R21 Curriculum and Syllabus

M.Sc. (Physics)

R21 Curriculum for M.Sc. (Physics)

SEMESTER-1							
Sl. No.	**Type**	**Course No.**	**Course Name**	**L**	**T**	**P**	**Credits**
THEORY							
1	CC	PPH1001	Mathematical Methods	3	1	0	4
2	CC	PPH1002	Classical and Relativistic Mechanics	3	1	0	4
3	CC	PPH1003	Electronics	3	1	0	4
THEORY (for students of other department Sl. No. 4 or SL No 5)							
4	OE	PPH 1004	Energy Sources and Harvesting Technologies	3	1	0	4
5	OE	PPH 1005	Material Science	3	1	0	4
PRACTICAL							
6	CC	PPH1101	Physics Laboratory -I	0	0	8	4
MANDATORY NON-CGPA COURSE							
7	MNCC	PPH1501	Seminar / Other Academic Activities	0	0	1	0
8	MNCC	PPH1502	SKILLX, NSS/ YOGA	0	0	1	0
TOTAL				**12**	**4**	**10**	**20**

CC- Core Course, OE- Open Elective, MNCC- Mandatory Non-CGPA Course

SEMESTER-2							
Sl. No.	**Type**	**Course No.**	**Course Name**	**L**	**T**	**P**	**Credits**
THEORY							
1	CC	PPH2001	Electrodynamics	3	1	0	4
2	CC	PPH2002	Quantum Mechanics	3	1	0	4
3	CC	PPH2003	Computational Physics	3	1	0	4
THEORY (for students of other department)							
4	OE	PPH2004	Physics: Large to Small Bodies	3	1	0	4
PRACTICAL							
5	CC	PPH2101	Physics Laboratory -II	0	0	8	4
MANDATORY NON-CGPA COURSE							
6	MNCC	PPH2501	Seminar / Other Academic Activities	0	0	1	0
7	MNCC	PPH2502	SKILLX, NSS/ YOGA	0	0	1	0
TOTAL				**12**	**4**	**10**	**20**

CC- Core Course, OE- Open Elective, MNCC- Mandatory Non-CGPA Course

SEMESTER-3							
Sl. No.	**Type**	**Course No.**	**Course Name**	**L**	**T**	**P**	**Credits**
THEORY							
1	CC	PPH3001	Statistical Physics	3	1	0	4
2	CC	PPH3002	Solid State Physics	3	1	0	4
3	CC	PPH3003	Nuclear and Particle Physics	3	1	0	4
THEORY (Student may select one subject from item no 4 - 10)							
4	DSE	PPH3004	Advanced Quantum Mechanics	3	1	0	4
5	DSE	PPH3005	Advanced Electronics I	3	1	0	4
6	DSE	PPH3006	Advanced Mathematical Physics	3	1	0	4
7	DSE	PPH3007	Advanced Nuclear Physics	3	1	0	4
8	DSE	PPH3008	Advanced Experiments of Physics	3	1	0	4
9	DSE	PPH3009	General Theory of Relativity and Cosmology	3	1	0	4
10	DSE	PPH3010	Advanced Optics	3	1	0	4
PRACTICAL							
11	CC	PPH3101	Physics Laboratory -III	0	0	8	4
MANDATORY NON-CGPA COURSE							
12	MNCC	PPH3501	Seminar / Other Academic Activities	0	0	1	0
13	MNCC	PPH3502	SKILLX, NSS/ YOGA	0	0	1	0
TOTAL				**12**	**4**	**10**	**20**

CC- Core Course, DSE-Discipline Specific Elective, MNCC- Mandatory Non-CGPA Course

