KONGUNADU ARTS AND SCIENCE COLLEGE
(AUTONOMOUS)
COIMBATORE - 641029

DEPARTMENT OF PHYSICS (PG)

CURRICULM AND SCHEME OF EXAMNINATIONS
(CBCS)

(2025-2026)

KONGUNADU ARTS AND SCIENCE COLLEGE (AUTONOMOUS)
COIMBATORE -641029

DEPARTMENT OF PHYSICS

Vision:
The goal of the Department of Physics is to bring eminence and excellence in teaching learning process andto fetch ours as one of the Benchmark Department with "Potential for Academic excellence"

Mission:
To execute the teaching profession to bring the students as an asset for a productive and fascinating career, successful in their life and to realize learning with real world experience.

PROGRAMME OUTCOMES (PO)

Upon successful completion of the programme, the student will be able to

PO1: Develop knowledge of scientific phenomena, facts, laws, concepts, theories, scientific quantities and their determination, scientific and technological applications as well as their social, economicand environmental implications.

PO2: Think critically; interpret precise concepts to arrive at scientific conclusions.

PO3: Acquire relevant information from a variety of sources and be able to communicate scientificinformation in a clear, concise and logical manner both verbally and in writing.

PO4: Students are expected to acquire a basic knowledge in various branches of Physics.

PO5: Students are expected to develop written and oral communication skills in communicating Physicsrelated topics.

PO6: Students will realize and develop an understanding of the impact of Physics and Science on thesociety.

PO7: Apply conceptual understanding of Physics in other disciplines such as Engineering, Mathematics,Computer science and Chemistry.

PO8: Demonstrate the ability to do advanced lab experiments that apply the principles learned in the classrooms.

PROGRAMME SPECIFIC OUTCOMES (PSO)

1. Students are expected to acquire a basic knowledge in various branches of Physics.
2. Students are expected to develop written and oral communication skills in communicating Physicsrelated topics.
3. Students will realize and develop an understanding of the impact of Physics and Science on thesociety.
4. Apply conceptual understanding of Physics in other disciplines such as Engineering, Mathematics,Computer science and Chemistry.
5. Demonstrate the ability to do advanced lab experiments that apply the principles learned in the classrooms.

KONGUNADU ARTS AND SCIENCE COLLEGE (AUTONOMOUS)
COIMBATORE-641 029

Programme Name: M.Sc. PHYSICS
Curriculum and Scheme of Examination under CBCS

(Applicable to students admitted during the Academic year 2025–2026 and onwards)

Semester	Subject code	Title of the Paper	Instruction hours/cycle	Exam. Marks			Duration of Exam. Hrs.	Credits
				CIA	ESE	Total		
I	25PPH101	Core Paper 1 - Classical Mechanics	5	25	75	100	3	4
	25PPH102	Core Paper 2 - Mathematical Physics	5	25	75	100	3	4
	25PPH103	Core Paper 3 - Condensed Matter Physics I	5	25	75	100	3	4
	25PPH1E1	**Major Elective 1**	5	25	75	100	3	5
	-	Core Practical 1 - General Experiments	5	-	-	-	-	-
	-	Core Practical 2 - Electronics Experiments	5	-	-	-	-	-
Total			**30**	**-**	**-**	**400**	**-**	**17**
II	25PPH204	Core Paper 4 - Quantum Mechanics I	5	25	75	100	3	4
	25PPH205	Core Paper 5 - Thermodynamics and Statistical Mechanics	5	25	75	100	3	4
	25PPH206	Core Paper 6 - Electronics and Microprocessors	5	25	75	100	3	4
	25PPH2E2	**Major Elective 2**	5	25	75	100	3	5
	25PPH2CL	Core Practical 1 - General Experiments	5	40	60	100	4	5
	25PPH2CM	Core Practical 2 - Electronics Experiments	5	40	60	100	4	4
Total			**30**	**-**	**-**	**600**	**-**	**26**

III	25PPH307	Core Paper 7 - Quantum Mechanics II	5	25	75	100	3	4
	25PPH308	Core Paper 8 - Electromagnetic Theory andElectrodynamics	5	25	75	100	3	4
	25PPH309	Core Paper 9 - Condensed Matter Physics II	4	25	75	100	3	4
	25PPH3N1	**Non Major Elective 1**	4	25	75	100	3	4
		EDC Paper	2	100	-	100	3	2
	-	Core Practical 3 - Advanced Experiments	5	-	-	-	-	-
	-	Core Practical 4 - Special Electronics Experiments	5	-	-	-	-	-
	25PPH3IT	**Internship Training ******	Grade					
Total			**30**	**-**	**-**	**500**	**-**	**18**
IV	25PPH410	Core Paper 10 - Problems in Physics II	5	25	75	100	3	4
	25PPH411	Core Paper 11 - Atomic & Molecular Spectroscopy	5	25	75	100	3	4
	25PPH412	Core Paper 12 - Nuclear and Particle Physics	5	25	75	100	3	4
	25PGI4N2	**Non Major Elective 2** [#]	4	100	-	100	3	4
	25PPH4CN	Core Practical 3 - Advanced Experiments	5	40	60	100	6	5
	25PPH4CO	Core Practical 4 - Special Electronics Experiments	5	40	60	100	6	4
	25PPH4Z1	**Project and Viva Voce**	1	20	80	100	-	4
Total			**30**	**-**	**-**	**700**	**-**	**29**
Grand Total			**-**	**-**	**-**	**2200**	**-**	**90**

Note:

- CBCS - Choice Based Credit System
- CIA - Continuous Internal Assessment
- ESE - End-of-Semester Examinations

**** The students shall undergo Internship training / field work for a minimum period of 14 working days at the end of the second semester during summer vacation and submit the report in the third semester which will be evaluated for 100 marks by the concerned guide and followed by an Internal Viva voce by the respective faculty or HOD as decided by the department. According to their marks, the grades will be awarded as given below.

Marks %	Grade
85 – 100	O
70 – 84	D
60 – 69	A
50 – 59	B
< 40	U (Reappear)

Major Elective papers

(4 papers are to be chosen from the following 8 papers)

1. Thin Film Physics, Plasma Physics and Crystal Growth
2. Communication Physics
3. Problems in Physics I
4. Semiconductor Devices
5. Energy Physics
6. Photovoltaic Science
7. Artificial Intelligence in Physics
8. Computational methods and programming

Non - Major Elective Papers

(2 papers are to be chosen from the following 4 papers)

1. Nanotechnology: Principles and Applications
2. Intellectual Property Rights
3. Research Ethics
4. Information Security #

To be offered by the department

Sub. Code & Title of the Extra Departmental Course (EDC):

25PPH3X1 - EDC Paper - Biomedical Instrumentation

Advanced Learners Course (ALC):

Advanced Experimental Techniques

Note : In core subjects, No. of papers both theory and practical are included wherever applicable. However the total credits and marks for core subjects remain the same as stated below.

Tally Table:

Subject	No. of Subjects	Total Marks	Credits
Core – Theory / Practical / Project	17	1700	70
Major Elective Papers	2	200	10
EDC Paper	1	100	2
Non Major Elective Paper	2	200	8
Grand Total	22	2200	90

- 25 % CIA is applicable to all subjects except JOC, ALC and COP which are considered as extra credit courses.

- 100 % CIA for Information Security and EDC.

- The students should complete any **MOOC course available for Online learning platforms like SWAYAM, NPTEL, IIT Bombay Spoken Tutorial, e-Pathshala etc.,** with a minimum of 4 weeks in duration before the completion of the 3rd semester and the course completion certificate should be submitted through the HOD to the Controller of Examinations. Extra credits will be given to the candidates who have successfully completed.

- **Onsite Training** preferably relevant to the course may be undertaken as per the discretion of the faculty or HOD.

BLOOM'S TAXONOMY BASED ASSESSMENT PATTERN

K1-Remembering; **K2**-Understanding; **K3**-Applying; **K4**-Analyzing; **K5**-Evaluating

Components of Continuous Internal Assessment

Components		Marks	Total
Theory			
CIA I	75	(75+75 = 150/10) 15	25
CIA II	75		
Assignment/Seminar		5	
Attendance		5	
Practical			
CIA Practical		25	40
Observation Notebook		10	
Attendance		5	
Project			
Review		15	20
Regularity		5	

1. Theory Examination

CIA I & II and ESE: 75 Marks

Knowledge Level	Section	Marks	Description	Total
K1 Q1 to 10	A (Answer all)	10 x 1 = 10	MCQ	75
K1– K5 Q11 to 15	B (Either or pattern)	5 x 5 = 25	Short Answers	
K2 – K5 Q16 to 20	C (Either or pattern)	5 x 8 = 40	Descriptive / Detailed	

2. Practical Examination

Knowledge Level	Section	Marks	Total
K3 to K5	Experiments	50	60
	Record Work	10	

ESE Practical Examination

Knowledge Level	Section	Marks	Total
K3 to K5	Procedure	20	50
	Experiment	20	
	Results	5	
	Accuracy and Presentation	5	
	Record	10	10

3. Project Viva Voce:

Knowledge Level	Section	Marks	Total
K3 to K5	Project Report	60	80
	Viva voce	20	

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Sub. Code: 25PPH101

Programme code : 03		**M.Sc. Physics**			
Title of the Paper		**Core Paper 1 – Classical Mechanics**			
Batch	**Semester**	**Hours/Week**	**Total Hours**	**Credits**	**Skill Development**
2025-2026	**1**	**5**	**75**	**4**	

Course Objectives

To enable the learners to know about the

1. Mechanics of single and system of particle
2. Generalized coordinates, Lagrangian formulation and mechanics of rigid body motion
3. Hamiltonian formulation of mechanics, Hamilton-Jacobi theory, harmonic oscillator problem, theory andapplications of small oscillations.

Course outcomes (CO)

On successful completion of the course, the students will be able to

K1 to K5	CO1	Know about Newtonian mechanics
	CO2	Gain knowledge about Lagrangian formulation
	CO3	Acquire knowledge about mechanics of rigid body motion.
	CO4	Know about Hamiltonian formulation
	CO5	Understand Hamilton-Jacobi theory and small oscillations

Syllabus

Unit – I **(15 hrs)**

Mechanics of single and system of particles

Newton's laws of motion – Mechanics of a particle - Equation of motion of a particle – Motionof a particle under constant force and alternating force – Mechanics of systems of particles – Angular momentum of the system – kinetic energy of the system – Motion of two particles equivalent to single particle – Equation of motion of center of mass with respect to center of force – Motion in an inverse square law force field – Classification of orbits.

Unit – II **(15 hrs)**

Lagrangian formulation

Generalized coordinates and constraints – principle of virtual work and D'Alembert's principle – Lagrange's equation for a conservative system – velocity dependent potentials and dissipation function - Hamilton's principle – Lagrange's equations of motion from Hamilton's principle – extension of the principle to non-conservative and non-holonomic systems – conservation theorems and symmetry properties - Applications of Lagrangian and variational principle: simple pendulum, compound pendulum, double pendulum, simple harmonic oscillators.

Unit - III **(15 hrs)**

Mechanics of rigid body motion

Generalized coordinates for rigid body motion – Euler's integrals – infinitesimal rotations – Coriolis force – application of a free fall of a body on earth's surface and Foucault's pendulum – moments and products of inertia – Euler's equation of motion – force free motion of a symmetrical rigid body – heavy symmetrical top under gravity **– fast top and sleeping top conditions*.**

Sub. Code: 25PPH101

Unit - IV **(15 hrs)**

Hamiltonian formulation

Hamilton's equation of motion – cyclic coordinates and Routh's procedure – conservation theorem – Hamilton's equation of motion from variational principle – principle of least action – canonical transformation – equations of canonical transformation and generating functions – examples of canonical transformations – integral invariance of Poincare-Lagrange and Poisson's brackets – equations of motion in Poisson bracket notation – Jacobi's identity- infinitesimal contact transformations – angular momentum – Poisson bracket relations – Liouville's theorem.

UNIT – V **(15 hrs)**

Hamilton-Jacobi theory and small oscillations

Hamilton-Jacobi equations for Hamilton's principle and characteristic functions – harmonic oscillator problem – separation of variable method – action angle variables – applications – linear harmonic oscillator and Kepler problem – theory of small oscillations – Eigenvalue equations – normal modes and normal coordinates – application to triatomic molecule.

* **Self study**

Teaching Methods: Smart Class Room / Power point presentation / Seminar / Quiz /Discussion / Flipped Class / Peer Learning / Experiential Learning / Blended Learning

Text Books:

1. Gupta S.L.Kumar, Sharma, (2012), Classical Mechanics – Pragathi Publications, Meerut.
2. Sathya Prakash, Gupta B.D, (2012), Classical Mechanics - Kedarnath Ramnath & Co.,Meerut.

Reference Books:

1. Aruldhas.G, (2008), Classical Mechanics - Prentice Hall of India Pvt. Ltd., New Delhi.
2. Goldstein, Pearson, (2014), Classical Mechanics - New Age International Ltd., New Delhi.
3. Sankara Rao, (2009), Classical Mechanics - PHI learning Pvt. Ltd., New Delhi.

e-Resources:

1. https://nptel.ac.in/courses/115106123
2. https://nptel.ac.in/courses/115105098
3. https://nptel.ac.in/courses/122106027
4. https://youtu.be/rk0rp2Jpidc?list=PLyqSpQzTE6M_d9f-9fKxUQYR1qI5YEnSz
5. https://www.youtube.com/watch?v=W0Kd_gouAyQ

Mapping

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	S	H	S	S	H
CO 2	S	H	S	S	H
CO 3	H	S	S	H	S
CO 4	S	H	H	S	S
CO5	S	H	S	S	H

S- Strong **H-High** **M-Medium** **L – Low**

Sub. Code: 25PPH102

Programme code : 03		M.Sc. Physics			
Title of the Paper		Core Paper 2 - Mathematical Physics			
Batch	Semester	Hours/Week	Total Hours	Credits	Skill Development
2025-2026	1	5	75	4	

Course Objectives

To enable the learners to

1. Understand complex variables, special functions
2. Know about types of differential equations in Physics
3. Study about group theory & tensors

Course Outcomes (CO)

On successful completion of the course, the students will be able to

K1 to K5	CO1	Understanding of complex analysis including important theorems and determination of residues to evaluate definite integrals
	CO2	Solve partial differential equations and be familiar with special functions such as Bessel, Legendre and Hermite
	CO3	Have knowledge in abstract group theory
	CO4	Have introductory knowledge in tensors
	CO5	Understand partial differential equations in Physics

Syllabus

UNIT I **(15 hrs)**

Complex variables

Elements of complex analysis –**Taylor and Laurent series** *- Cauchy- Riemann differential equation - Complex line integrals-Cauchy's integral theorem – Cauchy's integral formula-derivatives of an analytic function–Singularities of an analytic function - Residues and their evaluation - Cauchy's residue theorem – Evaluation of definite integrals by contour integration - integration round the unit circle of the type $f(\cos\theta, \sin\theta)d\theta$ - evaluation of $f(x)dx$.

UNIT II **(15 hrs)**

Special functions

Bessel differential equation: Series Solution – Bessel's function of first kind - Half order Bessel function - Recurrence formula for Jn(x) – Generating function for Jn(x). Legendre's differential equation: Series solution - Legendre polynomials - Generating function- Recurrence relations – Rodrigue's formula - Orthogonality of Legendre's polynomials. Hermite's differential equation: Series solution – Hermite's polynomials – Generating function Recurrence formula – **Rodrigue's formula for Hermite's polynomials - Orthogonality of Hermite's polynomials ***

UNIT III **(15 hrs)**

Group Theory

Definition of groups – groups of transformation – multiplication table (C_{4v}) - conjugate elements and classes – sub groups - cyclic groups - cosets - Lagrange's theorem- normal subgroups - factor subgroups - reducible and irreducible representation of a group - Schur's lemma orthogonality theorem – construction of character table for C_{2v}.

Sub. Code: 25PPH102

UNIT IV **(15 hrs)**

Tensors

Introduction – n dimensional space – superscripts and subscripts – coordinate transformation – indicial and summation conventions – dummy and real indices – Kronecker delta symbol – scalars, contravariant and covariant vectors – tensors of higher ranks – algebraic operations of tensors-symmetry and anti-symmetry tensors

UNIT V **(15 hrs)**

Partial differential equations in Physics

Introduction – solution of Laplace's equation in Cartesian coordinates – solution of Laplace's equation in two dimensional cylindrical coordinates(r, θ): circular harmonics - solution of Laplace equation in general cylindrical coordinates: cylindrical harmonics - solution of Laplace's equation in spherical polar coordinates; spherical harmonics - diffusion equation or Fourier equation of heat flow - solution of heat flow equation - (method of separation of variables) - two dimensional heat flow - three dimensional heat flow.

* **Self study**

Teaching Methods: Smart Class Room / Power point presentation / Seminar / Quiz /Discussion / Flipped Class / Peer Learning / Experiential Learning / Blended Learning

Text Books:

1. Sathya Prakash, (2001), Mathematical Physics with Classical Mechanics - S.Chand & Co.New Delhi.
2. H.K.Dass, (2010), Mathematical Physics – S.Chand & Co, New Delhi.

Reference Books:

1. B.D Gupta, (2010), Mathematical Physics - Vikas Publishing House, New Delhi.
2. A.W. Joshi, (2009), Elements of group theory for Physicists - New Age International Pub.,New Delhi.
3. A.Singaravelu, (2000), Engineering Mathematics - Meenakshi Pub. Co., Hyderabad.

e-Resources:

1. https://nptel.ac.in/courses/115105097 - Mathematical Methods in Physics-I
2. https://nptel.ac.in/courses/111106152 - Mathematical Methods in Physics-II

Mapping

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	S	H	H	S	H
CO 2	H	S	S	H	S
CO 3	S	H	S	S	H
CO 4	S	H	S	H	H
CO5	H	S	S	H	S

S- Strong **H-High** **M-Medium** **L – Low**

Sub. Code: 25PPH103

Programme code : 03		M.Sc. Physics			
Title of the Paper		Core Paper 3 – Condensed Matter Physics I			
Batch 2025-2026	Semester 1	Hours/Week 5	Total Hours 75	Credits 4	Skill Development

Course Objectives

To enable the learners to

1. Understand the crystal system of materials
2. Know about crystal imperfection and lattice vibrations
3. Study about lattice and electronic specific heat

Course Outcomes (CO)

On successful completion of the course, the students will be able to

K1 to K5	CO1	Understand the crystal structure and reciprocal lattice
	CO2	Understand the crystal structure by XRD
	CO3	Gain knowledge about crystal imperfection
	CO4	Acquire knowledge on lattice vibrations and thermal properties
	CO5	Acquire knowledge about lattice and electronic specific heat

Syllabus

Unit I **(15 hrs)**

Crystal structure and reciprocal lattice

Space lattices - Bravais lattices, crystal structures – finding Miller indices of a plane - Interplanar distance – separation between lattice planes in SC, FCC and BCC lattices - Hexagonal closed packed structure (qualitative) - crystal density - packing fraction - reciprocal lattice - Graphical construction and vector development – Properties of reciprocal lattice – **Bragg's condition in terms of reciprocal lattice**[*].

