3	2	3	3	3
<b>Total</b>	<b>15</b>	<b>13</b>	<b>10</b>	<b>11</b>	<b>10</b>	<b>10</b>	<b>15</b>	<b>10</b>	<b>14</b>	<b>12</b>	<b>8</b>
<b>Average</b>	<b>3</b>	<b>2.6</b>	<b>2</b>	<b>2.2</b>	<b>2</b>	<b>2</b>	<b>3</b>	<b>2</b>	<b>2.8</b>	<b>2.4</b>	<b>1.6</b>

3 – Strong, 2- Medium, 1- Low