SEMESTER-4							
Sl. No.	**Type**	**Course No.**	**Course Name**	**L**	**T**	**P**	**Credits**
THEORY							
1	CC	PPH4001	Atomic And Molecular Physics	3	1	0	4
THEORY (Student may select two subjects from item no 2 - 9)							
2	DSE	PPH4002	Energy Sources, Storage and Harvesting	3	1	0	4
3	DSE	PPH4003	Advanced Electronics Ii	3	1	0	4
4	DSE	PPH4004	Radiation Physics And Safety	3	1	0	4
5	DSE	PPH4005	Atmospheric Physics	3	1	0	4
6	DSE	PPH4006	Group Theory	3	1	0	4
7	DSE	PPH4007	Physics At The Nano Scale	3	1	0	4
8	DSE	PPH4008	Plasma Physics	3	1	0	4
9	DSE	PPH4009	Astrophysics	3	1	0	4
PRACTICAL							
10	CC	PPH4101	Project/Term Paper	0	0	12	6
11	CC	PPH 4102	Grand Viva	0	0	0	2
MANDATORY NON-CGPA COURSE							
12	MNCC	PPH4501	Seminar / Other Academic Activities	0	0	1	0
13	MNCC	PPH4502	SKILLX, NSS/ YOGA	0	0	1	0
TOTAL				**12**	**4**	**10**	**20**

CC- Core Course, DSE- Discipline Specific Elective, MNCC- Mandatory Non-CGPA Course

Semester 1
Curriculum and Detailed Syllabus

SEMESTER-1							
Sl. No.	**Type**	**Course No.**	**Course Name**	**L**	**T**	**P**	**Credits**
THEORY							
1	CC	PPH1001	Mathematical Methods	3	1	0	4
2	CC	PPH1002	Classical and relativistic Mechanics	3	1	0	4
3	CC	PPH1003	Electronics	3	1	0	4
THEORY (for students of other departments Sl. No. 4 or Sl No. 5)							
4	OE	PPH 1004	Energy Sources and Harvesting Technologies	3	1	0	4
5	OE	PPH 1005	Material Science	3	1	0	4
PRACTICAL							
6	CC	PPH1101	Physics Laboratory -I	0	0	8	4
MANDATORY NON-CGPA COURSE							
7	MNCC	PPH1501	Seminar / Other Academic Activities	0	0	1	0
8	MNCC	PPH1502	SKILLX, NSS/ YOGA	0	0	1	0
TOTAL				**12**	**4**	**10**	**20**

CC- Core Course, OE- Open Elective, MNCC- Mandatory Non-CGPA Course

Course Code	PPH1001			
Course Title	Mathematical Methods			
Category	Programme Core			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Course Objectives

The objective is to teach the students basic mathematical methods on Linear Vector Space, Probability distributions, Complex analysis, Bessel functions, Fourier transform that will be used in many of the other courses in the M.Sc. Syllabus.

Course Outcomes

CO 1: Linear Vector Space is applied to understand systems behavior in different coordinate systems.

CO 2: Students will get an idea of probability distributions and their applications

CO 3: Students will able to understand complex functions

CO 4: Differential equations and special functions will help students to study states of the physical systems and able to apply mathematical tooL in solving problems

Course Content

Module I: Statistics **(15 L)**

Statistics: Collection and presentation of data in tabular and graphical methods, sources of data, Scatter plot , Venn diagram, radial plot , frequency distribution, class mark, central tendency, Measures of dispersion. Measures of skewness and kurtosis. Descriptive statistics, concept of random variable. Probability distributions: binomial, Poisson and normal. Sampling theory, hypothesis testing and interval estimation for large samples. Chi-square test, t-test and F-test of significance. Correlation and regression. analysis. One way analysis of variance.

Module II: Complex Analysis **(15 L)**

Complex Analysis: Complex numbers and variables. Complex analyticity, Cauchy-Riemann conditions. Classification of singularities. Cauchy's theorem. Residues. Evaluation of definite integral. Taylor and Laurent expansions. Analytic continuation, Gamma function, zeta function. Method of steepest descent.

Module III: Linear Vector Space **(8 L)**

Linear Vector Space: A brief review of linear vector spaces, Inner product, norm, Schwarz inequality, linear operators, eigenvalue and eigenvector, adjoint of a linear operator, Hermitian or self-adjoint operators and their properties, unitary operators, ortho-normal basis –discrete and continuous.