Unit II **(15 hrs)**

Structure determination by x-ray diffraction

Structure factor - Bragg's law of x-ray diffraction - determination of lattice parameters and interplanar spacing from Bragg's equation - Powder method of x-ray diffraction - crystal structure determination - condition of reflections for SC, BCC, FCC and DC structures - Evaluation of lattice planes - lattice constant and inter - atomic distance from XRD data.

Bonding in solids

Ionic bonds – Metallic bonds – Vander waals' bonds – Hydrogen bonds – Binding energy of ionic crystals – Evaluation of the Madelung constant – Binding energy of crystals of inert gases.

Unit III **(15 hrs)**

Crystal imperfections

Classification of imperfections: Point imperfections: Frenkel defects and Schottky defect – Line imperfections: edge dislocation - screw dislocation - Burger's vector - energy of dislocation - Surface imperfections: grain boundaries - tilt boundary - twin boundary - Plastic deformation by slip: shear strength of perfect and real crystals - stress to move a dislocation -effect of temperature on stress to move a dislocation.

Sub. Code: 25PPH103

Unit IV **(15 hrs)**

Lattice vibrations and thermal properties

Concept of lattice mode of vibration - elastic vibrations of continuous media - phase velocity - group velocity - vibrations of one dimensional monatomic linear lattice - vibrations of one dimensional diatomic linear lattice - concept of phonons - momentum of phonons - inelastic scattering of photons by phonons - inelastic scattering of x-rays by phonons - inelastic scattering of neutrons by phonons.

Unit V **(15 hrs)**

Lattice specific heat: Concepts of specific heat - Dulong and Petit's law - Einstein theory oflattice specific heat - Debye theory of lattice specific heat

Free electron theory and electronic specific heat: Classical free electron theory of metals - drawbacks of classical theory - quantum theory of free electrons - free particle - tunnel effect - particle in one and three dimensional box - density of states - Fermi Dirac distribution function - heat capacity of electron gas - Sommerfeld's quantum theory for electronic heat capacity - electrical and thermal conductivity -failures of Sommerfeld's theory - thermoelectric power *.

* **Self study**

Teaching Methods: Smart Class Room / Power point presentation / Seminar / Quiz /Discussion / Flipped Class / Peer Learning / Experiential Learning / Blended Learning

Text Books:

1. S.O.Pillai, (2018), Solid State Physics - New Age Publishers, New Delhi.
2. V.Raghavan, (2015), Material science and Engineering - Prentice Hall Limited, New Delhi.

Reference Books:

1. Puri R.K, Babbar.V.K, (2017), Solid State Physics - S.Chand & Co., New Delhi.
2. Charles Kittel, (2019), Introduction to Solid State Physics – Wiley, India Edition.

e-Resources:

1. https://www.uou.ac.in/lecturenotes/science/MSCPHY17/Solid%20state%20physics%20unit%202%20(3)(1).pdf
2. https://khwarizmi.org/wp-content/uploads/2010/10/csd1.pdf
3. https://www.slideshare.net/Mandardj/types-of-bonding-in-solids
4. http://www.nitjsr.ac.in/course_assignment/MME09MM%201101Crystal%20Imperfections--%20point,%20line%20and%20planar%20defect.pdf

Mapping

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	S	S	S	M	L
CO 2	S	S	S	M	M
CO 3	S	L	S	M	L
CO 4	S	S	S	M	L
CO 5	S	M	S	M	L

S- Strong **H-High** **M-Medium** **L – Low**

Sub. Code: 25PPH204

Programme code : 03		**M.Sc. Physics**			
Title of the Paper		**Core Paper 4 – Quantum Mechanics I**			
Batch **2025-2026**	**Semester** **2**	**Hours/Week** **5**	**Total Hours** **75**	**Credits** **4**	**Skill Development**

Course Objectives

To enable the learners to

1. Gain knowledge on General formalism of quantum mechanics
2. Gain knowledge on energy Eigenvalue problems, angular momentum and approximation methods
3. Understand time dependent, time independent and perturbation theories.

Course Outcomes (CO)

On successful completion of the course, the students will be able to

K1 - K5	CO1	Gain knowledge on General formalism of quantum mechanics
	CO2	Attain knowledge on one and three dimensional energy Eigenvalue problems
	CO3	Acquire knowledge on three-dimensional energy Eigenvalue problems and angular momentum concepts
	CO4	Acquire knowledge on time independent quantum approximation methods
	CO5	Understand time dependent perturbation theory and semi-classical treatment of radiation

Syllabus

UNIT I **(15 hrs)**

General formalism of quantum mechanics

Linear vector space – linear operator – Eigenvalues and Eigenfunctions – Hermitian operator – postulates of Quantum mechanics – simultaneous measurability of observables – General uncertainty relation - Dirac's notation – equations of motion – Momentum representation.

UNIT II **(15 hrs)**

One dimensional energy Eigenvalue problems

Properties of one-dimensional motion: Discrete spectrum - Continuous spectrum - Mixed Spectrum - Symmetric potentials and Parity - The free particle Continuous states - Potential step - Potential barrier and well - Tunnelling effect - Infinite square well potential- asymmetric square well - symmetric potential well - Finite square well potential - scattering solutions - bound state solutions.

UNIT III

Three-dimensional energy Eigenvalue problems **(15 hrs)**

3D problems in Cartesian coordinates - Separation of variables- the free particle - Box potential-rectangular and cubic potential - Harmonic oscillator - anisotropic oscillator - isotropic harmonic oscillator.

Angular momentum and their properties

Angular momentum operator in position representation – spin angular momentum – total angular momentum operators – commutation relations of total angular momentum with components.

Sub. Code: 25PPH204

UNIT IV **(15 hrs)**

Time independent quantum approximation methods

Stationary perturbation theory (non-degenerate case): evaluation of first order energy and evaluation of first order correction to wave function – normal helium atom – stationaryperturbation theory (degenerate case): first order Stark effect in hydrogen atom – variation method – WKB method – application of WKB method – probability of penetration of a barrier

UNIT V **(15 hrs)**

Time dependent perturbation theory: Time development of states – transition probability – Fermi Golden rule – adiabatic approximation. **Semiclassical treatment of radiation:** Einstein coefficients – atom field interaction – spontaneous emission rate –quantum theory of radiation and its interaction with matter – quantization of radiationfield*

* **Self study**

Teaching Methods: Smart Class Room / Power point presentation / Seminar / Quiz /Discussion / Flipped Class / Peer Learning / Experiential Learning / Blended Learning

Text Books:

1. G.Aruldhas, (2021), Quantum Mechanics - PHI learning Pvt. Ltd., New Delhi.
2. Nouredine Zettili, (2022), Quantum Mechanics Concepts and Applications -Wiley Sons, UK.

Reference Books:

1. P.M.Mathews, K.Venkatesan, (2017), A Text Book of Quantum Mechanics - Tata McGraw Hill education Pvt. Ltd., New Delhi.
2. Leonard. I. Schiff, (2017), Quantum mechanics - McGraw Hill Co., New Delhi.

e-Resources:

1.https://web.mst.edu/~parris/QuantumOne/Class_Notes/GeneralFormulation.pdf
2.https://chem.libretexts.org/Bookshelves/Physical_and_Theoretical_Chemistry_Textbook_Maps/Supplemental_Modules_(Physical_and_Theoretical_Chemistry)/Quantum_Mechanics/05.5%3A_Par ticle_in_Boxes/Particle_in_a_3-Dimensional_box
3. https://www.lehman.edu/faculty/anchordoqui/chapter19.pdf
4. https://theory.physics.manchester.ac.uk/~xian/qm/chapter3.pdf
5. http://www.tcm.phy.cam.ac.uk/~bds10/aqp/handout_dep.pdf

Mapping

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	S	S	H	H	H
CO 2	H	S	S	S	S
CO 3	H	H	H	H	H
CO 4	S	S	H	S	S
CO5	H	S	S	H	S

S- Strong **H-High** **M-Medium** **L - Low**

Sub. Code: 25PPH205

Programme code : 03		M.Sc. Physics			
Title of the Paper		Core Paper 5 - Thermodynamics and Statistical Mechanics			
Batch	**Semester**	**Hours/Week**	**Total Hours**	**Credits**	**Employability**
2025-2026	**2**	**5**	**75**	**4**	

Course Objectives

To enable the learner to know about

1. Thermodynamics and ensembles
2. Classical distribution law and quantum statistics
3. Application of quantum statistics.

Course Outcomes (CO)

On successful completion of the course, the students will be able to

K1 to K5	CO1	Know about thermodynamics and radiations
	CO2	Acquire knowledge on ensembles
	CO3	Get knowledge about classical distribution law
	CO4	Get knowledge about quantum statistics
	CO5	Understand applications of quantum statistics

Syllabus

UNIT I: Equilibrium Thermodynamics (15 hrs)

Second law of thermodynamics: entropy - disorder - thermodynamic potentials and reciprocity relation - thermodynamic equilibrium - chemical potential -Maxwell's Relation-Phase space - volume in phase space - number of phase cells in a given energy range of harmonic oscillator – Microstates and Macrostates-number of phase cell in a given energy range of 3 dimensional free particle.

UNIT II: Ensembles (15 hrs)

Concept of ensemble - microcanonical ensemble - canonical ensemble- grand canonical ensemble Example ideal gas – Boltzman's entropy relation – Perfect gas in microcanonical Ensembles - Gibbs paradox- Partition function and its correlation with thermodynamics quantities - Partition functions and its properties. Comparison of ensembles- density distribution in phase space- principle of equal a priori probability - statistical equilibrium - thermal equilibrium - mechanical equilibrium - particle equilibrium - **connection between statistical and thermodynamic quantities*.**

UNIT III: Classical Distribution Law (15hrs)

Classical Maxwell Boltzmann distribution law- Evaluation of constants (α and β) - Maxwell's law of Distribution of velocities - Principle of equipartition of energy - Connection between the partition function and thermodynamic quantities.

UNIT IV: Quantum Statistics (15 hrs)

Indistinguishability and quantum statistics - Statistical weight and a priori probability- Identical particle's and symmetry requirements - Bose Einstein' Statistics - Fermi Dirac Statistics - Maxwell Boltzmann's statistics - Comparison of M-B, B-E, and F-D statistics- Thermodynamic interpretation of parameters (α and β) - Eigenstates and Maxwell Boltzmann's equation - Thermodynamic properties of diatomic molecules - Specific heat of solids: Dulong and Pettit's law - Einstein's Theory - Debye theory.

Sub. Code: 25PPH205

UNIT V: Application of Quantum Statistics (15 hrs)

Ideal Bose Einstein gas

Energy and pressure of ideal Bose Einstein gas - Gas Degeneracy - Bose Einstein condensation - Thermal properties of Bose Einstein gas - Liquid helium.

Ideal Fermi- Dirac gas

Energy and pressure of ideal Fermi Dirac gas – Weak degeneracy – Strong degeneracy at T=0 K - Fermi energy - Fermi temperature - Thermodynamic functions of degenerate Fermi Dirac gas - Electron gas - Free electron model and electronic emission.

*** Self study**

Teaching Methods: Smart Class Room / Power point presentation / Seminar / Quiz /Discussion / Flipped Class / Peer Learning / Experiential Learning / Blended Learning

Text Books:

1. Gupta Kumar, (2019), Elementary statistical mechanics - Pragati Prakashan Pub., Meerut.
2. Kamal Singh, S.P.Singh, (2019), Elements of Statistical Mechanics - S.Chand & Co., New Delhi.

Reference Books:

1. Keiser Huang, (2008), Fundamentals of Statistical Mechanics – Wiley, India.
2. Fried, (2010), Fundamentals of Statistical Mechanics and Thermal Physics - McGraw HillPub., New Delhi.

e-Resources:

1. https://nptel.ac.in/courses/115/103/115103113/
2. https://www.youtube.com/watch?v=rDHQ60CXDbU
3. https://www.youtube.com/watch?v=XIXQ38JnF0k
4. https://nptel.ac.in/courses/115/103/115103113/
5. https://www.youtube.com/watch?v=Ih01TfuEfqU

Mapping

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	S	S	H	H	S
CO 2	S	H	S	H	S
CO 3	S	S	H	S	S
CO 4	S	H	S	H	S
CO5	S	H	S	H	S

S- Strong H-High M-Medium L – Low

Sub.Code: 25PPH206

Programme code : 03		M.Sc. Physics			
Title of the Paper		Core Paper-6 Electronics and Microprocessor			
Batch 2025-2026	Semester 2	Hours/Week 5	Total Hours 75	Credits 4	Employability

Course Objectives

To enable the learners to

1. Know about power electronics, operational amplifiers and non-linear integrated circuits
2. Understand architecture of microprocessors
3. Know about peripheral devices, interfacing and data acquisition systems.

Course Outcomes (CO)

On successful completion of the course, the students will be able to

K1 to K5	CO1	Understand power electronics
	CO2	Gain knowledge on operational amplifiers and non-linear integrated circuits
	CO3	Understand architecture of microprocessors
	CO4	Know about peripheral devices and interfacing
	CO5	Know about data acquisition systems

Syllabus

UNIT I **(15 hrs)**

Power Electronics

Triac: construction - operation –characteristics – applications - Diac: applications - Unijunction transistor (UJT): equivalent circuit – characteristics – applications – Silicon controlled rectifier (SCR) – Power control - Thyristors - Power MOSFET.

UNIT II **(15 hrs)**

Nonlinear integrated circuits

Operational amplifiers: inverting, non-inverting and differential amplifiers - integrator and differentiator – log and antilog amplifiers - voltage to current converters – current to voltage converters – sample and hold circuits - high input impedance amplifiers – Instrumentation amplifiers: sensing amplifier and comparator – zero crossing detector – window detector – Time marker.

UNIT III **(15 hrs)**

Microprocessor architecture

Introduction – Intel 8085 - pin diagram - Instruction cycle –Timing diagram for OP code - fetch cycle – Memory read – Memory write – I/O read - I/O write – Instruction set – Addressing mode.

UNIT IV **(15 hrs)**

Peripheral devices and interfacing

Addressing space partitioning – memory and I/O interfacing – programmable peripheral interface - Intel 8255 - programmable DMA controller - Intel 8257 - programmable communication interface - Intel 8251 - Programmable counter - Time interval - Intel 8253.

UNIT V **(15 hrs)**

Microprocessor based data acquisition system

Analog to digital converter (ADC) - Digital to analog (DAC) - **LED Interfacing*** – Stepper Motor Interfacing – Traffic control simulation – Music tone generator –Temperature controller.

*** Self study**

Sub.Code: 25PPH206

Teaching Methods: Smart Class Room / Power point presentation / Seminar / Quiz /Discussion / Flipped Class / Peer Learning / Experiential Learning / Blended Learning

Text Books:

1. Millman Halkias, (2017), Integrated Electronics - Tata McGraw Hill, New Delhi.
2. B.Ram, (2011), Fundamentals of Microprocessors & Microcontrollers - Dhanpat RaiPublications, New Delhi.

Reference Books:

1. P.Mathur, C.Kulshreshta, R.Chada, (2005), Electronic Devices Applications and Integrated Circuits - Umesh Publications, New Delhi.
2. D.Roy Choudhary, Shail B.Jain, (2014), Linear Integrated Circuits - New Age International, New Delhi.

e-Resources:

1. https://www.youtube.com/watch?v=R9dQ875hkfg
2. https://youtu.be/iXSXIJn_Xwc
3. https://youtu.be/djbJm-xWo2w
4. https://www.youtube.com/watch?v=tas2eUavhRE
5. https://www.youtube.com/watch?v=FJknBjBJrOM

Mapping

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	S	H	H	H	S
CO 2	S	S	S	S	H
CO 3	H	H	S	S	S
CO 4	H	S	S	H	S
CO 5	S	S	H	S	H

S- Strong **H-High** **M-Medium** **L - Low**

Sub.Code: 25PPH307

Programme: 03		**M.Sc. Physics**			
Title of the Paper		**Core Paper 7 - Quantum Mechanics II**			
Batch 2025-2026	**Semester 3**	**Hours/Week 5**	**Total Hours 75**	**Credits 4**	**Skill Development**

Course Objectives

To enable the learners to

1. Understand the basic approximate methods in molecular quantum mechanics
2. Understand relativistic quantum theory, quantum optics
3. Understand quantization of fields and scattering

Course Outcomes (CO)

On successful completion of the course, the students will be able to

K1 to K5	CO1	Understand different approximations and models to describe a many electron system
	CO2	Comparison of MO and VB theories to explain molecular structure of hydrogen molecule and hydrogen ion
	CO3	Understand relativistic quantum mechanics
	CO4	Acquire knowledge on quantum field theory
	CO5	Interpret scattering theory in terms of quantum aspects.

Syllabus

UNIT I **(15 hrs)**

Many electron atoms

Indistinguishable particles – Pauli principle – Inclusion of Spin – Spin functions for two electrons - Spin functions for three electrons – Helium atom – Central Field approximation – Thomas Fermi model of the atom – Hartree equation – Hartree Fock equation

UNIT II **(15 hrs)**

Molecular structure

Born Oppenheimer approximation – molecular orbital theory (LCAO approximation) - hydrogen molecule ion – hydrogen molecule (MO method) - valence bond (VB method) – comparison of MO and VB theories

UNIT III **(15 hrs)**

Relativistic Quantum mechanics

Klein Gordan equation – interpretation of Klein Gordan equation – particle in a coulomb field – Dirac's equation for a free particle – Dirac matrices – covariant form of Dirac's equation - probability density - plane wave solution - negative energy states - spin of Dirac particle – magnetic moment of the electron – spin orbit interaction.

UNIT IV **(15 hrs)**

Quantum field theory

Concept of field - second quantization - quantization of wave field –Lagrangian & Hamiltonian density – Lagrangian and Hamiltonian field equations - quantum canonical equations - Quantum equations for nonrelativistic Schrödinger equation - creation, destruction and number operators – anti commutation relations (basic concepts) – **Quantization of electromagnetic field***

Sub.Code: 25PPH307

UNIT V **(15 hrs)**

Quantum theory of scattering

Scattering cross section - scattering amplitude – partial waves – scattering by a central potential - partial wave analysis - significant number of partial waves - Born approximation – scattering by a screened coulomb potential – validity of Born approximation.

*** Self study**

Teaching Methods: Smart Class Room / Power point presentation / Seminar / Quiz /Discussion / Flipped Class / Peer Learning / Experiential Learning / Blended Learning

Text Books:

1. G.Aruldhas, (2019). Quantum mechanics - PHI learning Pvt. Ltd., New Delhi.
2. A.K.Chandra, (2017), Introductory Quantum Chemistry - Tata McGraw Hill.,

Reference Books:

1. Gupta Kumar Sharma, (2010), Quantum mechanics - Jai Prakash Nath & Co, Meerut.
2. P.M.Mathews, K.Venkatesan, (2010), A Text Book of Quantum Mechanics -Tata Mc Graw Hill, India
3. Lenard I Schiff, (2010), Quantum mechanics - Tata Mc Graw Hill, India

e-Resources:

1. https://youtu.be/RTjJ7H79WAI
2. https://youtu.be/iPRW1ft90vk
3. https://youtu.be/ryp5FRIB6A0
4. https://youtu.be/JjidYZYb_ck
5. https://www.youtube.com/watch?v=OO9Wr9uveFg

Mapping

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	S	H	H	H	S
CO 2	H	H	H	S	H
CO 3	S	S	S	H	S
CO 4	S	H	H	S	S
CO5	S	S	S	H	S

S- Strong **H-High** **M-Medium** **L – Low**

Sub.Code: 25PPH308

Programme: 03		**M.Sc. Physics**			
Title of the Paper		**Core Paper 8 – Electromagnetic Theory and Electrodynamics**			
Batch 2025-2026	**Semester 3**	**Hours/Week 5**	**Total Hours 75**	**Credits 4**	**Skill Development**

Course Objectives

To enable the learners to know about

1. Electrostatics and magnetostatics
2. Applications of Maxwell's equations
3. Antenna arrays

Course Outcomes (CO)

On successful completion of the course, the students will be able to

K1 to K5	CO1	Understand electrostatics and magnetostatics
	CO2	Acquire knowledge on field equations and conservation laws
	CO3	Understand the propagation of electromagnetic waves in different media on microscopic scale
	CO4	Study the interaction of electromagnetic waves with different media on macroscopic scale
	CO5	Acquire knowledge on relativistic electrodynamics

Syllabus

UNIT I **(15 hrs)**

Electrostatics

Dielectric polarization – external field of a dielectric medium – electric displacement vector (D) - linear dielectrics – relation connecting electric susceptibility, polarization vector (P), D and dielectric constant – Molecular field and Clausius Mosotti relation for nonpolar molecules Langevin Debye formula for polar molecules - Electrostatic energy and energy density.

Magnetostatics

Biot Savart law statement – Lorentz force law and definition of B – general proof of Ampere's Circuital law – divergence and curl of B – magnetic scalar potential (derivation of expression only) – equivalence of a small current loop and a magnetic vector potential (derivation of expression only).

UNIT II **(15 hrs)**

Field equations and conservation laws

Equation of continuity – displacement current –Maxwell's equations derivation and Physical significance – Poynting vector – momentum in electromagnetic fields - electromagneticpotentials - Maxwell's equation in terms of electromagnetic potentials - concept of gauge – Lorentz gauge - Coulomb gauge - radiation from an accelerated charged particle at low velocity (Larmour formula) - oscillating electric diode- radiation from a small current element - linear half wave antenna - **antenna array*.**

UNIT III **(15 hrs)**

Propagation of electromagnetic waves

Electromagnetic waves in free space – poynting vector of free space (energy flow) - plane electromagnetic waves in matter – isotropic dielectric in conducting media – poynting vector in conducting media - propagation in ionized gases.

Interaction of EMW with matter on microscopic scale

Scattering and scattering parameters - scattering by a free electron (Thomson scattering) – scattering by a bound electron (Rayleigh scattering) – dispersion in gases – normal andanomalous dispersion in liquids and solids.

Sub.Code: 25PPH308

UNIT IV **(15 hrs)**

Interaction of EMW with matter on macroscopic scale

Boundary conditions at interfaces – reflection and refraction - Fresnel's law – Brewster's law and degree of polarization – total internal reflection and critical angle - reflection from a metal surface - wave guide (rectangular) – TE waves – TM waves.

UNIT V **(15 hrs)**

Relativistic Electrodynamics

Four vectors and Tensors – Transformation equations for charge (ρ) and current densities (J) – Transformation equations for the electromagnetic potentials A and ϕ - Electromagnetic field tensor - Transformation equations for the field vectors E and B – Covariance of Maxwell equation in terms offour vectors – Covariance and Transformation law of Lorentz force.

* **Self study**

Teaching Methods: Smart Class Room / Power point presentation / Seminar / Quiz /Discussion / Flipped Class / Peer Learning / Experiential Learning / Blended Learning

Text Books:

1. Chopra & Agarwal, (2010), Electromagnetic theory - K.Nath & Co, Meerut.
2. Gupta Kumar& Singh, (2020), Electromagnetics - Pragathi Prakashan, Meerut.
3. Electromagnetic theory (Electrodynamics), (2020), K.K.Chopra and G.C. Agarwal, Kethar Nath& Co, Meerut.

Reference Book:

1. Sathya Prakash, (2018), Electromagnetic theory and Electrodynamics - Kedar Nath, Ram Nath & Co, Meerut.

e-Resources:

1. https://www.youtube.com/watch?v=ZC4GgMapjHo
2. https://www.youtube.com/watch?v=CX7X6YrVUdk
3. https://www.youtube.com/watch?v=GvtFNfotKaE
4. https://www.youtube.com/watch?v=GurdC_KknKY
5. https://www.youtube.com/watch?v=e8EjV0AzKVI

Mapping

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	H	S	H	H	S
CO 2	H	S	S	S	H
CO 3	S	H	H	H	H
CO 4	H	S	H	H	S
CO 5	H	S	H	H	S

S- Strong **H-High** **M-Medium** **L – Low**

Sub. Code: 25PPH309

Programme: 03		**M.Sc. Physics**			
Title of the Paper		**Core Paper 9 – Condensed Matter Physics II**			
Batch 2025-2026	**Semester 3**	**Hours/Week 4**	**Total Hours 60**	**Credits 4**	**Skill Development**

Course Objectives

To gain knowledge about

1. Band theory of solids
2. Semiconductors, dielectrics and ferroelectrics
3. Magnetism and superconductors

Course Outcomes (CO)

On successful completion of the course, the students will be able to

K1 to K5	CO1	Gain knowledge on band theory of solids
	CO2	Understand semiconductors and hall effect
	CO3	Acquire knowledge on superconductors
	CO4	Gain knowledge on dielectrics and ferroelectric materials
	CO5	Acquire knowledge on magnetism

Syllabus

Unit I **(12 hrs)**

Band Theory of solids

Kronig Penney model - construction of 1D, 2D and 3D Brillouin zones - Extended, Reduced and Periodic zone schemes – Number of possible wave function in a band - motion of electron in one dimensional periodic potential - Effective mass of an electron and hole – classification of materials using band theory - **Energy bands in metals, semiconductors and insulators***.

Unit II **(12 hrs)**

Semiconductors

Intrinsic semiconductors: band model - electron and hole concentrations – law of mass action – electrical conductivity – Extrinsic semiconductors: impurity state and band model – electron and hole concentrations – impurity electrical conductivity - variation of electrical conductivity with temperature - Hall effect – Hall parameters - PN junction and Fermi energy.

UNIT III **(12 hrs)**

Superconductivity

Mechanism of superconductivity - critical current – critical magnetic field - Meissner effect – Type I and Type II superconductors - energy gap - isotope effect - penetration depth - specific heat capacity - BCS theory - London equation - superconductors in AC fields - Quantum tunneling: Josephson Superconductor tunneling - DC Josephson effect - AC Josephson effect – Macroscopic Quantum Interference - SQUID.

Sub. Code: 25PPH309

Unit IV **(12 hrs)**

Dielectrics and Ferroelectrics

Maxwells equation – Polarization – Macroscopic Electric field : depolarization electric field – Local electric field in an atom – Lorentz field –field of dipoles inside a cavity – dielectric constant and: Electric polarizability – structural phase transition – Ferroelectric crystals : classifications – displacive transition - soft optical phonon – antiferroelectricity and ferroelectric domains – Piezoelectricity - Pyroelectricity - Ferroelasticity.

Unit V **(12 hrs)**

Magnetism

Langevin's theory of diamagnetism : quantum theory of diamagnetism of mono nuclear systems – Paramagnetism: quantum theory of paramagnetism - rare earth ions – Ferromagnetism: Spontaneous magnetization - Weiss theory of spontaneous magnetization – Hysteresis – Weiss theory of Hysteresis – Ferromagnetic domains – Antiferromagnetism – Molecular field theory – Susceptibility above and below Neel temperature – Ferrimagnetism – Molecular field theory of Ferrimagnetism.

***Self-study**

Teaching Methods: Smart Class Room / Power point presentation / Seminar / Quiz /Discussion / Flipped Class / Peer Learning / Experiential Learning / Blended Learning

Text Books:

1. S.O.Pillai, (2018), Solid State Physics- New Age Publishers, New Delhi.
2. R.L.Singhal, (2019), Solid State Physics - Kedar Nath Ram Nath & Co., Meerut.

Reference Books:

1. R.K Puri, V.K Babbar, (2010), Solid State Physics - S.Chand & Co., New Delhi.
2. Charles Kittel, (2012), Introduction to Solid State Physics-Wiley, India.
3. V.Raghavan, (2015), Material science and Engineering- Prentice Hall Ltd, New Delhi.

e-Resources:

1. http://hyperphysics.phy-astr.gsu.edu/hbase/Solids/band.html
2. https://byjus.com/jee/semiconductors/
3. https://youtu.be/D-9M3GWoBrw
4. https://en.wikipedia.org/wiki/Superconductivity
5. https://en.wikipedia.org/wiki/Magnetism

Mapping

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	S	H	S	H	S
CO 2	S	S	H	S	S
CO 3	S	S	S	S	H
CO 4	S	S	S	S	S
CO 5	S	S	S	S	H

S- Strong **H-High** **M-Medium** **L - Low**

Sub. Code: 25PPH410

Programme: 03		M.Sc. Physics			
Title of the Paper		Core Paper 10 - Problems in Physics II			
Batch 2025-2026	Semester 4	Hours/Week 5	Total Hours 75	Credits 4	Skill Development

Course Objectives

To enable the learners to

1. Acquire knowledge and skills to solve problem through the concept behind physics
2. Apply creative thinking techniques towards realistic problem
3. Visualize the basic concepts clearly

Course outcomes (CO)

On successful completion of the course, the students will be able to

K1 to K5	CO1	Understand and solve problems in classical mechanics
	CO2	Gain knowledge to solve problems in quantum mechanics
	CO3	Acquire knowledge to solve problems in electromagnetics
	CO4	Understand and solve problems in electronics
	CO5	solve problems in thermodynamics and statistical Physics

Syllabus

UNIT I

Classical Mechanics (15 hrs)

Newton's laws – dynamical systems – phase space dynamics – stability analysis – central force motions – two body collisions – scattering in laboratory and center of mass frames – rigid body dynamics – moment of inertia tensor–non-inertial frames and pseudo forces–variational principle – generalized co-ordinates–Lagrangian and Hamiltonian formalism and equations of motion– conservation laws and cyclic coordinates – periodic motion – small oscillations, normal modes.

Objective type questions (Problem no. 1-100, page no. 148-158), Descriptive type questions (Problem no. 1-15 , page no.185-193)

UNIT II (15 hrs)

Quantum Mechanics

Wave-particle duality – Schrodinger equation (time-dependent and time-independent) – Eigenvalue problems (particle in a box, harmonic oscillator) –Tunneling through a barrier – Wave function in coordinate and momentum representations – Commutators and Heisenberg uncertainty principle – Dirac notation for state vectors – Motion in a central potential: orbital angular momentum, angular momentum algebra, spin, addition of angular momenta – Hydrogen atom – Stern Gerlach experiment – Time-independent perturbation theory and applications.

Objective type questions (Problem no. 1-100, page no. 330-339), Descriptive type questions (Problem no. 1-15 , page no.388-398

UNIT III (15 hrs)

Electromagnetics

Charge density – total charge of the system – distribution of electric charge – Yukawa potential – spherically symmetric charge distribution – scalar and vector functions of an electric field –electric field inside a uniformly polarized sphere and inside a dielectric – electrostatic energy of an electron – coplanar electric dipoles – array of charges – repulsion between a point chargeand a spherical conductor – negative charge inside an hydrogen atom – potential energy of a nucleus.

Objective type questions (Problem no. 1-100, page no. 223-253), Descriptive type questions (Problem no. 1-15,page no.288-293)

Sub. Code: 25PPH410

UNIT IV **(15 hrs)**

Electronics

Semiconductor device Physics : diodes - junctions – transistors – field effect devices – homo and heterojunction devices – device structure – device characteristics – Optoelectronic devices : solar cells – photodetectors – LEDs – operational amplifiers and their applications- impedance matching, amplification.

Objective type questions (Problem no. 1-100, page no. 570-577), Descriptive type questions (Problem no. 1-15,page no.637-642)

UNIT V **(15 hrs)**

Thermodynamics and Statistical Physics

Laws of thermodynamics and their consequences – thermodynamics potentials – axwell relations, chemical potential, phase equilibria – phase space – micro and macrostates – micro canonical – grand canonical ensembles and partition functions –free energy and its connection with thermodynamic quantities.

Objective type questions (Problem no. 1-100, page no. 440-450), Descriptive type questions (Problem no. 1-10,page no.493-498)

Text Book:

1. Dr.Surekha Tomar, (2017), CSIR-UGC NET/JRF/SET Physical Science - Upkar Prakashan,Agra, India

Reference Books:

1. Jain K.C.Arora, (2013), Numerical Problems in Physics - S.Chand & Co., New Delhi.
2. Bukhovtsev.B.Krivchenkov, (2012), Problems in Elementary Physics - CBS Publishers and distributors Pvt. Ltd., New Delhi.

e-Resources:

1. https://iopscience.iop.org/book/978-0-7503-1401-5
2. https://youtu.be/vblPUxn7Om8
3. https://ostad.hormozgan.ac.ir/ostad/UploadedFiles/1859694/1859694-1368629834498910.pdf
4. https://stemez.com/subjects/technology_engineering/1LElectromagnetics/1LElectromagnetics.php
5. https://youtu.be/tw3lZ-GFgpk

Mapping

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	S	H	H	S	H
CO 2	H	S	H	H	H
CO 3	H	S	H	H	S
CO 4	S	H	S	H	H
CO5	S	H	H	S	H

S- Strong **H-High** **M-Medium** **L - Low**

Sub. Code: 25PPH411

Programme: 03		**M.Sc. Physics**			
Title of the Paper		**Core Paper 11 - Atomic and Molecular Spectroscopy**			
Batch 2025-2026	**Semester 4**	**Hours/Week 5**	**Total Hours 75**	**Credits 4**	**Skill Development**

Course Objectives

To enable the learners to

1. Understand atomic, microwave and IR spectroscopy
2. Know about Raman, NMR and NQR spectroscopy
3. Know about ESR and Mossbauer spectroscopy

Course Outcomes (CO)

On successful completion of the course, the students will be able to

K1 to K5	CO1	Understand atomic spectroscopy
	CO2	Gain knowledge on microwave and IR spectroscopy
	CO3	Acquire knowledge on Raman spectroscopy
	CO4	Understand NMR and NQR spectroscopy
	CO5	Acquire knowledge on ESR and Mossbauer spectroscopy

Syllabus

UNIT I **(15 hrs)**

Atomic spectroscopy

Spectra of alkali metals – elements with more than one outer valence electron - space quantization of angular momentum - magnetic moment of an atom – normal Zeeman effect – anomalous Zeeman effect – emitted transitions in anomalous Zeeman transitions – Lande's g formula – Paschen back effect – hyperfine structure of spectral line – Zeeman effect of hyperfine structure – Back Goudsmit effect.

UNIT II **(15 hrs)**

Microwave Spectroscopy

Rotation of molecules – rotational spectra of rigid diatomic molecules – intensities of spectral lines – non rigid rotator –spectrum of a non rigid rotator – symmetric top molecules.

IR Spectroscopy

Vibrating diatomic molecules –simple harmonic oscillator – anharmonic oscillator – diatomic vibrating rotator – fundamental vibrations and their symmetry – influence of rotation on vibrational spectra of polyatomic molecules – linear molecules – symmetric top molecules.

Unit III **(15 hrs)**

Raman spectroscopy

Quantum theory – classical theory – pure rotational Raman spectra – linear molecules – symmetric top molecules – Raman activity of vibrations – rule of mutual exclusion – vibrational Raman spectra – rotational fine structure.

Electronic spectra of diatomic molecules

Vibrational coarse structure – Deslandres tables – Frank Condon principle – rotational finestructure of electronic vibrational transition.

Sub. Code: 25PPH411

UNIT IV **(15 hrs)**

NMR spectroscopy

Quantum mechanical and classical description – Bloch equations - relaxation processes - spin lattice and spin relaxation – Fourier transformation - Experimental technique - principles and working of Fourier transform - NMR spectrometer - chemical shift.

NQR spectroscopy

Fundamental requirements - general principles - Half integral spins - Integral spins - experimental detection of NQR frequencies.

UNIT V **(15 hrs)**

ESR Spectroscopy

Basic principles of ESR - ESR Spectrometer - Reflection cavity and microwave bridge – ESR spectrum - Hyperfine structure **– Study of free radicals*.**

Mossbauer Spectroscopy

Mossbauer effect - recoil emission and adsorption – Mossbauer spectrum - experimentalmethods.

*** Self study**

Teaching Methods: Smart Class Room / Power point presentation / Seminar / Quiz /Discussion / Flipped Class / Peer Learning / Experiential Learning / Blended Learning

Text Books:

1. C.N.Banwell, E.M.Mc Cash, (2017), Fundamentals of Molecular Spectroscopy-Tata McGraw Hill, India
2. B.P.Straughan, S.Walker, (2016), Spectroscopy - John Wiley & Sons, UK.

Reference Books:

1. Gupta Kumar, (2011), Elements of spectroscopy - Pragathi Prakasan, Meerut.
2. G. Aruldhas, (2008), Molecular structure and Spectroscopy - Prentice Hall ofIndia, New Delhi

e-Resources :

1. https://nptel.ac.in/courses/115105100 - Atomic and Molecular Physics
2. https://www.classcentral.com/course/youtube-special-select-topics-in-atomic- physics-47820 - Special/Select Topics in Atomic Physics
3. https://www.classcentral.com/course/youtube-quantum-chemistry-and- spectroscopy-53141 - Quantum Chemistry and Spectroscopy
4. https://www.digimat.in/nptel/courses/video/104108078/L01.html
5. https://www.youtube.com/watch?v=NzbDEjI8IKE

Mapping

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CO 1	S	H	H	S	H
CO 2	H	S	H	H	H
CO 3	H	S	H	H	S
CO 4	S	H	S	H	H
CO 5	H	S	H	H	S

S- Strong **H-High** **M-Medium** **L - Low**

Sub. Code: 25PPH412

Programme: 03		M.Sc. Physics			
Title of the Paper		Core Paper 12 - Nuclear and Particle Physics			
Batch 2025-2026	Semester 4	Hours/Week 5	Total Hours 75	Credits 4	Skill Development

Course Objectives

To enable the learners to

1. Know about radioactivity
2. Gain knowledge on Alpha and Beta particles and Gamma rays
3. Understand nuclear models and particle Physics

Course Outcomes (CO)

On successful completion of the course, the students will be able to

K1 to K5	CO1	Study the phenomenon of radioactivity
	CO2	Understand Alpha and Beta particles and Gamma rays
	CO3	Gain knowledge on nuclear properties
	CO4	Acquire knowledge on nuclear models
	CO5	Gain knowledge on elementary particles

Syllabus

UNIT I **(15 hrs)**

Radioactivity

Discovery of radioactivity - law of radioactive decay – half life of radioactive nuclei – average or mean life of an atom – successive radioactive transformations – radioactive equilibrium – unit of radioactivity – radioactive dating - carbon dating- ratio of Uranium to Helium – ratio of Pb^{206} to Pb^{207} – specific ionization – secondary ionization and delta rays – straggling : stopping power – range of straggling for electrons.