Module IV: Special Functions **(10 L)**

Ordinary Differential Equations and Special Functions, Linear ordinary differential equations and their singularities. Sturm- Liouville problem, expansion in orthogonal functions. Series solution of second-order equations. Hypergeometric function and Bessel functions, classical polynomial. Fourier series and Fourier Transform.

Reference/Text Books:

1. V. Balakrishnan "Mathematical Physics", Ane Books
2. G. Arfken , "Mathematical Methods for Physicists", ELevier,
3. E. Kreyzig , "Advanced Engineering Mathematics", Pearson
4. R.V. Dukkipati , "Probability and Statistics for Scientists" , New Age International Publisher
5. P.M. Morse and H. Feshbach, "Methods of Theoretical Physics (Vol. I & II)", Feshbach Publishing
6. M.R. Spiegel, "Complex Variables", McGraw-Hill

CO-PO Mapping

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO 11**	**PO 12**
CO 1	3	2	2		2							3
CO 2	3	1	2		2							3
CO 3	3	2	2		2							3
CO 4	3	2	2		2							3

Course Code	PPH1002				
Course Title	Classical and Relativistic Mechanics				
Category	Programme Core				
LTP & Credits	L	T	P	Credits	
	3	1	0	4	
Total Contact Hours	48				
Pre-requisites	None				

Course Objectives

To apply Hamilton's equations to solve dynamical systems and the theory of rigid body dynamics to analyse the motion of rigid bodies

Course Outcomes

CO 1: Student will have detail idea about Lagrangian formalism and Hamilton's equations and will be able to solve dynamical systems.

CO 2: Students will get the knowledge of rigid dynamics and will be able to analyze the dynamics of rigid bodies.

CO 3: Students able to understand the basic necessity and principles of the special theory of relativity

CO 4: Students may get knowledge about Poincare and Minkowski's 4-dimensional formulation

Course Content

Module I: Lagragian Equation and Hamilton Principle (15 L)

Constraints and Degrees of Freedom, Generalised coordinates and momenta. Principle of Virtual work, Calculus of variation. Hamilton's principle, Lagrange's equation of motion, Cyclic coordinates, Hamilton's equations of motion. Canonical Transformations, Generating function. Hamilton-Jacobi theory. Lagrange and Poisson's bracket, Action and angle variable and their applications. Liouville's theorem.

Module II: Motion of Rigid Body (15 L)

Non inertial frames of reference, Pseudo forces, Foucault's pendulum. Central force motion, General equation of an orbit, Keplers laws of planetary motion, Rutherford scattering. General motion of a rigid body, Moment of inertia, Euler angles, Principal axis transformation, Euler equations of motion, Motion of a symmetric top. Small oscillations, Normal mode analysis.

Module III: Theory of Relativity (10 L)

Inertial frames, Michelson Morley experiment, Fizeau's experiment, Principle and postulate of relativity, Lorentz transformations. Simultaneity, Length contraction, time dilation, Doppler effect, Relativistic aberration, Velocity addition formula, Relativistic dynamics, Rest mass, Mass energy equivalence, Four- vector notation. Coordinate, velocity and momentum four-vectors, Energy-momentum four-vector.

Module IV: Minkowski's Space (8 L)

Poincare and Minkowski's 4-dimensional formulation, geometrical representation of Lorentz transformations in Minkowski's space, Light cone, Tensors, contra- and covariant vectors, time-like and space-like vectors.