UNIT II **(15 hrs)**

Alpha particles: Properties of alpha particles – velocity and energy of alpha particles – alpha decay and barrier penetration – Gamow's theory of alpha decay.

Beta particles: General features of beta ray spectrum – Pauli's hypothesis – Fermi's theory of allowed beta decay – beta decay lifetime – experimental verification of beta decay – forms of interaction and selection rules.

Gamma rays: Nature of Gamma rays – passage – photoelectric absorption – Compton scattering – electron – positron pair production and annihilation.

Unit III **(15 hrs)**

Nuclear properties

Nonexistence of electrons inside the nucleus – nuclear spin – Pauli's spin – parity – statistics – angular momentum – magnetic dipole moment – electric moments – electric quadrupole moment – nuclear size – electrical methods : Mesonic x rays – electron scattering method Nuclear methods – neutron scattering method – isotopic shift in line spectra – nuclear mass and mass spectrometery : Aston's mass spectrograph – double focusing spectrometer – Nier's mass spectrograph – mass synchrometer – nuclear stability – binding energy – mass defect and packing fraction – semiempirical mass formula.

Sub. Code: 2PPH412

Unit IV **(15 hrs)**

Nuclear models

Constitution of nucleus – neutron proton hypothesis – nuclear models – liquid drop model – Bethe Weizsacker formula – applications of semiempirical binding energy formula – ermi gas model of the nucleus – nuclear shell structure – single particle shell model – individual particle model – collective model.

UNIT V **(15 hrs)**

Particle Physics

Classification of elementary particles – fundamental interactions: gravitational – electromagnetic – strong and weak – properties of elementary particles – Gell Mann Okubo mass formula for Baryons – CP violation in K decay – Quark model – **Higgs boson*.**

* **Self study**

Teaching Methods: Smart Class Room / Power point presentation / Seminar / Quiz /Discussion / Flipped Class / Peer Learning / Experiential Learning / Blended Learning

Text Books

1. M.L.Pandya, R.P.S.Yadav, Amitya Dash, (2020), Elements of Nuclear Physics-Kedar Nath Ram Nath & Co, Meerut.
2. S.N.Ghoshal, (2019), Nuclear Physics - S.Chand & Co., New Delhi.

Reference Books

1. Bernard L Cohen, (2018), Concept of Nuclear Physics - Tata Mc Graw Hill, India.
2. Kenneth S Krane, (2019), Modern Physics, JohnWiley & Sons.
3. D.C.Tayal, (2018), Nuclear Physics - Himalayan Publishing House, New Delhi.

e-Resources:

1. https://www.youtube.com/watch?v=Rd0CJje59bE
2. https://www.youtube.com/watch?v=josqjcH79PE&list=PLbMVogVj5nJRvq-w3zway7k3GzmUDte3a
3. https://www.youtube.com/watch?v=iMhDYarsfII&list=PLbMVogVj5nJRvq-4w3zway7k3GzmUDte3a&index=25
4. https://www.youtube.com/watch?v=VTHQYjkCqV0
5. https://www.youtube.com/watch?v=cD-ZlLA2UgI

Mapping

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	S	H	S	H	S
CO 2	S	H	H	S	S
CO 3	H	S	S	S	H
CO 4	S	H	H	H	S
CO 5	S	H	S	H	S

S- Strong **H-High** **M-Medium** **L - Low**

Sub. Code: 25PPH2CL

Programme: 03		**M.Sc. Physics**			
Title of the Paper		**Core Practical 1 – General Experiments**			
Batch 2025-2026	**Semesters 1 & 2**	**Hours/Week 5**	**Total Hours 150**	**Credits 5**	**Skill Development**

Course Objectives

To enable the learners to

1. Perform experiments in the field of general Physics
2. Explain physical phenomena and enable to relate physical laws and their applications
3. Apply standard techniques and analyze the experimental results and output.

Course outcomes (CO)

On successful completion of the course, the students will be able to

K3 to K5	CO1	Have a foundation in fundamentals and applications of general Physics
	CO2	Design, carry out record and analyze experimental data.
	CO3	Get hands on experiences in conducting laboratory experiments.
	CO4	Understand the relationship between theory and experimental results.
	CO5	Practice record keeping of experimental work and data graphing.

List of Experiments <u>(Any fifteen)</u>

1. Determination of Young's modulus-elliptical fringes (Cornu's method)
2. Determination of Young's modulus-hyperbolic fringes (Cornu's method)
3. Determination of coefficient of viscosity of a liquid-Mayer's oscillating disc
4. Determination of Stefan's constant
5. Determination of Rydberg's constant - solar spectrum
6. Determination of thickness of insulation of a thin wire using laser source
7. Determination of wavelength by oblique incidence - Grating
8. Determination of wavelength of laser source - Grating
9. Determination of refractive index of a liquid - Newton's ring method
10. Determination of refractive index of a liquid - Air wedge method

Sub. Code: 25PPH2CL

11. Study of emission line spectra - Constant deviation spectrometer

12. Determination of refractive index of given liquids – Laser

13. Study of characteristics of Laser
    a) Determination of Gaussian nature of laser source and evaluation of beam spot size.
    b) Measurement of laser beam divergence.
    c) Study of absorption of light on various filters.

14. Determination of TCR and band gap energy of thermistor- Carey Foster's bridge

15. Determination of thermal conductivity – Forbe's method

16. Determination of specific heat of liquid - Ferguson's method

17. Determination of liner expansion of solids - Fizeau's method

18. Determination of coefficient of self inductance of a coil - Anderson's bridge method.

19. Determination of audio frequencies -Wien Bridge method

20. Determination of e/m - Millikan's method

21. Determination of e/m - Thomson's method

e- Resources:

1. https://www.youtube.com/watch?v=acBEQ8qqVKU
2. https://www.youtube.com/watch?v=U5sdiQSjyHA
3. https://www.youtube.com/watch?v=9mmgpRDoENo
4. https://www.youtube.com/watch?v=UFiPWv03f6g
5. https://www.youtube.com/watch?v=3XJez8bzU34

Mapping

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	S	H	H	S	H
CO 2	H	S	S	H	S
CO 3	S	H	S	S	H
CO 4	S	H	S	H	H
CO5	S	H	H	S	H

S- Strong **H-High** **M-Medium** **L – Low**

Sub. Code: 25PPH2CM

Programme Code: 03		**M.Sc. Physics**			
Title of the Paper		**Core Practical 2 – Electronics Experiments**			
Batch 2025-2026	**Semesters 1 & 2**	**Hours/Week 5**	**Total Hours 150**	**Credits 4**	**Skill Development**

Course Objectives

To enable the learners to

1. Design and construct electronic circuits
2. Develop experimental skills and understand relation between experimental dataand theoretical analysis.
3. Have a foundation in the fundamentals and applications of experimental Physics.

Course outcomes (CO)

On successful completion of the course, the students will be able to

K3 to K5	CO1	Acquire a basic knowledge in solid state electronics
	CO2	Analyse and design analog electronic circuits using discrete components.
	CO3	Observe the amplitude / frequency response of amplifiers.
	CO4	Take measurements to compare experimental results in the laboratory with the theoretical analysis.
	CO5	Practice record keeping of experimental work and data graphing.

List of Experiments <u>(Any fifteen)</u>

1. Construction of dual regulated power supply
2. Determination of Op-Amp parameters
3. Study of triangular and square wave generator
4. Study of Wien’s bridge oscillator
5. Study of active filters - Op Amp
6. Study of Monostable Multivibrator - Op Amp
7. Study of inverting and non-inverting amplifiers – Op Amp
8. Study of phase shift oscillator – Op Amp
9. Study of clippers and clampers
10. Study of differentiator and integrator – Op Amp

11. Solving first order differential equations - Op Amp

12. Study of pulse width modulation

13. Characteristics of MOSFET

14. Characteristics of tunnel Diode

15. Characteristics of SCR

16. Characteristics of UJT

17. UJT relaxation oscillator

18. Study of FET as common source amplifier

19. Study of Astable Multivibrator - Op Amp

20. Study of square wave generator

e-Resources:

1. https://www.youtube.com/watch?v=gbUXbaxvX94
2. https://www.youtube.com/watch?v=hpCu3HbAiWg
3. https://www.youtube.com/watch?v=j47Yk7bJbxw
4. https://www.youtube.com/watch?v=RZAiZSM92gQ
5. https://www.youtube.com/watch?v=gaSLHttLwag

Mapping

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	S	H	H	S	H
CO 2	H	S	S	H	S
CO 3	S	H	S	S	H
CO 4	S	H	S	H	H
CO5	S	H	S	S	H

S- Strong **H-High** **M-Medium** **L - Low**

Sub. Code: 25PPH4CN

Programme: 03		**M.Sc. Physics**			
Title of the Paper		**Core Practical 3 – Advanced Experiments**			
Batch 2025-2026	**Semesters 3 & 4**	**Hours/Week 5**	**Total Hours 150**	**Credits 5**	**Skill Development**

Course Objectives

To enable the learners to

1. Perform experiments in the field of advanced Physics and interpret the results.
2. Explain physical phenomena and enable to estimate various related parameters and to analyze them.
3. Apply the experimental techniques to research level.

Course outcomes (CO)

On successful completion of the course, the students will be able to

K3 to K5	CO1	Gain fundamental knowledge on applications of advanced Physics.
	CO2	Understand the relationship between theory and experiments
	CO3	Get hands on experiences in conducting scientific investigations
	CO4	Acquire hands on experiences in conducting laboratory experiments.
	CO5	Recording and analyzing experimental data.

List of Experiments (Any Fifteen)

1. Determination of numerical aperture, acceptance angle and fiber loss of an optical fiber

   - Fiber optic experiment

2. Determination of λ of a monochromatic light – Biprism – Optical bench

3. Determination of λ, $d\lambda$ and thickness of mica sheet – Michelson interferometer

4. Study of optoelectronic devices

5. Determination of Planck's constant – Photocell

6. Determination of magnetic field strength – Search Coil method

7. Determination of magnetic susceptibility of the given solutions – Quincke's method

8. Determination of magnetic susceptibility of the given solutions – Guoy's method

9. Determination of bulk modulus and compressibility of liquids – Ultrasonic diffraction

10. Determination of resistivity of a semiconductor material – Four probe method

Sub. Code: 25PPH4CN

11. Determination of Hall parameters of n-type and p-type semiconductors

12. Determination of very low resistance and specific resistance – Kelvin's double Bridge

13. Determination of e/m – Zeeman effect

14. Determination of e/m – Magnetron method

15. Determination of e/m – Helical method

16. Study of BH curve – Anchor ring

17. Study of BH curve – Solenoid

18. Study of IH curve – Solenoid

19. Study of emission arc spectra (Copper/Brass/Iron) – Constant Deviation Spectrograph

20. Study of absorption spectra using $KMNO_4$ solution

e-Resources:

1. https://www.youtube.com/watch?v=Iq3Xv2GdgQk
2. https://www.youtube.com/watch?v=MD_zkNzF3eA
3. https://www.youtube.com/watch?v=qHptDfsBxAs
4. https://www.youtube.com/watch?v=vb8KwB0ANrg
5. https://www.youtube.com/watch?v=bAkNC1wIlGc

Mapping

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	**S**	**S**	**H**	**S**	**H**
CO 2	**H**	**S**	**S**	**H**	**S**
CO 3	**S**	**H**	**S**	**S**	**H**
CO 4	**S**	**H**	**S**	**H**	**H**
CO 5	**S**	**H**	**S**	**S**	**H**

S- Strong **H-High** **M-Medium** **L – Low**

Sub. Code: 24PPH4CO

Programme: 03		M.Sc. Physics			
Title of the Paper		Core Practical 4 – Special Electronics Experiments			
Batch 2025-2026	Semesters 3 & 4	Hours/Week 5	Total Hours 150	Credits 4	Skill Development

Course Objectives

To enable the learners to

1. Design and construct special electronic circuits
2. Develop experimental skills and understand relation between experimental dataand theoretical analysis.
3. Have a foundation in the fundamentals and applications of experimental Physics.

Course outcomes (CO)

On successful completion of the course, the students will be able to

K3 to K5	CO1	Acquire knowledge in solid state electronics
	CO2	Develop the ability to construct electronic circuits using discrete components.
	CO3	Acquire knowledge to construct Op. amp based circuits
	CO4	Acquire knowledge to construct microprocessor based circuits
	CO5	Understand the relation between theory and experiments

List of Experiments (Any Fifteen)

1. Study of V to I and I to V converters – Op Amp
2. Study of D/A converter – binary weighted and ladder methods – Op Amp
3. Study of A/D converter – voltage indicator – Op Amp
4. Study of log and antilog amplifiers – Op Amp
5. Study of half wave and full wave rectifiers – Op Amp
6. Study of clippers and clampers – Op Amp
7. Study of comparator and zero crossing detector – Op Amp
8. Study of window detector and time marker – Op Amp
9. Study of light intensity inverse square law – Op Amp
10. Solving second order differential equations – Op Amp

11. Study of monostable and astable multivibrators – 555 Timer

12. Study of Schmitt trigger and voltage controlled oscillator – 555 Timer

13. Microprocessor – Music tone generator

14. Microprocessor – DAC – Wave form generator

15. Microprocessor – ADC interface

16. Microprocessor – LED display interfacing

17. Microprocessor – Stepper motor interfacing

18. Microprocessor – Traffic control simulation

19. Microprocessor – Temperature controller

e-Resources:

1. https://www.youtube.com/watch?v=Uc2R7GND0Dk
2. https://circuitdigest.com/electronic-circuits/jk-flip-flop-truth-table-working
3. https://www.youtube.com/watch?v=w9otDOoAUpk
4. https://www.wikitechy.com/tutorials/linear-integrated-circuits/clippers
5. https://www.youtube.com/watch?v=ypV6gdIJJU4

Mapping

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	**S**	**H**	**H**	**S**	**H**
CO 2	**H**	**S**	**S**	**H**	**S**
CO 3	**S**	**H**	**S**	**S**	**H**
CO 4	**S**	**H**	**S**	**H**	**H**
CO 5	**S**	**H**	**S**	**S**	**H**

S- Strong **H-High** **M-Medium** **L - Low**

Sub. Code: 25PPH4Z1

Programme: 03		**M.Sc. Physics**			
Title of the Paper		**Project and Viva Voce**			
Batch 2025-2026	**Semester 4**	**Hours/Week 1**	**Total Hours 15**	**Credits 4**	**Skill Development**

Course objectives

To enable the learners to

1. Have foundations in the fundamentals of Physics and related area.
2. Acquire skills to develop a working model
3. Visualize the applications of theoretical concepts

Course Outcomes (CO)

On successful completion of the course, the students will be able to

K3 to K5	CO1	Construct working models
	CO2	Gain expertise to present the idea systematically through PPT
	CO3	Get familiarized to develop a report on the project work
	CO4	Accomplish the result accumulation and data graphing
	CO5	Gain expertise to apply knowledge on multiciliary field

Marks Distribution

CIA / ESE	**Particulars**	**Marks**
CIA	Project Review	15
	Regularity	05
	Total Internal Marks	20
ESE *	Project Report Presentation	60
	Viva Voce	20
	Total External Marks	80
Total Marks (CIA + ESE)		**100**

* Project report and viva voce will be evaluated jointly by project supervisor and external examiner.

Mapping

CO / PSO	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO 1	**S**	**H**	**H**	**S**	**H**
CO 2	**H**	**S**	**S**	**H**	**S**
CO 3	**S**	**H**	**S**	**S**	**H**
CO 4	**S**	**H**	**S**	**H**	**H**
CO 5	**S**	**H**	**S**	**S**	**H**

S- Strong **H-High** **M-Medium** **L - Low**

MAJOR ELECTIVE PAPERS

(4 papers are to be chosen from the following 8 papers)

1. Thin Film Physics, Plasma Physics and Crystal Growth
2. Communication Physics
3. Problems in Physics I
4. Semiconductor Devices
5. Energy Physics
6. Photovoltaic Science
7. Artificial Intelligence in Physics
8. Computational methods and programming

Programme: 03		M.Sc. Physics		
Title of the Paper		Major Elective Paper – Thin Film Physics, Plasma Physics and Crystal Growth		
Batch 2025-2026	Hours/Week 5	Total Hours 75	Credits 5	Entrepreneurship

Course Objectives

To enable the learners to

1. Understand the preparation and characterization of thin films
2. Understand the fundamentals of plasma Physics
3. Acquire knowledge about crystal growth techniques

Course outcomes (CO)

On successful completion of the course, the students will be able to

K1 to K5	CO1	Understand the principles, advantages and disadvantages of different thin film deposition methods
	CO2	Understand the growth mechanism of thin films
	CO3	Understand the fundamentals of plasma
	CO4	Can distinguish single particle approach and fluid approach
	CO5	Understand different crystal growth techniques

Syllabus

UNIT I **(15 hrs)**

Methods of preparation of thin films

Physical vapor deposition: Basic vacuum systems - vacuum evaporation – sputtering - DC/RF sputtering - electron beam evaporation - pulsed laser deposition.

Chemical deposition: Sol-gel method - spin coating - dip coating- spray pyrolysis- chemicalbath deposition- atomic layer deposition.

UNIT II **(15 hrs)**

Nucleation, growth and thickness measurements

Nucleation and growth: Thermodynamics of nucleation – nucleation theories - film growth - incorporation of defects, impurities in thin film – deposition parameters - grain size.

Thickness measurements: Interferometry – Fringes of equal thickness (FET) – Fringes of equal chromatic order (FECO) – step gauges - ellipsometry – stylus profilometry - vibrating quartz crystal method - gravimetric balance method.

UNIT III **(15 hrs)**

Plasma state characterization

Occurrence of plasma in nature - definition of plasma – concept of temperature - Debye shielding - plasma parameters - criteria for plasma – single particle motion: uniform B field – uniform E and B fields - Gravitational field – **Non uniform B field*** – curved B –magnetic mirrors.

UNIT IV **(15 hrs)**

Fluid theory and Application of Plasma

Derivation of fluid equation of motion - fluid drifts perpendicular to B - fluid drifts parallel toB - Production of nanoparticles by plasma - Plasma nitriding - Plasma sources for hospital waste - Plasma treatment of textiles.

UNIT V **(15 hrs)**

Crystal growth

Growth from liquid solution: Aqueous solution growth – Holden's rotary crystallizer- Mason jar method - temperature differential methods- chemical reactions – sol gel growth – liquid crystal (preliminary ideas only). Hydrothermal growth: Modified Bridgemann hydrothermal autoclave- Morley hydrothermal autoclave – phase equilibria and solubility - kinetic quartz.

*** Self-study**

Teaching Methods: Smart Class Room / Power point presentation / Seminar / Quiz /Discussion / Flipped Class / Peer Learning / Experiential Learning / Blended Learning

Text Books:

1. A.Goswami, (2006), Thin Film Fundamentals - New Age International Ltd, New Delhi.
2. Francis F.Chen, (2016), Introduction to Plasma Physics and controlled fusion -Plenum Press, Open library.
3. P.I. John, (2005), Plasma Sciences and the creation of wealth, Tata McGraw Hill, India.
4. H. L. Bhat, (2014), Introduction to Crystal Growth: Principles and Practice, CRC Press, USA.

Reference Books:

1. L.T. Meisssel and R.Glang, (1970), Hand book of thin film Technology - McGraw Hill,India
2. Nichola A. Krall, Alvin W. Trivelpiece, (1986), Principles of Plasma Physics- McGraw Hill, India.
3. K.L. Chopra, (1979), Thin Film Phenomena - Robert E. Krieger Publishing Company, USA.

e-Resources:

1. https://www.youtube.com/watch?v=p0XxWT2QdEk
2. https://www.youtube.com/watch?v=lxNYAxr5lPc
3. https://www.youtube.com/watch?v=wO2HS7hcSb8
4. https://www.digimat.in/nptel/courses/video/115102020/L01.html
5. https://www.youtube.com/watch?v=NTVGPRvFpR0

Mapping

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	S	H	S	H	H
CO 2	S	H	H	S	S
CO 3	H	S	S	S	H
CO 4	S	H	H	H	S
CO 5	H	S	H	S	H

S- Strong **H-High** **M-Medium** **L - Low**

Programme: 03		M.Sc. Physics		
Title of the Paper		Major Elective Paper - Communication Physics		
Batch 2025-2026	Hours/Week 5	Total Hours 75	Credits 5	Entrepreneurship

Course Objectives

To enable the learners to

1. Understand various modulation and detection techniques
2. Acquire knowledge about antennas and wave propagation
3. Understand generation and propagation of microwaves

Course Outcomes (CO)

On successful completion of the course, the students will be able to

K1 to K5	CO1	Understand the concept of modulation and demodulation
	CO2	Understand the principle of antennas and wave propagation
	CO3	Knowledge on television and satellite communication
	CO4	Acquire knowledge on communication electronics
	CO5	Understand microwave generation

Syllabus

UNIT I **(15 hrs)**

Modulation and Detection

Need for modulation – modulation index - Principles of AM and FM with circuit diagrams – Comparison of DSB, SSB, DSBSC and VSB transmission – multichannel communications (FDM, TDM) – AM detection – Frequency Discriminator - Ratio detector.

UNIT II **(15 hrs)**

Antennas and Wave propagation

Elementary doublet - terms and definitions in connection with antennas - effect of ground on antennas – effect of antenna height - antenna coupling at medium frequencies - antenna arrays :Yagi Uda antenna - broad side array - end fire array - Wide band and special purpose antennas : Helical antenna, Discone antenna and phased arrays – Ground wave propagation - Sky wave propagation - Line of sight.

UNIT III **(15 hrs)**

Television and Satellite communication

Black and white TV: Transmission – reception – Color TV: Transmission - Reception - Introduction – Satellite Orbit – Satellite Position – Up link – Down Link – Cross Link – Assignable Satellite Frequencies - Transponder – Antenna System – Power Package and Station Keeping – Forms of Modulation–Free Path Space Losses–Ground Station– Aligning the Satellite Dish.

UNIT IV **(15 hrs)**

Mobile Communication

Overview of Wireless communication systems - Multiplexing (Space division multiplexing, Frequency division multiplexing, Time division multiplexing - Code division multiplexing) - Modulation (Amplitude shift keying, Frequency shift keying, Phase shift keying, Advanced frequency shift keying) - Spread spectrum (Direct sequence spread spectrum, Frequency hopping spread spectrum) - Medium access control*

UNIT V **(15 hrs)**

Microwaves

Microwave generation – Multicavity Klystron - Reflex Klystron – Magnetron, TWT – Cross field amplifier – Backward wave oscillator - Microwave integrated circuits – Parametric amplifiers – Tunnel diode – Gunn diode.

* **Self study**

Teaching Methods: Smart Class Room / Power point presentation / Seminar / Quiz /Discussion / Flipped Class / Peer Learning / Experiential Learning / Blended Learning

Text Books:

1. George Kennedy Davis, (2011), Electronic Communication systems-Tata McGraw Hill,India.
2. Anokh Singh, A.K.Chhabra, (1999), Principles of Communication Engineering -S.Chand & Co., New Delhi.
3. Jochen H. Schiller, (2004), Mobile Communication, Pearson Education.

Reference Books:

1. F.E. Terman, (1992), Electronics and Radio Engineering - McGraw Hill, India.
2. Simon Haykin, (2010), Communication Systems - John Wiley & Sons, India.

e-Resources:

1. https://www.youtube.com/watch?v=Q-9VkiR_RE0
2. https://www.youtube.com/watch?v=fSoXIqBlg9M
3. https://www.youtube.com/watch?v=XlUx9xDJqeg
4. https://www.youtube.com/watch?v=qhjj6WG7Rgc
5. https://www.youtube.com/watch?v=ZbNItCNZK3s

Mapping

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	S	H	H	S	H
CO 2	H	S	S	H	S
CO 3	S	H	S	S	H
CO 4	S	H	S	H	H
CO 5	S	H	H	S	H

S- Strong **H-High** **M-Medium** **L – Low**

Programme code : 03	M.Sc. Physics			
Title of the Paper	Major Elective Paper – Problems in Physics I			
Batch 2025-2026	Hours/Week 5	Total Hours 75	Credits 5	Skill Development

Course Objectives

To enable the learners to

1. Acquire knowledge and skills to solve problem through the concept behind physics
2. Apply creative thinking techniques towards realistic problem
3. Visualize the basic concepts clearly

Course Outcomes (CO)

On successful completion of the course, the students will be able to

K1 to K5	CO1	Understand and solve problems in mathematical methods in physics
	CO2	Understand and solve problems in experimental techniques and data analysis
	CO3	Understand and solve problems in atomic and molecular physics
	CO4	Understand and solve problems in condensed matter physics
	CO 5	Understand and solve problems in nuclear and particle physics

Syllabus

UNIT I **(15 hrs)**

Basic mathematical methods

Vector Algebra - gradient, divergence and Curl - Vector calculus- Integral Calculus -Green's theorem- Stoke's theorem - Matrices and its rank - Cauchy -Riemann equation - Cauchy residue theorem -Fourier series- Partial differential equations.

Objective type questions (Problem no. 1-100, page no. 38P-46P), Descriptive type questions (Problem no. 1-15, page no.101P-108P)

UNIT II **(15 hrs)**

Experimental techniques and data analysis

Error analysis – Curve fitting: Graphical method, method of least squares – Transducers (Temperature, pressure/vacuum, magnetic fields, vibration, optical and particle detectors) – Measurement and control – Filters.

Objective type questions (Problem no. 1-100, page no. 717P-726P), Descriptive type questions (Problem no. 1-15, page no.741P-747P)

UNIT III **(15 hrs)**

Atomic and molecular physics

Quantum states of an electron in an atom – Electron spin – Spectrum of helium and alkali atom – Relativistic corrections for energy levels of hydrogen atom – Hyperfine structure and isotopic shift – Width of spectrum lines – LS coupling – Zeeman and Stark effect.

Objective type questions (Problem no. 1-100, page no. 771P-778P), Descriptive type questions (Problem no. 1-15, page no.797P-802P)

Unit – IV **(15 hrs)**

Condensed matter physics

Bravais lattices – Reciprocal lattice – Diffraction and structure factor – Bonding of solids – Elastic properties – Phonons – lattice specific heat – Free electron theory - Drude model of electrical and thermal conductivity – Hall effect and thermo electric power – Electron motion in a periodic potential – Band theory of solids.

Objective type questions (Problem no. 1-100, page no. 867P-874P), Descriptive type questions (Problem no. 1-10, page no.907P-912P)

Unit – V **(15 hrs)**

Nuclear and particle physics

Basic nuclear properties – Binding energy – Semi empirical mass formula – Liquid drop model – Nuclear force – Deuteron problem – Shell model – Rotational spectra – Alpha, beta and gamma decay – Nuclear fission and fusion – Nuclear reaction, reaction mechanism, compound nuclei and direct reactions.

Objective type questions (Problem no. 1-100, page no. 964P-972P), Descriptive type questions (Problem no. 1-15, page no.986P-991P)

Text Books:

1. Dr.Surekha Tomar, (2017), CSIR-UGC NET/JRF/SET Physical Science - Upkar Prakashan, Agra, India

Reference Books:

1. Jain K.C.Arora, (2013), Numerical Problems in Physics - S.Chand & Co., New Delhi.
2. Bukhovtsev.B.Krivchenkov, (2012), Problems in Elementary Physics - CBS Publishers and distributors Pvt. Ltd., New Delhi.

e-Resources:

1. https://youtu.be/9pbaaiAWrfI
2. https://youtu.be/GZGxqjj37tY
3. https://youtu.be/SCmtEhGVhSM
4. https://youtu.be/_Ckh-60B6LY
5. https://youtu.be/josqjcH79PE

Mapping

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	S	H	H	S	H
CO 2	H	S	S	H	S
CO 3	S	H	S	S	H
CO 4	S	H	S	H	H
CO 5	H	S	S	H	S

S- Strong **H-High** **M-Medium** **L - Low**

Programme code : 03	M.Sc. Physics			
Title of the Paper	Major Elective Paper – Semiconductor Devices			
Batch 2025-2026	Hours/Week 5	Total Hours 75	Credits 5	Employability

Course Objectives

To enable the learners to

1. Impart knowledge on application of semiconducting materials
2. Understand the photolithography and etching processes
3. Impart knowledge on IC manufacturing

Course Outcomes (CO)

On successful completion of the course, the students will be able to

K1 to K5	CO1	Understand silicon oxidation process
	CO2	Understand photolithography
	CO3	Gain knowledge on different etching processes
	CO4	Know about ion implantation
	CO 5	Acquire knowledge on production of ICs

Syllabus

UNIT I

Silicon Oxidation **(15 hrs)**

Thermal oxidation process – kinetics of growth – thin oxide growth – impurity redistribution during oxidation – masking properties of silicon dioxide – oxide quality – oxide thickness characterization – oxidation simulation**.**

UNIT II **(15 hrs)**

Photolithography

Optical lithography – the clean room – exposure tools – masks – photoresist – pattern transfer – resolution enhancement techniques – electron beam lithography – extreme ultraviolet lithography – x-ray lithography – ion beam lithography – **comparison of various lithographic techniques***.

UNIT III **(15 hrs)**

Etching

Wet chemical etching: silicon etching – silicon dioxide etching – silicon nitride and polysilicon etching – aluminum etching – GaAs etching – dry etching: reactive plasma etching techniques and equipment – reactive plasma etching applications – etch simulation.

UNIT IV **(15 hrs)**

Ion implantation

Range of implanted ions – ion distribution – ion stopping – ion channeling – implant damage and annealing – multiple implantation and masking – tilt-angle ion implantation – high energy and high current implantation – ion implantation simulation.

UNIT V **(15 hrs)**

Process integration and IC manufacturing

Process integration: integrated circuit resistor – integrated circuit capacitor – integrated circuit inductor – IC manufacturing: electrical testing – packaging – statistical process control – statistical experimental design – yield – **computer integrated manufacturing***.

*** Self study**

Teaching Methods: Smart Class Room / Power point presentation / Seminar / Quiz /Discussion / Flipped Class / Peer Learning / Experiential Learning / Blended Learning

Text Books:

1. Fundamentals of semiconductor fabrication (2003), Gary. S. May, S. M. Sze , J o h n Wiley & Sons.
2. An Introduction to Solid State Physics (1974) R.J.Elliot and A.P.Gibson, Barnes & Noble, New York.
3. A textbook of applied physics (2015), A. K. Jha, IK International Publishing House Pvt. Ltd.

Reference Books:

1. Modern Semiconductor Physics and Device Applications (2021), Vitalii Dugaev, Vladimir Litvinov, CRC Press.
2. Semiconductor nanocrystals and metal nanoparticles: Physical properties and device applications (2017), Tupei Chen, Yang Liu, CRC Press.

e-Resources:

1. https://www.youtube.com/watch?v=JmPDAf4oTLQ
2. https://www.youtube.com/watch?v=udXHWVejDj0
3. https://www.youtube.com/watch?v=-SfizD6kcg8
4. https://www.youtube.com/watch?v=GCMtRJnMvH8
5. https://www.youtube.com/watch?v=cIlwGFcDLhI

Mapping

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	S	H	H	S	H
CO 2	H	S	S	H	S
CO 3	S	H	S	S	H
CO 4	S	H	S	H	H
CO 5	H	S	S	H	S

S- Strong **H-High** **M-Medium** **L - Low**

Programme: 03		M.Sc. Physics		
Title of the Paper		Major Elective Paper - Energy Physics		
Batch 2025-2026	Hours/Week 5	Total Hours 75	Credits 5	Entrepreneurship

Course Objectives

To enable the learners to

1. Know about Solar thermal and photovoltaic energy
2. Understand hydrogen energy, wind energy and ocean thermal energy
3. Understand energy auditing and carbon credits.

Course Outcomes (CO)

On successful completion of the course, the students will be able to

K1 to K5	CO1	Understand Solar thermal energy
	CO2	Gain knowledge on solar photovoltaic energy
	CO3	Understand wind and ocean thermal energy
	CO4	Know about Hydrogen energy and Fuel cells
	CO5	Understand energy auditing and carbon credits

Syllabus

UNIT I **(15 hrs)**

Solar thermal energy

Solar radiation : solar constant - solar radiation at the earth surface - physical principles of conversion of solar radiation into heat – Solar energy collectors : flat plate collectors - concentrating collector - parabolic reflectors and mirror - strip reflector - advantages and disadvantages of concentrating collectors over flat plate collectors - solar energy storage - solar pond - principle of operation and description of non-convective solar pond - **applications of solar ponds***.

UNIT II **(15 hrs)**

Solar photovoltaic energy

Fundamentals of photovoltaic conversion - semiconductor materials - photon energy - electron hole concentration - Fermi level – pn junction – light absorption in a semiconductor - solar cell materials - efficiency of solar cells - silicon solar cell - polycrystalline and amorphous silicon cells - photovoltaic applications.

UNIT III **(15 hrs)**

Wind and Ocean thermal energy

Wind energy

Basic principles of wind energy conversion – nature and power of wind - forces on the blades and thrust on turbines - wind energy conversions (WEC) - site selection conservations - basic components of the wind energy conversion system - classification of WEC systems - advantages and disadvantages of WECs - energy storage - applications of wind energy.

Ocean thermal energy

Ocean thermal energy conversion (OTEC) – methods of ocean thermal electric power generation - open cycle OTEC system - heat exchangers - bio-fouling – site selection – energyutilization - hybrid Cycle.

UNIT IV **(15 hrs)**

Hydrogen energy and Fuel cells

Hydrogen energy

Hydrogen production - electrolysis or electrolytic production of hydrogen - solar energy methods - biophotolysis and photoelectrolysis - hydrogen storage - hydrogen transformation - utilization of hydrogen gas - electric power generation - hydrogen in fuel cells - hydrogen as analternative fuel for motor vehicles - safety and management.

Fuel Cells

Principle of operation - classification -hydrogen fuel cells - Advantages and disadvantages of fuel cells - applications of fuel cells.

Unit V **(15 hrs)**

Energy Auditing and Carbon Credit

Economic concept of energy – Principles of Energy conservation and Energy Audit - types of energy Audits – **Global Climate change - Greenhouse effect*** – Emissions from Combustion of Natural gas - Emission trading - carbon credits – carbon currency – carbon credits under Kyoto Protocol - Trading of Carbon Credits and India's perspectives – Implementing of CDM projects in India - Potential CDM projects in India.

***Self-study**

Teaching Methods: Smart Class Room / Power point presentation / Seminar / Quiz /Discussion / Flipped Class / Peer Learning / Experiential Learning / Blended Learning

Text Books:

1. H.P.Garg, J. Prakash, (2016), Solar energy fundamentals and applications-McGraw Hill,India.
2. G.D.Rai, (2017), Non-Conventional Energy Sources - Khanna Publishers, New Delhi.

Reference Books:

1. Fahrebruch, Bube, (2012), Fundamentals of solar cells- Academic Press Inc. New York
2. Winter, Nitch, (2012), Hydrogen as an Energy Carrier- Springer, India.
3. Albert Thumann, (1984), Fundamentals of Energy Engineering - Fairmont Press Inc.

E-Resources:

1. https://nptel.ac.in/courses/103103206
2. https://youtu.be/VdYtTWOQrNs
3. https://youtu.be/DD0Y6Snxpdk
4. https://youtu.be/L2VSOccUrSk
5. https://youtu.be/CNgVv2bBj00

Mapping

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	S	H	H	S	H
CO 2	H	S	S	H	S
CO 3	S	H	S	S	H
CO 4	S	H	S	H	H
CO 5	H	S	H	S	S

S- Strong **H-High** **M-Medium** **L - Low**

Programme code : 03	M.Sc. Physics			
Title of the Paper	Major Elective Paper – Photovoltaic Science			
Batch 2025-2026	Hours/Week 5	Total Hours 75	Credits 5	Entrepreneurship

Course Objectives

To enable the learners to

1. Understand the science behind photovoltaics
2. Understand he classification of solar cells
3. Understand the characterization of silicon and dye sensitized solar cells

Course Outcomes (CO)

On successful completion of the course, the students will be able to

K1 to K5	CO1	Explain Photovoltaic and solar cell
	CO2	Understand the basics about semiconductors
	CO3	Classify amorphous silicon solar cell
	CO4	Know about construction and working of solar cells and Thin film fabrication methods.
	CO 5	Know about preparation and mechanism of dye sensitized solar cell.

Syllabus

UNIT I **(15 hrs)**

Photovoltaics

Properties of irradiance-Photons- Solar irradiance- Reflection, refraction and transmission- Properties of Semiconductors: Crystal structure-Energy band structure Conduction and valence band density of states – Equilibrium carrier concentrations – Light absorption –Recombination –Carrier transport – Semiconductor equations-Minority carrier diffusion equation –PN – Junction Diode Electrostatics

UNIT II **(15 hrs)**

Physics of solar cells

Solar cell boundary conditions – Generation rate – Solution of the minority carrier diffusion - Terminal characteristics – Solar cell I to V characteristics – Properties of efficient solar cell – Lifetime and surface recombination effects.

UNIT III **(15 hrs)**

Amorphous Silicon Solar Cell

Amorphous silicon: The first bipolar amorphous semiconductor – Designs for amorphous silicon solar cells – Staebler–Wronski Effect –Atomic and Electronic Structure of Hydrogenated. Depositing Amorphous Silicon : Deposition Techniques – RF glow discharge deposition- Glow discharge deposition at different frequencies – Hot wire chemical vapor deposition.