Reference/Text Books :

1. H. Goldstein, "Classical Mechanics", Narosa Pub. House
2. I. Percival and D. Richards, "Introduction to Dynamics", Cambridge University Press
3. L. D. Landau and E. M. Lifshitz, "Mechanics", Pergamon.
4. N. C. Rana and P. S. Jaog, "Classical Mechanics" McGraw-Hill.
5. D. Rindler, "Special Theory of Relativity", Oxford University Press
6. A.P. French, "Special Relativity", W.W. Norton

CO-PO Mapping

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO 1	3	2		2								3
CO 2	3	1		2			2					3
CO 3	3	2		-	2		2					3
CO 4	3	-		2								3

Course Code	PPH1003
Course Title	Electronics
Category	Programme Core
LTP & Credits	L T P Credits 3 1 0 4
Total Contact Hours	48
Pre-requisites	None

Course Objectives

To build up on the basic knowledge of electronics with the introduction of advanced topics in circuit analysis and applications of semiconductor devices in different circuits.

Course Outcomes

CO 1: Understand the working of active and passive systems.
CO 2: Understand the working of Different Semiconductor devices
CO 3: Understand the basic Analog circuits
CO 4: Understand the basic s of communication systems

Course Content

Module I: Circuit Analysis **(16 L)**

Circuit Analysis: Admittance, impedance, scattering and hybrid matrices for two and three port networks and their cascade and parallel combinations. Review of Laplace Transforms. Response functions, location of poles and zeros of response functions of active and passive systems (Nodal and Modified Nodal Analysis).

Module II: Semiconductor Devices **(10 L)**

Physics of Semiconductor Devices: p-n junction, BJT, JFET, equivalent circuits and high frequency effects, UJT, 4 layer pnpn device (SCR),. MOS diode, accumulation, depletion and inversion, MOSFET: I-V, C-V characteristics. Enhancement and depletion mode MOSFET. Metal-semiconductor junctions; Ohmic and rectifying contacts, Schottky diode, I-V, C-V relations.

Module III Analog Circuits **(10 L)**

Analog circuits: Active filters and equalizers with feedback, Phase shift and delay.
Digital Circuits: Introduction to digital IC parameters (switching time, propagation delay, fan out, fan in etc.). TTL, MOS and CMOS gates, Emitter-coupled logic, MOSFET as transmission gate. A/D and D/A converters. Basics of micro-processor and micro-controller.

Module IV Communication **(12 L)**

Communication Systems: Amplitude, Angle and Pulse-analog modulation: Generation and detection. Model of communication system, classification of signal, representation of signal.

References/Text Books:

1. F.F. Kuo, “ Network Analysis and Synthesis”, Wiley
2. W.D. Stanley, “ Network Analysis with Applications”, Pearson
3. J. Millman and C. C. Halkias and S. Jit , “Electronic Devices and Circuits, McGraw-Hill
4. J. Millman, C. C. Halkias and C. D. Parikh, “Integrated Electronics”, McGraw- Hill,
5. J. G. Proakis and D. G. Manolakis, “Digital Signal Processing”, Pearson,
6. M. S. Tyagi, ‘Introduction to Semiconductor Material and Devices’, Wiley

CO-PO Mapping

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
CO 1	3	2										3
CO 2	3			2							2	3
CO 3	3	2							2			3
CO 4	3			1							2	3

Course Code	PPH1101
Course Title	Physics Laboratory I
Category	Programme Core
LTP & Credits	L / T / P / Credits: 0 / 0 / 8 / 4
Total Contact Hours	96
Pre-requisites	None

Course objectives

The objective of this course is to revise the basic concepts of electronics/nuclear physics through standard set of experiments to correlate them with the corresponding theory.

Course Outcomes

CO 1: Learn the basics of gates.
CO 2: Construct basic combinational circuits and verify their functionalities
CO 3: Apply the design procedures to design basic sequential circuits
CO 4: To design current control oscillator, power supply and stabilizer

Suggestive List of Experiments

1. Study of multivibrator **[2 days]**
2. Study of Filter Circuits **[2 days]**
3. Microprocessor – I (Basic Experiments) **[2 days]**
4. Microprocessor – II (Advanced Experiments) **[2 days]**
5. Study of Amplitude Modulation **[2 days]**
6. Study of P-N junction at elevated temperatures **[2 days]**
7. Design and study of an ECL OR-NOR circuit. **[2 days]**
8. Design and study of an active band pass filter. **[2 days]**
9. Design and study of an active phase sifter. **[2 days]**
10. Design and study of a current controlled oscillator **[2 days]**
11. FET – characteristics, biasing and its applications as an amplifier **[2 days]**
12. SCR – Characteristics and its application as a switching device. **[2 days]**

13. Power supply-regulation and stabilization. **[2 days]**

14. Study of Gaussian and Poisson distributions **[2 days]**

15. Multi stage and tuned amplifiers. **[2 days]**

16. A/D and D/A converters. **[2 days]**

Reference/Text Books:

1. B.K. Jones, “Electronics for Experimentation and Research”, Prentice-Hall
2. P.B. Zbar, A.P. Malvino and M.A. Miller, “Basic Electronics”, A Text-Lab Manual, Tata Mc-Graw Hill, New Delhi
3. K. L. Ashley, “Analog Electronics with Lab VIEW”, Pearson Education.

CO-PO Mapping

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	3											3
CO 2	3				1							3
CO 3	3		2			1			2			3
CO 4	3	1							1			3

Semester 2

Curriculum and Detailed Syllabus

SEMESTER-2							
Sl. No.	**Type**	**Course No.**	**Course Name**	**L**	**T**	**P**	**Credits**
THEORY							
1	CC	PPH2001	Electrodynamics	3	1	0	4
2	CC	PPH2002	Quantum Mechanics	3	1	0	4
3	CC	PPH2003	Computational Physics	3	1	0	4
THEORY (for students of other departments)							
4	OE	PPH2004	Physics: Large to small bodies	3	1	0	4
PRACTICAL							
5	CC	PPH2101	Physics Laboratory - II	0	0	8	4
MANDATORY NON-CGPA COURSE							
6	MNCC	PPH2501	Seminar / Other Academic Activities	0	0	1	0
7	MNCC	PPH2502	SKILLX, NSS/ YOGA	0	0	1	0
TOTAL				**12**	**4**	**10**	**20**

CC- Core Course, OE- Open Elective, MNCC- Mandatory Non-CGPA Course

Course Code	PPH2001			
Course Title	Electrodynamics			
Category	Programme Core			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Course Objectives

This course aims to introduce the student to topics in Electromagnetic Theory and the Relativistic formulation of electromagnetism. It also builds up a covariant formulation of electrodynamics and includes a study of motion of charges in fields as well as radiation from moving charges.

Course Outcomes

CO 1: Students able to explain about Laplace and Poisson's equations, Static fields in material media, Polarization vector, macroscopic equations, classification of dielectric media, Molecular polarizability and electrical susceptibility

CO 2: Students able to update their knowledge about the differential equations of magneto statics, vector potential, magnetic fields of a localized current distribution Singularity

CO 3: Students able to understand about Formal solution of electrostatic boundary value problem with Green function, total power radiated by accelerating charge

CO 4: Students may apply knowledge of electrodynamics to solve problems

Course Contents

Module I: Basics of Electromagnetism (15 L)

Coulomb's law, Properties of conductors, Poisson and Laplace equations, Method of images, formal solution for potential with Green's functions, boundary value problems; Multipole expansion; Dielectrics, polarization of a medium; Electric displacement, Biot-Savart law, Ampere's law, Magnetic vector potential, Para / Dia / Ferro-magnetism, magnetic field from localized current distributions; Ohm's law, Faraday's law of induction; energy densities of electric and magnetic fields.

Module II: Maxwell's Equation and Conservation Laws (15L)

Maxwell's equations in vacuum, Displacement current, Continuity equation, Poynting's theorem, Electromagnetic momentum, Vector and Scalar potential in electrodynamics, gauge invariance and gauge fixing, Coulomb and Lorenz gauges, Conservation laws.