UNIT IV **(15 hrs)**

Cadmium Telluride solar cell

CdTe Properties and Thin – Film Fabrication Methods-Condensation/Reaction of Cd and Te_2 Vapors on a Surface – Galvanic Reduction of Cd and TeI on Surface - Precursor Reaction at a Surface-Window Layers – CdTe Absorber Layer and $CdCl_2$ Treatment - CdS/CdTe Intermixing- Back Contact- Solar Cell Characterization – CdTe modules.3

UNIT V

Dye sensitized solar cells **(15 hrs)**

Operating mechanism of dye-sensitized solar cell – Materials – Performance of highly efficient DSSCs – Electron transfer processes: Electron Injection from Dye to Metal Oxide - Electron Transport in Nanoporous Electrode - Kinetic Competition of the Reduction of Dye Cation - **Charge Recombination between Electron and I^-_3 Ion *.**

*** Self study**

Teaching Methods: Smart Class Room / Power point presentation / Seminar / Quiz /Discussion / Flipped Class / Peer Learning / Experiential Learning / Blended Learning

Text Book:

1. Antonio Luque, Steven Hegedus. 2012. Hand book of Photovoltaic Science and Engineering. [2nd Edition] Wiley, New York.
2. Angele reinders, Pierre Verlinden, Wilfriedvansark. 2017. Photovoltaic Solar Energy. [3rd Edition] Wiley, New York.

Reference Book:

1. Brabec C J, ParisiJ, Dyakonov V, Sariciftci N S. 2003. Organic Photovoltaics. [3rdEdition]. Springer, German.
2. John Twidell, Tony Weir,. 2006. Renewable Energy Resources. [2ndEdition]. Taylor &Francis Group.
3. Kothari. 2014 . Renewable Energy Source and Emerging Technologies. [2ndEdition]. Prentice Hall.

e-Resources:

1. https://youtu.be/5zAQot4pKgU
2. https://youtu.be/k-IJ7ulxWe4https://archive.nptel.ac.in/courses/113/104/113104084/
3. http://www.digimat.in/nptel/courses/video/113104084/L22
4. https://www.digimat.in/nptel/courses/video/117108141/L01

Mapping

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	S	H	H	S	H
CO 2	H	S	S	H	S
CO 3	S	H	S	S	H
CO 4	S	H	S	H	H
CO 5	H	S	S	H	S

S- Strong **H-High** **M-Medium** **L – Low**

Programme code : 03	M.Sc. Physics			
Title of the Paper	Major Elective Paper – Artificial Intelligence in Physics			
Batch 2025-2026	Hours/Week 5	Total Hours 75	Credits 5	Skill Development

Course Objectives

To enable the learners to know about the

1. Mechanics of Machine learning
2. Algorithms and Statistical Model
3. AI for Particle Physics, Cosmology and Condensed Matter Physics.

Course outcomes (CO)

On successful completion of the course, the students will be able to

K1 to K5	CO1	Know about Machine Learning Physics
	CO2	n knowledge about Algorithms and Statistical Model
	CO3	Acquire knowledge about AI for Particle Physics
	CO4	Acquire knowledge about AI for Cosmology
	CO5	Acquire knowledge about AI for Condensed Matter Physics

Syllabus

Unit I **(15 hrs)**

Machine Learning (ML) Physics

AI and Machine Learning - Machine Learning Physics – Impact of Physics on machine learning: Statistical Physics of ML – Analog Computers – Quantum Computers – Machine learning the physical world from subatomic to cosmic scales

Unit II **(15 hrs)**

Algorithms and Statistical Model

Introduction – Classification Versus Regression – Simple Mapping – Complex Mapping – Decision Trees – Artificial Neural Networks – Bayesian Interference – Symbolic Regression – Autoencoders – Restricted Boltzmann Machine

Unit III **(15 hrs)**

AI for Particle Physics

The Standard Model – Open Problems - Theories beyond SM – Machine learning Particle Physics – Cut based Event Selection in a Particle Physics Experiment – Particle and Event Selection with Neutral Networks and Boosted Decision Trees – Machine Learning for jet Physics – Convolutional Neural Networks for Neutrino Experiments.

Unit IV **(15 hrs)**

AI for Cosmology

The Concordance model of Cosmology – Machine Learning big data and Global Shape of the Universe – Machine Learning New Physics Versus Instrumental Effects – Machine Learning Photometric Red Shift – Machine Learning Cosmic Structure – Distortion Probes Gravitation: Interstellar Lensing – Machine Learning Gravitational Waves.

Unit V **(15 hrs)**

AI for Condensed Matter Physics

Machine Learning to Overcome Sampling Problem for Spin Glasses – Machine Learning Toplogical Order Transition – Machine Learning Quantum Many-Body Systems – Machine Learning Quantum Tomography – **Machine Learning based Design of New Materials and Quantum States***.

*** Self study**

Teaching Methods: Smart Class Room / Power point presentation / Seminar / Quiz /Discussion / Flipped Class / Peer Learning / Experiential Learning / Blended Learning

Text Books:

1. AI for Physics, Volker Knecht, CRC Press (2023)
2. AI meets Physics: a comprehensive survey, Jiao, L., Song, X., You, C, Artificial Intelligence Review 57, 256 (2024)

Reference Books:

1. Artificial Intelligence for High Energy Physics, Paolo Calafiura, David Rousseau and Kazuhiro Terao, World Scientific Connect (2022)
2. Machine Learning for Engineers, Introduction to Physics-Informed, Explainable Learning Methods for AI in Engineering Applications, Marcus J. Neuer, Springer (2025)
3. Physics of Artificial Intelligence, Achint Kumar, Self Publisher (2024)

e-Resources:

1. https://physicsbaseddeeplearning.org/intro.html
2. https://www.thebrighterside.news/post/science-textbooks-come-alive-via-new-interactive-ai-technology/

Mapping

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	S	H	S	H	H
CO 2	S	H	H	S	S
CO 3	H	S	S	S	H
CO 4	S	H	H	H	S
CO 5	H	S	H	S	H

S- Strong H-High M-Medium L - Low

Programme code: 03		M.Sc. Physics			
Title of the Paper		Major Elective Paper – Computational Methods and Programming			
Batch 2025-2026	Semester 1 / 2	Hours/Week 5	Total Hours 75	Credits 5	Employability

Course Objectives

To enable the learners to

1. Understanding zeros of linear & simultaneous equations, curve fitting, interpolating methods.
2. Understanding finding eigenvalues, integration of functions, ordinary and partial differential equations.
3. Writing programs using python for the numerical methods.

Course Outcomes (CO)

On successful completion of the course, the students will be able to

K1 to K5	CO1	Find roots of different types of equations
	CO2	Understand experimental data, its behavior, various interpolating techniques
	CO3	Obtain the eigenvalues of matrices and understand techniques to evaluate integrals.
	CO4	Solve initial value and boundary value problems of ordinary and partial differentials - applicability in physics
	CO5	Exposure to write scientific programming using python and apply for various techniques studied

Syllabus

UNIT I **(15 hrs)**

Roots of equation – Simultaneous equations

Roots of equation: Bisection method – False position method – Newton Raphson method – Secant method – Order of convergence

Simultaneous Equations: Existence of solutions- Basic Gauss elimination method – Gauss elimination with partial pivoting – Gauss Jacobi iteration method – Gauss Seidal iteration method – Inversion of a matrix using Gauss elimination method – LU decomposition.

UNIT II **(15 hrs)**

Curve fitting – Interpolation

Curve fitting: Method of least squares – straight line, parabola, $y = ax^n$, $y = ae^{bx}$, $y = a+bx^n$ type curves – sum of squares of residuals for straight line and parabola fit – Weighted least squares approximation – Method of least squares for continuous functions

Interpolation: Polynomial Interpolation – Lagrange polynomial – Newton polynomial - Forward and Backward differences – Gregory Newton forward and backward interpolation formula for equal intervals – Divided difference – properties of divided differences – Newton's divided differences formula – Lagrange's interpolation formula for unequal interval – Linear spline – Quadratic spline interpolation

UNIT III **(15 hrs)**

Eigenvalues – Integration

Eigenvalues: Power method to find dominant Eigenvalue - Jacobi method

Integration: Newton – cotes formula – Trapezoidal rule, Simpson's rule, Simpson's 3/8 rule, Boole's rule – Error estimates in trapezoidal and Simpson's rule – Gauss quadrature - Adaptive quadrature – Romberg Integration

Unit – IV **(15 hrs)**

Differential Equations

Ordinary differential equation: Solution by Taylor's series – Picard's method for successive approximation - Basic Euler method – Improved Euler method – Modified Euler method – RungeKutta fourth order method – RK4 method for simultaneous first order differential equation - RK4 Method for second order differential equation

Partial differential equation: Classification of partial differential equation of the 2nd order - Difference quotients – Graphical representations of partial quotients – standard and diagonal five-point formula for Laplace equations – solution of Laplace's equation (Liebman's iteration) – Parabolic equations – Bender Schmidt recurrence relation - Crank Nicolson formula - Hyperbolic equations – three level schemes.

Unit – V **(15 hrs)**

Python Programming and applications to Numerical methods

Bisection and Newton – Raphson's method of finding roots of the equation, Newton forward and backward interpolation formulae – solution of ordinary differential equation by Euler method and Runge - Kutta second and fourth order methods – Evaluation of integral by means of Trapezoidal and Simpson's one third rule.

*** Self study**

Teaching Methods: Smart Class Room / Power point presentation / Seminar / Quiz /Discussion / Flipped Class / Peer Learning / Experiential Learning / Blended Learning

Text Books:

1. Numerical methods for mathematics, science and engineering, John H. Matthews, Prentice Hall of India, 2nd Edition, (2000)
2. Introductory methods of numerical analysis, S. S. Shastry, Prentice Hall of India, (2010)
3. Scientific computing in python, Abhijit Kar Gupta, Techno World, (2018)

Reference Books:

1. Numerical Mathematical Analysis, J. B. Scarborough, Oxford Publishing, 6th Edition, (1990)
2. Computer Applications in Physics, S. Chandra, M.K. Sharma, Narosa, 3rd Edition, (2014)

e-Resources:

1. https://ocw.mit.edu/courses/mathematics/18-335j-introduction-to-numerical-methods-spring-2019/
2. https://www.coursera.org/learn/intro-to-numerical-analysis
3. https://onlinecourses.nptel.ac.in/noc19_ma21/preview
4. https://onlinecourses.nptel.ac.in/noc20_ge20/preview
5. https://archive.nptel.ac.in/courses/111/101/111101165/#

Mapping

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	S	H	H	S	H
CO 2	H	S	S	H	S
CO 3	S	H	S	S	H
CO 4	S	H	S	H	H
CO 5	H	S	S	H	S

S- Strong H-High M-Medium L – Low

NON-MAJOR ELECTIVE PAPERS

(2 papers are to be chosen from the following 4 papers)

1. Nanotechnology: Principles and Applications

2. Intellectual Property Rights

3. Research Ethics

4. Information Security

Programme: 03	M.Sc. Physics			
Title of the Paper	Non Major Elective Paper – Nanotechnology : Principles and Applications			
Batch 2025-2026	Hours/Week 4	Total Hours 60	Credits 4	Entrepreneurship

Course Objectives

To enable the learners to

1. Understand the concepts in nanomaterials
2. know about different synthesis processes of nanomaterials
3. know about characterization techniques and applications of nanomaterials

Course Outcomes (CO)

On successful completion of the course, the students will be able to

K1 to K5	CO1	Understand the concepts in nanomaterials
	CO2	Know the synthesis methods of 0-D, 1-D, 2-D and 3-D nanomaterials
	CO3	Know the various characterization methods
	CO4	Gain knowledge on properties of nanomaterials
	CO5	Understand the applications of nanomaterials

Syllabus

UNIT I **12 hrs**

Concepts in Nanomaterials

Classification of nanomaterials – Quantum confinement in semiconductor nanostructures: quantum well, quantum wires and quantum dots - Electronic density of states - Surface to volume ratio versus shape - quantum Hall effect - Resonant tunneling – Inter band and Intra band absorption in semiconductor nanostructures - Light emission processes in nanostructures
- phonon bottleneck in quantum dots.

UNIT II **12 hrs**

Synthesis of Nanoscale materials and structures

Methods of making 0-D Nanomaterials: Inert gas condensation - Inert gas expansion - Sonochemical processing - Spray pyrolysis - Sol-gel deposition and molecular self-assembly - Methods of making 1-D and 2-D Nanomaterials: Foil beating – Electrodeposition – Physical Vapor Deposition (PVD) – Chemical Vapor Deposition (CVD) -Methods of making 3-D Nanomaterials: Top down processes: Milling and mechanical alloying - Methods of nanoprofiling -Micromachining – **Photolithography*.**

UNIT III **12 hrs**

Characterization of Nanomaterials

X- ray Diffraction - UV-Vis Spectrophotometer - Scanning Electron Microscope – Transmission Electron Microscope, HR-TEM – Atomic Force Microscope – Scanning Tunneling Microscope – Laser Raman Spectrometer – x ray Photoelectron Spectroscopy.

UNIT IV **12 hrs**

Properties of Nanomaterials

Mechanical properties of nanostructured materials: nanodispersions - nanocrystalline solids - Thermal properties: melting point, thermal transport - Electrical properties – Magnetic properties: GMR - Optical properties - Surface plasmon resonance - photocatalytic properties.

UNIT V **12 hrs**

Applications of Nanotechnology

Biosensors: Silicon nanowire biosensor, Cantilever biosensor - drug delivery - photovoltaics: dye sensitized solar cell - quantum dot sensitized solar cell – nanocatalysis – QDLED display - batteries – supercapacitors.

*** Self Study**

Teaching Methods: Smart Class Room / Power point presentation / Seminar / Quiz /Discussion / Flipped Class / Peer Learning / Experiential Learning / Blended Learning

Text Books:

1. Micheal F. Ashby, Paulo J. Ferreira, Daniel L. Schodek, (2009), Nanomaterials, Nanotechnologies and An Introduction for engineers and Design Architects- Elsevier Science, USA
2. Robert Kelsall, Ian Hamley, Mark Geoghegan, (2005), Nanoscale Science andTechnology - John Wiley & Sons, UK.

Reference Books:

1. Guozhong Cao, (2004), Nanostructures and Nanomaterials: Synthesis, Propertiesand Applications-Imperial College Press, UK.
2. Masuo Hosokawa, Kiyoshi Nogi, Makio Naito, Toyokazu Yokoyama,(2008), Nanoparticle Technology Handbook - Elsevier Science, UK.
3. Hari Singh Nalwa, (2000), Handbook of Nanostructured Materials and Nanotechnology - Academic Press, USA.

e-Resources:

1. https://youtu.be/ayHfS_RCGaw
2. https://youtu.be/Z51R49OOqAA
3. https://youtu.be/RNpP-PUBno8
4. https://www.youtube.com/watch?v=YZnGnvn3qrM
5. https://www.youtube.com/watch?v=kQ6CY1qpGjY&t=385s

Mapping

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	S	H	H	S	H
CO 2	H	S	S	H	S
CO 3	S	H	S	S	H
CO 4	S	H	S	H	H
CO 5	H	S	S	H	S

S- Strong H-High M-Medium L – Low

Programme code : 03	M.Sc. Physics			
Title of the Paper	Non Major Elective Paper - Intellectual Property Rights			
Batch 2025-2026	Hours/Week 4	Total Hours 60	Credits 4	Entrepreneurship

Course Objectives

To enable the learners to

1. Understand the aspects of Intellectual Property Rights
2. Know about Patents, Copyrights, Trademarks and Registration aspects
3. Know about Design and Geographical Indication of IPR

Course outcomes (CO)

On successful completion of the course, the students will be able to

K1 to K5	CO1	Acquire knowledge about Intellectual Property Rights
	CO2	Understand about patents and patent registration
	CO3	Acquire knowledge on copyrights and registration
	CO4	Gain knowledge on trademarks and registration
	CO5	Understand the design and geographical indication of IPR

Syllabus

UNIT I **(12 hrs)**

Overview of Intellectual Property

Introduction and the need for intellectual property right (IPR) - Kinds of Intellectual Property Rights: Patent, Copyright, Trade Mark, Design, Geographical Indication, Plant Varieties and Layout Design – Genetic Resources and Traditional Knowledge – Trade Secret - IPR in India : Genesis and development – IPR in abroad.

UNIT II **(12 hrs)**

Patents

Patents - Elements of Patentability: Novelty , Non Obviousness (Inventive Steps), Industrial Application - Non - Patentable Subject Matter - Registration Procedure, Rights and Duties of Patentee, Assignment and license , Restoration of lapsed Patents, Surrender and Revocation of Patents, Infringement, Remedies & Penalties- Patent office and Appellate Board

UNIT – III **(12 hrs)**

Copyrights

Nature of Copyright - Subject matter of copyright: original literary, dramatic, musical, artistic works; cinematograph films and sound recordings - Registration Procedure, Term of protection, Ownership of copyright, Assignment and license of copyright - Infringement, Remedies & Penalties – Related Rights - Distinction between related rights and copyrights.

UNIT - IV **(12 hrs)**

Trademarks

Concept of Trademarks - Different kinds of marks (brand names, logos, signatures, symbols, well known marks, certification marks and service marks) - Non Registrable Trademarks - Registration of Trademarks - Rights of holder and assignment and licensing of marks - Infringement, Remedies & Penalties - **Trademarks registry and appellate board*.**

UNIT – V **(12 hrs)**

Design and Geographical Indication

Design: meaning and concept of novel and original - Procedure for registration, effect of registration and term of protection Geographical Indication (GI).

Geographical indication: meaning, and difference between GI and trademarks - Procedure for registration, effect of registration and term of protection.

*** Self study**

Teaching Methods: Smart Class Room / Power point presentation / Seminar / Quiz /Discussion / Flipped Class / Peer Learning / Experiential Learning / Blended Learning

Text Books:

1. Nithyananda, K V. (2019). Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited.
2. Neeraj, P., & Khusdeep, D. (2014). Intellectual Property Rights. India, IN: PHI learningPrivate Limited.

Reference Books:

1. Ahuja, V K. (2017). Law relating to Intellectual Property Rights. India, IN: Lexis Nexis.

e-Resources:

1. Cell for IPR Promotion and Management (http://cipam.gov.in/)
2. World Intellectual Property Organisation (https://www.wipo.int/about-ip/en/)
3. Office of the Controller General of Patents, Designs & Trademarks (http://www.ipindia.nic.in/)
4. https://nptel.ac.in/courses/110/106/110106081/
5. https://youtu.be/TaDfxrTo0HE

Mapping

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	S	H	H	S	H
CO 2	H	S	S	H	S
CO 3	S	H	S	S	H
CO 4	S	H	S	H	H
CO 5	H	S	S	H	S

S- Strong H-High M-Medium L – Low

Programme Code : 03	M.Sc. Physics			
Title of the Paper	Non Major Elective Paper - Research Ethics			
Batch 2025-2026	Hours/Week 4	Total Hours 60	Credits 4	Skill Development

Course Objectives

To enable the learners

1. To understand the philosophy of science and ethics,
2. To know about research integrity and publication ethics.
3. To understand indexing, citation databases and the usage of plagiarism tools.
4. At the end of the course the student will have awareness about the publication ethics and publication misconducts

Course Outcomes (CO)

On successful completion of the course, the students will be able to

K1 - K5	CO1	Understand the philosophy of science and ethics, research integrity and publication ethics
	CO2	Identify research misconduct and predatory publications
	CO3	Know about indexing and citation databases, open access publications, research metrics (citations, h-index, impact Factor, etc.)
	CO4	Understand the usage of plagiarism tools
	CO5	Gain knowledge on the publication ethics and publication misconducts

Syllabus

Unit I **(12 hrs)**

Philosophy and Ethics

Introduction to philosophy: definition, nature and scope, concept, branches - Ethics: definition, moral philosophy, nature of moral judgements and reactions.