Module III: Electromagnetic Radiation (10 L)

Plane waves, reflection and refraction, Polarization,. Absorption and dispersion, frequency dispersion in dielectrics and metal. Metallic wave guides, Electric and Magnetic dipole Radiation, Radiation by moving charges, Radiation reaction, Jefimenko's equations, Lienard-Wiechert potential, total power radiated by an accelerated charge.

Module IV: Relativistic Electrodynamics (8 L)

4-vector potential, invariance of electric charge, Electromagnetic field tensor. Covariance of Maxwell's equations. Transformation of electromagnetic field. Relativistic potential Energy momentum-stress tensor of electromagnetic fields ,Covariant Lagrangian formulation of particle mechanics in presence of electromagnetic fields.

References/Text Books:

1. J.D. Jackson, "Classical Electrodynamics", Wiley
2. W.K.H. Panofsky and M. Phillips, "Classical Electricity and Magnetism", Dover
3. J.R.Reitz, F.J. Milford and R.W. Clisty, "Foundations of Electromagnetic theory", Pearson
4. D.J. Griffiths, "Introduction to Electrodynamics", Cambridge University Press
5. C.A. Brau, "Modern Problems in Classical Electrodynamics", Oxford University Press

CO-PO Mapping

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO 1	3		2									3
CO 2	3	2					3					3
CO 3	3		1									3
CO 4	3						2					3

Course Code	PPH2002
Course Title	Quantum Mechanics
Category	Programme Core
LTP & Credits	L T P Credits 3 1 0 4
Total Contact Hours	48
Pre-requisites	None

Course Objectives

The course provides knowledge about basic postulate of quantum mechanics give idea of standard one dimensional problem of quantum mechanics. This will acquaint students to apply quantum mechanical postulates on single, multi body problems and method of approximations.

Course Outcomes

CO 1: Students will learn the mathematical formalism of Hilbert space and will be able to apply the postulates of quantum mechanics to solve problems.

CO 2: Understanding the concept of quantum mechanical operators and Eigen value equation.

CO 3: Introduce the concept of approximation methods for quantum mechanical problems and will have idea of orbital angular momentum and spin concept.

CO 4: Students will gain their knowledge of scattering theory and will be able to solve problems related to scattering.

Module I: Basics of Quantum Theory (20 L)

The Schrodinger equation; Statistical interpretation; Gaussian wave packet; Spreading of a wave packet; Coordinate and Momentum space: Coordinate and Momentum representations; x and p in these representations; Expectation values; Stationary states; One-dimensional problems: Free particle, Infinite and Finite Square well problem ($E > 0$); Delta-function potential; Double-δ potential; Linear Harmonic Oscillator; Tunneling problem. Hilbert Space and Observables; Operator method in Quantum Mechanics; Uncertainty principle for two arbitrary operators; Schrodinger, Heisenberg and interaction pictures.. Eigenvalues and Eigen functions: Commutativity and simultaneous Eigen functions; Complete set of Eigen functions; Dirac Notation. Schrodinger equation in Spherical coordinates, The Hydrogen atom, Angular momentum algebra; Raising and lowering operators; Addition of two angular momenta — Clebsch-Gordan coefficients, examples. Spin; Stern-Gerlach experiment.

Module II: Different Methods and Approximations **(10 L)**

WKB Approximation: Quantization rule, tunneling through a barrier, qualitative discussion of α-decay. Time-independent Perturbation Theory: Approximation Methods; First and second order corrections to the energy eigenvalues; First order correction to the eigenvector; generate perturbation theory; Application to one-electron system – Relativistic mass correction, Spin-orbit coupling (L-S and j-j), Zeeman effect and Stark effect. Vibrational method: He atom as example; First order perturbation; Exchange degeneracy; Ritz principle for excited states for Helium atom, Hydrogen molecule ion. Identical particles: Quantum statistical mechanics. Identical Particles Meaning of identity and consequences; Symmetric and antisymmetric wave functions; Slater determinant; Symmetric and antisymmetric spin wave functions of two identical particles; Collisions of identical particles.