Unit II **(12 hrs)**

Scientific Conduct

Ethics with respect to science and research - Intellectual honesty and research integrity - Scientific misconducts: Falsification, Fabrication and Plagiarism (FFP) - Redundant Publications: duplicate and overlapping publications, salami slicing - Selective reporting and misrepresentation of data.

Unit III **(12 hrs)**

Publication Ethics

Publication ethics: definition, introduction and importance - Best practices / standards setting initiatives and guidelines: COPE, WAME, etc. - Conflicts of interest - Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa, types - Violation of publication ethics, authorship and contributor ship - Identification of publication misconduct, complaints and appeals - Predatory publisher and journals.

Unit IV **(12 hrs)**

Open Access Publishing and Plagiarism tools

Open access publications and initiatives - SHERPA/RoMEO online resource to check publisher copyright & self-archiving policies - Software tool to identify predatory publications developed by SPPU - Journal finger / journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer, Journal Suggester, etc. Use of plagiarism software like Turnitin, Urkund and other open source software tools.

Unit V **(12 hrs)**

Databases and Research Metrics

Databases: Indexing databases, Citation databases: Web of Science, Scopus, etc. Research Metrics: Impact Factor of journal as per Journal Citations Report, SNIP, SJR, IPP, CiteScore - **Metrics: h-index, g index, i10 Index, altmetrics*.**

*** Self study**

Teaching Methods: Smart Class Room / Power point presentation / Seminar / Quiz /Discussion / Flipped Class / Peer Learning / Experiential Learning / Blended Learning

Text Books:

1. Nicholas H. Steneck. Introduction to the Responsible Conduct of Research. Office of Research Integrity. 2007. Available at: https://ori.hhs.gov/sites/default/files/rcrintro.pdf
2. The Student's Guide to Research Ethics by Paul Oliver Open University Press, 2003

Reference Books:

1. Responsible Conduct of Research by Adil E. Shamoo; David B. Resnik Oxford University Press, 2003
2. Ethics in Science Education, Research and Governance Edited by Kambadur Muralidhar, Amit Ghosh Ashok Kumar Singhvi. Indian National Science Academy, 2019. ISBN: 978-81- 939482-1-7.
3. Anderson B.H., Dursaton, and Poole M.: Thesis and assignment writing, Wiley Eastern 1997.
4. Bijorn Gustavii: How to write and illustrate scientific papers? Cambridge University Press.
5. Bordens K.S. and Abbott, B.b.: Research Design and Methods, Mc Graw Hill, 2008.
6. Graziano, A., M., and Raulin, M.,L.: Research Methods – A Process of Inquiry, Sixth Edition, Pearson, 2007.

e- Resources:

1. https://youtu.be/LmMDIBENHhU (NPTEL)
2. https://youtu.be/AgRcZaqMPfc
3. https://youtu.be/6E-NrR8jANk
4. https://youtu.be/iXGbH2hRsUw

Mapping

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	S	H	H	S	H
CO 2	H	S	S	H	S
CO 3	S	H	S	S	H
CO 4	S	H	S	H	H
CO 5	H	S	S	H	S

S- Strong H-High M-Medium L – Low

Sub.Code: 25PGI4N2

Programme Code: 03		**M.Sc Physics**			
Title of the Paper		**Non-Major Elective Paper: Information Security**			
Batch 2025-2026	**Semester 4**	**Hours/Week 4**	**Total Hours 60**	**Credits 4**	**Skill Development**

Course Objectives

To enable the learners to

1. identify the core concepts of Information security.
2. examine the concepts of Information Security.
3. design and implement the security features for IT and Industrial sectors.

Course Outcomes (CO)

On successful completion of the course, the students will be able to

K1 – K5	CO1	Learn the principles and fundamentals of information security.
	CO2	Demonstrate the knowledge of Information security concepts
	CO3	Understand about Information Security Architecture.
	CO4	Analyze the various streams of security in IT and Industrial sector.
	CO5	Know about Cyber Laws and Regulations.

Syllabus

UNIT I **(12 hrs)**

Information Security basics: Definition of Information Security - History of Information Security - Characteristics of Information Security - Components of Information Security - Security System Development Life Cycle (SDLC). Information Security for technical administrators: Server Security – Network security- Social MediaSecurity.

UNIT II **(12 hrs)**

Cryptography: Basic concepts - plain text - Cipher text - Encryption Principles - CRYPT Analysis - Cryptographic Algorithms - Cryptographic Tools – Authentication -**Biometrics*** - passwords - Access Control Devices - Physical Security - Security and Personnel.

Language-based Security: Analysis of code for security errors, Safe language and sandboxing techniques.

UNIT III **(12 hrs)**

Firewalls, Viruses, Worms & Digital Rights Management : Viruses and Worms-Worms - Digital Rights Management – Firewalls - Application and Circuit Proxies - Stateful Inspection - Design Principles of Firewalls.

Logical Design: Access Control Devices- Physical Security-Security and Personnel - NIST Models- VISA International Security Model- Design of Security Architecture-Planning for Continuity.

UNIT IV **(12 hrs)**

Hacking : Introduction – Hacker Hierarchy – Password cracking – Phishing - Network Hacking - Wireless Hacking - Windows Hacking - **Web Hacking***- Ethical Hacking.

Security Investigation: Need for Security- Business Needs-Threats- Attacks- IP Addressing and Routing - Social Media.

Sub.Code: 25PGI4N2

UNIT V **(12 hrs)**

Cyber Laws: What is Cyber Law? - Need for Cyber laws - Common Cyber Crimes and Applicable Legal Provisions: A Snapshot - Cyber Law (IT Law) in India – The Information Technology Act of India 2000 - Cyber Law and Punishments in India - Cyber Crime Prevention guide to users – Regulatory Authorities.

***Self-study.**

Teaching Methods:

Smart Class Room / Power point presentation / Seminar / Quiz /Discussion / Flipped Class / Peer Learning / Experiential Learning / Blended Learning

Text Book:

1. 'Information Security' (2022), Textbook is prepared by Kongunadu Arts and Science College, Coimbatore.

Reference Books:

1. Charles P Pfleeger and Shai Lawrence Pfleeger, "Security in Computing", Fourth & ThirdEdition, Prentice Hall, 2007 & 2011.
2. Ross J. Anderson and Ross Anderson, "Security Engineering: A guide to buildingDependable Distributed System", Wiley,2009.
3. Thomas R. Peltier, Justin Peltier and John Bleckley, "Information Security Fundamentals",2nd Edition, Prentice Hall 1996.
4. Gettier, Urs E. Information Security: Strategies for Understanding and Reducing RisksJohn Wiley & Sons, 2011.
5. "Principles of information security". Michael Whiteman and Herbert J. Mattord,2012.
6. Information security -Marie wright and John kakalik,2007.
7. Information security Fundamentals- Thomas R. Peltier, Justin Peltier and John Blackley-2005.
8. Information Security theory and practical PHI publication, Dhiren R. Patel-2008.
9. Debby Russell and Sr.G.T. Gangemi," computer Security Basics,2nd edition, O'Reilly Media,2006.

Mapping

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	S	H	H	S	H
CO 2	H	S	S	H	S
CO 3	S	H	S	S	H
CO 4	S	H	S	H	H
CO 5	H	S	S	H	S

S- Strong H-High M-Medium L – Low

Sub.Code: 25PGI4N2

Question Paper Pattern

Duration: 3 hrs **Max: 75 marks**

Section - A (10x1=10)
Choose the correct answer

Section - B (5x5=25)
Short answer questions, either or type, one question from each unit.

Section - C (5x8=40)
Essay answer questions, either or type, one question from each unit.

CIA EXAMINATION MARK BREAKUP

S. NO	DISTRIBUTION COMPONENT	MARKS
1.	CIA I – 75 Marks Converted to 30	30
2.	CIA II – 75 Marks Converted to 30	30
3.	Assignment I	10
4.	Assignment II	10
5.	Attendance	05
6.	Any Case Study related to Information Security	15
	Total	**100**

EXTRA DEPARTMENTAL COURSE (EDC)

Biomedical Instrumentation

Sub. Code: 25PPH3X1

Programme: 03		**M.Sc. Physics**			
Title of the Paper		**Extra Departmental Course (EDC) -Biomedical Instrumentation**			
Batch **2025-2026**	**Semester** **3**	**Hours/Week** **2**	**Total Hours** **30**	**Credits** **2**	**Employability**

Course Objective

To enable the learners to

1. Gain knowledge on bioelectric signals and transducers
2. Understand blood gas analyzers, pulmonary function analyzers and Oximeters
3. Understand the modern imaging systems and electrical safety

Course outcome (CO)

On successful completion of the course, the students will be able to

K1 to K5	**CO1**	Gain knowledge on bioelectric signals and transducers
	CO2	Understand Blood gas analyzers, pulmonary function analyzers and Oximeters
	CO3	Acquire knowledge on blood cell counters and audiometer
	CO4	Acquire knowledge on bio-medical recorders
	CO5	Gain knowledge on modern imaging systems and electrical safety

Syllabus

UNIT I **(6 hrs)**

Bioelectric signals and transducers

Origin of bioelectric signals – Electromyogram – Physiological transducers – classifications – characteristics – variable resistance, capacitance, inductance transducers – LVDT – Piezoelectric transducers – pressure transducers – LVDT and strain gauge transducers – electrical resistance thermometer – Photoelectric transducers – Photovoltaic and Photoemissive cells – **Silicon diode detectors and diode arrays*.**

UNIT II **(6 hrs)**

Blood gas analyzers, Pulmonary function analyzers and Oximeters

Blood pH measurements – electrodes for blood pH measurements – Measurement of blood pCO_2 - blood pO_2 measurements - complete blood gas analyzer - Pulmonary function analyzers **–** ventilation - distribution and diffusion – Respiratory volumes and capacities – basicspirometer and ultrasonic spirometer. Oximeters**:** Ear oximeter and pulse oximeter.

UNIT III **(6 hrs)**

Blood cell counters, audiometer and Bio-medical recorders

Types of blood cells - Methods of cell counting- Automatic optical method - Electrical conductivity method - Hearing Aids – conventional and digital hearing aids. Bio-medical Recorders: Electrocardiograph (ECG) – Electroencephalograph (EEG).

UNIT IV **(6 hrs)**

Modern imaging systems

Principle of X-ray Computed Tomography - Magnetic Resonance Imaging**:** Principles of NMR imaging systems – Fourier transformation of free induction decay (FID) - Basic NMR components – block diagram – biological effects of NMR imaging.

Sub.Code: 25PPH3X1

UNIT V **6 hrs**

Electrical safety of medical instruments

Physiological effects due to 50 Hz current passage – micro shock – macro shock – electrical accidentsin hospitals – devices to protect against electrical hazards – hospital architecture.

*** Self study**

Teaching Methods: Smart Class Room / Power point presentation / Seminar / Quiz /Discussion / Flipped Class / Peer Learning / Experiential Learning / Blended Learning

Text Books:

1. R.S Kandpur, (2014), Hand book of biomedical instrumentation - Tata McGraw Hill, India
2. M.Arumugam, (2013), Biomedical Instrumentation- Anuradha Agencies, Chennai.

Reference Books:

1. Leslie Crombwell, Fred.J.Weibell, Trich.A.Pfeiffer, Biomedical Instrumentationand Measurements, (2011) - Prentice Hall India, New Delhi.
2. H.S.Kalsi, (2016), Electronic Instrumentation - Tata Mc Graw Hill, India.

e-Resources:

1. https://www.youtube.com/watch?v=iK-6q4 nnmtA
2. https://www.youtube.com/watch?v=JD-x-3OwEZs
3. https://www.youtube.com/watch?v=FEAQBDiHYPk
4. https://www.youtube.com/watch?v=W8-rOxQBbPA
5. https://www.youtube.com/watch?v=--meT13GtBs

Mapping

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	S	H	H	S	H
CO 2	H	S	H	H	H
CO 3	H	S	H	H	S
CO 4	S	H	S	H	H
CO 5	H	S	H	H	S

S- Strong **H-High** **M-Medium** **L – Low**

Sub. Code: 25PPH3X1

Question Paper Pattern

Duration: 3 hrs **Max: 75 marks**

Section - A (10x1=10)
Choose the correct answer

Section - B (5x5=25)
Short answer questions, either or type, one question from each unit.

Section - C (5x8=40)
Essay answer questions, either or type, one question from each unit.

CIA EXAMINATION MARK BREAKUP

S. NO	DISTRIBUTION COMPONENT	MARKS
1.	CIA I – 75 Marks Converted to 30	30
2.	CIA II – 75 Marks Converted to 30	30
3.	Assignment I	10
4.	Assignment II	10
5.	Attendance	05
6.	Any Case Study related to Information Security	15
Total		**100**

ADVANCED LEARNERS COURSE (ALC)

Advanced Experimental Techniques

Programme: 03	M.Sc. Physics
Title of the Paper	ALC - Advanced Experimental Techniques
Batch	2025-2026
Extra Credits	2

Course Objective

To enable the learners to

1. Understand different types of structural and surface morphological and spectroscopic characterization techniques
2. Gain knowledge about magnetic techniques
3. Understand thermal analytical techniques

Course outcome (CO)

On successful completion of the course, the students will be able to

K1 to K5	CO1	Gain knowledge on structural characterization
	CO2	Acquire knowledge on spectroscopic analysis
	CO3	Gain knowledge on morphological techniques
	CO4	Acquire knowledge on magnetic properties of materials
	CO5	Gain knowledge on thermal analytical techniques

Unit I

Structural Characterization

Atomic Absorption Spectroscopy (AAS): Instrumentation - Sample preparation - Analysis – limitations. Inductively Coupled Plasma (ICP): Instrumentation and measurement techniques. Atomic Emission Spectroscopy (AES): Instrumentation and measurement techniques.

Unit II

Spectroscopic analysis

InfraRed (IR) – Fourier Transform Infra-Red (FTIR) – Ultraviolet-Visible (UV-VIS), Diffused Reflectance Spectroscopy (DRS) – X-ray Absorption (XPS) – Electron Spin Resonance (ESR) – Nuclear Magnetic Resonance (NMR).

Unit III

Morphological techniques

Confocal microscope - Field Emission Scanning Electron Microscope (FESEM) – Advantages FESEM over SEM - TEM - Selected Area Electron Diffraction (SAED) – Atomic Force Microscope (AFM).

Unit IV

Magnetic properties

Vibrational Magnetometer - Cyclic Voltammetry - SQUID Magnetometer - Magnetic Force Microscopy – Magneto optical (MO) technique - Magnetic resonance imaging technique.

Unit V

Thermal analytical techniques

Thermo gravimetric (TGA) – Differential Thermal Analysis (DTA) – Differential Scanning Calorimetry (DSC) – Graphical analysis affecting various factors.

Text Books:

1. John B. Wachtman, Zwi. H. Kalman, (1993), Characterization of Materials -Butterworth Heinemann, UK.
2. H. H. Willard, (1991), Instrumental Methods of Analysis-CBS Publishers, New Delhi.

Reference Books:

1. Banewall, (2017), Fundamentals of Molecular Spectroscopy - McGraw Hill, India.
2. B.K. Sharma, (2007), Spectroscopy - GOEL Publishing House- Krishna Prakashan, Meerut.

e-Resources:

1. https://www.digimat.in/nptel/courses/video/103108138/L01.html
2. https://www.youtube.com/watch?v=SbSS130KoCs
3. https://www.youtube.com/watch?v=9Mv1MEKLAhQ
4. https://www.youtube.com/watch?v=VvZk_gIQJRo
5. https://www.youtube.com/watch?v=sy47Jp22gYY

Mapping

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	S	H	H	S	H
CO 2	H	S	H	H	H
CO 3	H	S	H	H	S
CO 4	S	H	S	H	H
CO 5	H	S	H	H	S

S- Strong **H-High** **M-Medium** **L – Low**

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PG DIPLOMA COURSE

PG Diploma in Particle Accelerator

Programme name: PG Diploma in Particle Accelerator

Curriculum and Scheme of Examination under CBCS

(Applicable to Students Admitted from the Academic Year 2025-2026 and onwards)

Semester	Subject Code	Title of the paper	Instruction	Exam Marks			Exam Duration (hrs)	Credits
				CIA	ESE	Total		
I	**25PDP101**	Core Paper 1 – Nuclear Physics	2	25	75	100	3	2
	25PDP102	Core Paper 2 - Radioactivity	2	25	75	100	3	2
	25PDP103	Core Paper 3 – Charged Particle Interaction	2	25	75	100	3	2
	25PDP1Z1	Project & Viva voce	2	25	75	100	-	2
		Total	**8**	**-**	**-**	**400**	**-**	**8**
II	**25PDP204**	Core Paper 4- Physics of Basic Particle Accelerators	2	25	75	100	3	2
	25PDP205	Core Paper 5- Physics of Advanced Particle Accelerators	2	25	75	100	3	2
	25PDP206	Core Paper 6- Elementary Particles	2	25	75	100	3	2
	25PDP2Z2	Project & Viva voce	2	25	75	100	-	2
		Total	**8**	**-**	**-**	**400**		**8**
		Grand Total	**16**			**800**		**16**

Note:

CBCS - Choice Based Credit System,
CIA - Continuous Internal Assessment
ESE - End of Semester Examinations

Tally Table

S.No.	Subject	No. of Subjects	Total marks	Credits
1.	**Core -Theory**	**06**	**600**	**12**
2.	**Project**	**02**	**200**	**4**
Grand Total		**08**	**800**	**16**

- 50% CIA is applicable for all subjects

Components of Continuous Internal Assessment (25 Marks)

Components		Marks	Total
Theory			
CIA I	75	15	25
CIA II	75		
Assignment/Seminar		5	
Attendance		5	
Project			
Review	20	25	
Regularity	5		

PDP - 02 –

BLOOM'S TAXONOMY BASED ASSESSMENT PATTERN

(K1-Remembering; **K2**-Understanding; **K3**-Applying; **K4**-Analyzing; **K5**-Evaluating)

1. Theory Examination

i) CIA I & II and ESE: 75 Marks

Knowledge Level	Section	Marks	Description	Total
K1 – K2 Q1 to 10	A (Answer all)	10 x 1 = 10	MCQ-10	75
K2 – K5 Q11 to 15	B (Either or pattern)	5 x 5= 25	Short Answers	
K2 – K5 Q16 to 20	C (Either or pattern)	5 x 8 = 40	Descriptive / Detailed	

2. ESE Project Viva Voce:

Knowledge Level	Section	Marks	Total
K3, K4, K5	Project Report	25	75
	Viva voce	50	

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Sub. Code: 25PDP101

Programme code : 03		PG Diploma in Particle Accelerator			
Title of the Paper		Core Paper 1 – Nuclear Physics			
Batch 2025-2026	Semester 1	Hours/Week 2	Total Hours 30	Credits 2	Employability

Course Objectives

To enable the learners to know about the

1. Basic properties of nucleus.
2. Various nuclear forces, nuclear models and nuclear reaction.
3. Different types of nuclear detectors.

Course outcomes (CO)

On successful completion of the course, the students will be able to

K1 to K5	**CO1**	Know about basic properties of nucleus.
	CO2	Gain knowledge about nuclear forces.
	CO3	Acquire knowledge about nuclear models.
	CO4	Know about nuclear reactions.
	CO5	Understand the working of various nuclear detectors.

Syllabus

UNIT I **(6 hrs)**

Basic Properties

Basic properties of nucleus- Nuclear size- Nuclear mass- Nuclear density- Nuclear charge- Binding energy- Stability of nucleus- Packing fraction.

UNIT II **(6 hrs)**

Nuclear forces

General properties of nuclear force- Exchange forces- Velocity dependent forces- Meson theory of nuclear force- Charge independence of nuclear force.

UNIT III **(6 hrs)**

Nuclear Models

Fermi-Gas model- The Liquid Drop model- Shell model- Evidence for the existence of magic numbers- Extreme single particle model- Unified model- Superconductivity.

UNIT IV **(6 hrs)**

Nuclear Reaction

Introduction-Types- Reactions based on reaction mechanism- Reaction based on the mass of projectile- Nuclear reaction cross-section- Conservation laws in nuclear reactions- Nuclear fission- Energy released in fission- Nuclear fusion- Energy released in fusion.

UNIT V **(6 hrs)**

Nuclear Detectors

Radiation detector: Classifications- Gas filled detectors- Ionization chamber- Proportional Counter- Geiger-Muller counter- Scintillation counter.

Teaching Methods: Smart Class Room / Power point presentation / Seminar / Quiz /Discussion / Flipped Class / Peer Learning / Experiential Learning / Blended Learning

Sub. Code: 25PDP101

Text Books:

1. D. C. Tayal, Nuclear Physics, Himalaya Publishing House, 2013
2. Bernard L. Cohen, Concepts of Nuclear Physics, Tata McGraw Hill Edition, 2009
3. V.K. Mittal, R.C. Verma, S.C. Gupta, Introduction to Nuclear and Particle Physics, PHI Learning Private Ltd, 2018

Reference Books:

1. SN Ghoshal, Nuclear Physics, S. Chand Publishing, 1997
2. Brian R. Martin, Graham Shaw, Nuclear and Particle Physics: An introduction, John Wiley & Sons, 2019

Mapping

CO PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	S	H	S	S	H
CO 2	S	H	S	S	H
CO 3	H	S	S	H	S
CO 4	S	H	H	S	S
CO5	S	H	S	S	H

S- Strong H-High M-Medium L – Low

Sub. Code: 25PDP102

Programme code : 03		**PG Diploma in Particle Accelerator**			
Title of the Paper		**Core Paper 2 – Radioactivity**			
Batch	**Semester**	**Hours/Week**	**Total Hours**	**Credits**	**Employability**
2025-2026	**1**	**2**	**30**	**2**	

Course Objectives

To enable the learners to know about the

1. Basics of radioactivity and its types.
2. Characteristics of alpha (α), beta (β) and gamma (γ) rays.
3. Fundamental laws of radioactivity.

Course outcomes (CO)

On successful completion of the course, the students will be able to

K1 to K5	**CO1**	Know about basics of radioactivity and its types.
	CO2	Gain knowledge about alpha rays.
	CO3	Acquire knowledge about beta rays.
	CO4	Know about gamma rays.
	CO5	Understand the fundamentals laws of radioactivity.

Syllabus

UNIT I **(6 hrs)**

Radioactivity

Discovery of radioactivity- Types: Natural radioactivity-Induced radioactivity- Alpha (α) rays- Beta rays (β)- Gamma (γ) rays- Properties of α, β and γ rays.

UNIT II **(6 hrs)**

Alpha rays

Determination of e/m of α particle – Determination of charge of α particle – velocity of α particle – Range of α particle – Experimental measurement of range of α particle- α particle disintegration energy.

UNIT III **(6 hrs)**

Beta rays

Nature of β rays- Kaufmann's experiment- Bucherer's experiment- β ray spectra- Origin of line and continuous spectra- The Neutrino theory of β decay.

UNIT IV **(6 hrs)**

Gamma rays

Determination of wavelength of γ rays- Origin of γ rays- Nuclear isomerism- Internal conversion- Mossbauer effect- Experimental arrangement.

UNIT V **(6 hrs)**

Fundamental laws

Soddy Fajan's displacement law- Law of radioactive disintegration- Mean life- Measurement of decay constants- Law of successive disintegration- Radioactive dating.

Teaching Methods: Smart Class Room / Power point presentation / Seminar / Quiz / Discussion / Flipped Class / Peer Learning / Experiential Learning / Blended Learning

Text books:

1. Modern Physics, (S Chand Publishing, 2016) R. Murugesan, Kiruthiga Sivaprasath
2. Nuclear Physics (Himalaya Publishing House, 2013) D. C. Tayal.
3. Nuclear Physics (S. Chand Publishing, 1997), SN Ghoshal.

Sub. Code: 25PDP102

Reference books:

1. Radioactivity: Introduction and History, From Quantum to Quarks (Elsevier, 2016) Michael F. L'Annunziata.
2. Introductory Nuclear Physics (Wiley, 2008) Kenneth S. Krane.

Mapping

CO PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	S	H	H	S	H
CO 2	H	S	S	H	S
CO 3	S	H	S	S	H
CO 4	S	H	S	H	H
CO5	H	S	S	H	S

S- Strong H-High M-Medium L – Low

Sub. Code: 25PDP103

Programme code : 03		PG Diploma in Particle Accelerator			
Title of the Paper		Core Paper 3 – Charged Particle Interaction			
Batch 2025-2026	Semester 1	Hours/Week 2	Total Hours 30	Credits 2	Employability

Course objective

To enable the learners to know about the

1. Basics of particle interaction.
2. Interaction of electromagnetic waves with matter.
3. Pair production.

Course outcomes (CO)

On successful completion of the course, the students will be able to

K1 to K5	CO1	Know about basics of particle interaction.
	CO2	Gain knowledge about interaction of electromagnetic waves with matter.
	CO3	Acquire knowledge about photoelectric effect.
	CO4	Know about Compton effect.
	CO5	Understand pair production.

Syllabus

UNIT I **(6 hrs)**

Particle Interaction

Introduction- Energy loss by heavy charged particles- Calculation of bmin and bmax- Interaction of electrons with matter- Range of charged particles- Energy dependence- Bragg's curve.

UNIT II **(6 hrs)**

Interaction of γ-rays with matter

Introduction- Radiation length- Half thickness- Experimental determination of Attenuation co-efficient.

UNIT III **(6 hrs)**

Photoelectric Effect

Introduction- Nature of photo particles- Lenard's method- Experimental investigation on photoelectric effect- Laws of photoelectric emission- Einstein's photoelectric equation- Millikan's experiment- Photoelectric cells.

UNIT IV **(6 hrs)**

Compton Effect

Production of X-rays- Properties of X-rays- Bragg's law- X-ray spectra- Continuous X-ray spectrum- Characteristics X-ray spectrum- Compton effect- Experimental verification of Compton Effect.

UNIT V **(6 hrs)**

Pair production

Introduction- Dirac theory of pair production- Positron annihilation- Pair production in vaccum.

Teaching Methods: Smart Class Room / Power point presentation / Seminar / Quiz /Discussion / Flipped Class / Peer Learning / Experiential Learning / Blended Learning

Text Books:

1. Modern Physics, (S Chand Publishing, 2016) R. Murugesan, Kiruthiga Sivaprasath
2. Nuclear Physics (Himalaya Publishing House, 2013) D. C. Tayal.
3. Nuclear Physics (S. Chand Publishing, 1997), SN Ghoshal.

Sub. Code: 25PDP103

Reference Books:

1. Charged Particle and Photon Interactions with Matter (CRC Press, 2020) A. Mozumder, Yoshihiko Hatano.
2. Trapped Charged Particles and Fundamental Interactions (Springer-Verlag Berlin and Heidelberg GmbH & Co, 2008) Habil Klaus, Frank Herfurth.

Mapping

CO PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	S	S	H	H	S
CO 2	S	H	S	H	S
CO 3	S	S	H	S	S
CO 4	S	H	S	H	S
CO5	S	H	S	H	S

S- Strong H-High M-Medium L – Low

Sub. Code: 25PDP204

Programme code : 03		PG Diploma in Particle Accelerator			
Title of the Paper		Core Paper 4 – Physics of Basic Particle Accelerators			
Batch 2025-2026	Semester 2	Hours/Week 2	Total Hours 30	Credits 2	Employability

Course Objective

To enable the learners to know about the

1. Importance of particle accelerators.
2. Various types of accelerators and their applications.
3. Working principles, limitations and applications of Cyclotron, Betatron, Synchrotron and Microtron.

Course outcomes (CO)

On successful completion of the course, the students will be able to

K1 to K5	CO1	Know about particle accelerators and its types.
	CO2	Gain knowledge about RF linear accelerator.
	CO3	Acquire knowledge about linear accelerator designs and set up.
	CO4	Know about Cyclotron and Betatron.
	CO5	Understand Synchrotron and Microtron.

Syllabus

UNIT I **(6 hrs)**

Introduction to X-rays and Gamma rays

Basic principles of X-ray, Gamma ray sources, Characteristic properties of X-rays and Gamma rays

Particle Accelerators

Need for Accelerators- History of Accelerators-Basic principles of DC and RF Accelerators-Application of Accelerators in medical and industry.

UNIT II **(6 hrs)**

Electrostatic Accelerators

Cockcroft-Walton Accelerators- Van de Graff Accelerator- Pelletron and Laddertron charging system- Tandem Accelerator- Folded Tandem- Resonance Transformer.

UNIT III **(6 hrs)**

Linear Accelerators

Early designs- Radial focusing- Phase focusing- Drift tube accelerator (LINAC)- Wave guide accelerator- Electron linear Accelerator.

UNIT IV **(6 hrs)**

Cyclotron and Betatron

Basic principle-AVF cyclotron- Synchrocyclotron- Betatron tunes-Shape of the cyclotron magnet-Injection, Extraction, Beam quality, time structure, energy resolution and emittance, limitations and applications.

UNIT V **(6 hrs)**

Synchrotron and Microtron

Basic principle of synchrotron, Electron and ion synchrotron, Synchrotron radiation source, Total radiated power-Properties of synchrotron radiation, Basic principle of Microtron, limitations and applications.

Teaching Methods: Smart Class Room / Power point presentation / Seminar / Quiz /Discussion / Flipped Class / Peer Learning / Experiential Learning / Blended Learning

Sub. Code: 25PDP204

Text Books:

1. An Introduction to Particle Accelerators (Oxford University Press, 2001) Edmund Wilson.
2. Principles of Charged Particle Acceleration (Wiley, 1986) Stanley Humphries, Jr.
3. Principles of Cyclic Particle Accelerators (Van Nostrand, NJ 1961) John Jacob Livingood.
4. Industrial Radiology-Theory and Practice (Springer, 1982) R.Halmshaw.

Reference Books:

1. Nuclear Physics (S. Chand Publishing, 1997), SN Ghoshal.
2. Nuclear and Particle Physics: An introduction (John Wiley & Sons, 2019) Brian R. Martin, Graham Shaw.

Mapping

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	S	S	S	M	L
CO 2	S	S	S	M	M
CO 3	S	L	S	M	L
CO 4	S	S	S	M	L
CO 5	S	M	S	M	L

S- Strong **H-High** **M-Medium** **L – Low**

Sub. Code: 25PDP205

Programme code : 03		**PG Diploma in Particle Accelerator**			
Title of the Paper		**Core Paper 5 – Physics of Advanced Particle Accelerators**			
Batch	**Semester**	**Hours/Week**	**Total Hours**	**Credits**	**Employability**
2025-2026	**2**	**2**	**30**	**2**	

Course Objective

To enable the learners to know about the

1. Charged particle dynamics.
2. Importance of advanced particle accelerators.
3. Various types of advanced accelerators and their applications.

Course outcomes (CO)

On successful completion of the course, the students will be able to

K1 to K5	CO1	Know about charged particle dynamics.
	CO2	Gain knowledge about RIB accelerator science.
	CO3	Acquire knowledge about ion source for particle accelerators.
	CO4	Know about synchrotron radiation.
	CO5	Understand advance accelerators.

Syllabus

UNIT I **(6 hrs)**

Charged Particle Dynamics

Particle motion in electric and magnetic fields- Beam transport system-Beam pulsing and bunching techniques-micro beams-Particle and ion sources-Secondary beams-Measurement of beam parameters.

UNIT II **(6 hrs)**

RIB Accelerator Science

Introduction and overview of RIB facilities-Different types of RIB facilities-Ion sources and charge breeder, Ion guides and gas-jet systems-RFQ cooler, Mass seperators, RFQ linac, Heavy ion LINAC, Applications of RIB in different fields.

UNIT III **(6 hrs)**

Ion source for particle Accelerators

Principles of ionization- Ion sources for positive ions-Duoplasmatron, PIG, ECR, Ion sources for negative ions- surface, volume and charge exchange, ECR ion source and beam transport line.

UNIT IV **(6 hrs)**

Synchrotron radiation

Radiation from moving charges-Coulomb regime-Radiation regime- Radiation sources-Bending magnet radiation- Wavelength shifter- Wiggler magnet radiation- Undulator radiation- Radiation power and angular distribution- Beam lifetime.

UNIT V **(6 hrs)**

Advance accelerators

Free electron laser- Plasma accelerators- Spallation neutron sources- Accelerator driven subcritical systems (ADSS)

Teaching Methods: Smart Class Room / Power point presentation / Seminar / Quiz /Discussion / Flipped Class / Peer Learning / Experiential Learning / Blended Learning

Sub. Code: 25PDP205

Text Books:

1. An Introduction to Particle Accelerators (Oxford University Press, 2001) Edmund Wilson.
2. Principles of Charged Particle Acceleration (Wiley, 1986) Stanley Humphries, Jr.
3. Principles of Cyclic Particle Accelerators (Van Nostrand, NJ 1961) John Jacob Livingood.
4. Industrial Radiology-Theory and Practice (Springer, 1982) R.Halmshaw.

Reference Books:

1. Nuclear Physics (S. Chand Publishing, 1997), SN Ghoshal.
2. Nuclear and Particle Physics: An introduction (John Wiley & Sons, 2019) Brian R. Martin, Graham Shaw.

Mapping

CO PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	S	S	H	H	H
CO 2	H	S	S	S	S
CO 3	H	H	H	H	H
CO 4	S	S	H	S	S
CO5	H	S	S	H	S

S- Strong H-High M-Medium L - Low

Sub. Code: 25PDP206

Programme code : 03		PG Diploma in Particle Accelerator			
Title of the Paper		Core Paper 6 – Elementary Particles			
Batch 2025-2026	Semester 2	Hours/Week 2	Total Hours 30	Credits 2	Employability

Course Objectives

To enable the learners to know about the

1. Fundamental interaction of elementary particles.
2. Various conservation laws of elementary particles.
3. Production and properties of various elementary particles.

Course outcomes (CO)

On successful completion of the course, the students will be able to

K1 to K5	CO1	Know about fundamental interaction of elementary particles.
	CO2	Gain knowledge about various conservation laws.
	CO3	Acquire knowledge on production and properties of elementary particles.
	CO4	Know about mesons and its properties.
	CO5	Understand quarks and its properties.

Syllabus

UNIT I **(6 hrs)**

Fundamental Interaction

Introduction - Classification - Gravitational interaction - Electromagnetic interaction - Weak interaction: Charged weak interaction and Neutral weak interaction- Strong interactions.

UNIT II **(6 hrs)**

Conservation laws

Conservation of linear momentum- Conservation of angular momentum - Conservation of energy - Conservation of charge - Conservation of lepton number - Conservation of baryon number - Conservation of isospin - Conservation of strangeness- Conservation of hypercharge.

UNIT III **(6 hrs)**

Production and Properties of Elementary Particles

Electron and Positron- Proton and Anti-proton- Neutron and Anti-neutron- Graviton- Photon- Gluon: Production and Properties.

UNIT IV **(6 hrs)**

Mesons

Muon: Production- Mass of muons- Decay and mean life- Interaction with matter- Spin and magnetic moments of muons.

UNIT V **(6 hrs)**

Quarks

Quarks: Experimental evidence- Quark masses- Quantum numbers- Isospin of Quarks- Quark wavefunction of pseudo scalar mesons- Quark wave function of Baryons.

Text Books:

1. Nuclear Physics (Himalaya Publishing House, 2013) D.C.Tayal.
2. Nuclear Physics (S. Chand Publishing, 1997), SN Ghoshal.

Sub. Code: 25PDP206

Reference Books:

1. Nuclear and Particle Physics: An introduction (John Wiley & Sons, 2019) Brian R. Martin, Graham Shaw.
2. Introduction to Elementary Particle Physics, (Cambridge University Press, 2014) Alessandro Bettini.

Mapping

CO PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	S	S	H	H	S
CO 2	S	H	S	H	S
CO 3	S	S	H	S	S
CO 4	S	H	S	H	S
CO5	S	H	S	H	S

S- Strong H-High M-Medium L – Low

Sub. Code: 25PDP2Z2

Programme: 03		**M.Sc. Physics**			
Title of the Paper		**Project and Viva Voce**			
Batch	**Semester**	**Hours/Week**	**Total Hours**	**Credits**	**Skill Development**
2025-2026	**2**	**2**	**30**	**2**	

Course objectives

To enable the learners to

1. Have foundations in the fundamentals of Particle accelerators.
2. Acquire knowledge on elementary particles
3. Understand the applications of radioactive materials

Course Outcomes (CO)

On successful completion of the course, the students will be able to

K3 to K5	CO1	Construct working models
	CO2	Gain expertise to present the idea systematically through PPT
	CO3	Get familiarized to develop a report on the project work
	CO4	Accomplish the result accumulation and data graphing
	CO5	Gain expertise to apply knowledge on multidisciplinary field

Marks Distribution

CIA / ESE	**Particulars**	**Marks**
CIA	Project Review	20
	Regularity	05
	Total Internal Marks	**25**
ESE	Project Report	25
	Viva Voce	50
	Total External Marks	**75**
Total Marks (CIA + ESE)		**100**

Mapping

CO / PSO	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO 1	**S**	**H**	**H**	**S**	**H**
CO 2	**H**	**S**	**S**	**H**	**S**
CO 3	**S**	**H**	**S**	**S**	**H**
CO 4	**S**	**H**	**S**	**H**	**H**
CO 5	**S**	**H**	**S**	**S**	**H**

S- Strong H-High M-Medium L - Low

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