Module III: Perturbation Theory **(8 L)**

Time-dependent Perturbation Theory: Interaction picture; Constant and harmonic perturbations — Fermi's Golden rule; Sudden and adiabatic approximations.

Module IV: Scattering **(10 L)**

Scattering theory: Laboratory and center of mass frames, differential and total scattering cross-sections, scattering amplitude; Green's function in scattering theory Born approximation; Partial wave analysis and phase shifts; Coulomb scattering; Formal theory of scattering;

Reference/Text Books:

1. S. Gasiorowicz, " Quantum Physics", Wiley
2. P.M. Mathews and K. Venkatesan, " A Text Book of Quantum Mechanics", Mc Grow
3. E. Merzbacher, "Quantum Mechanics", Wiley
4. L.I. Schiff, "Quantum Mechanics", Cappella
5. J.J. Sakurai, "Modern Quantum Mechanics", World Scietific
6. P.M. Mathews and K. Venkatesan, "A Text Book of Quantum Mechanics", McGrow
7. A. Messiah, " Quantum Mechanics, Vol. II", Adison Wesley
8. D. Griffiths , "Introduction to Quantum Mechanics" , Pearson Education.

CO-PO Mapping

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO 1	3		2	3			2					3
CO 2	3	2		2			1					3
CO 3	3	1	2	2								3
CO 4	3	1		1			1					3

<table>
<tr><td>Course Code</td><td colspan="4">PPH2003</td></tr>
<tr><td>Course Title</td><td colspan="4">Computational Physics</td></tr>
<tr><td>Category</td><td colspan="4">Programme Core</td></tr>
<tr><td rowspan="2">LTP & Credits</td><td>L</td><td>T</td><td>P</td><td>Credits</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>4</td></tr>
<tr><td>Total Contact Hours</td><td colspan="4">48</td></tr>
<tr><td>Pre-requisites</td><td colspan="4">None</td></tr>
</table>

Course objectives

This course is an Introduction to a programming Language as well as application for Numerical Analysis. The course would impart training in the structure of the programming language as well as train the students in using programs to numerically solve problems in various areas.

Course Outcomes:

CO 1: Students able to Analyze the C characters, operators, analytic expression, arrays, functions and simple programs, Python interpreter and interactive mode.

CO 2: Students able to describe and apply the basics of MATLAB to solve linear systems and interpolation

CO 3: Students able to apply MATLAB to solve linear equation, non- linear equation and simultaneous equations

CO 4: Describe and Apply C language and MATLAB to solve interpolations, numerical differentiation and integration

Course Content

Module I: Basics of Computers **(10 L)**

Functional units-CPU, Memory, I/O units; Data Storage System; Memory management; IO Units – keyboard, mouse, VDU, printers; Number representation; Accuracy, range, overflow and underflow of number; error propagation and instability; Character representation: Alphanumeric codes, BCD, Gray, ASCII codes; Error detection and error correcting codes: Hamming codes; CRC codes; Operating Systems.

Module II: Algorithms and Flowchart **(10 L)**

Algorithms and flowchart; Structure of a high level language program; Features of C/F90 language; constants and variables; expressions; Input and output statements;

conditional statements and loop statements; arrays; functions; character strings; structures; pointer data type; list and trees; Subroutines and functions,; data files

Module III: Microsoft (16 L)

Microsoft Word: Typing Text, Save a document, Copying, Moving and Inserting, Insert Special Characters, Spell Check and Grammar, Formatting, Paragraph, Page setup, Headers and Footers, Page Breaks, Border and Shading, Document Printing, Graphics, Table and Columns, Caption, Templates, Web Pages, Hyperlinks. Microsoft PowerPoint: Enter and exit Text, Computer presentation, Slide Show, Applying Designs to slides, Formatting Presentation, Drawing Object, Master Slide, Hidden Slide, PowerPoint Objects, Adding Clipart, Create and Insert WordArt, Hyperlinks. Microsoft Excel: Worksheet, Cell Formatting, Entering Formula, Operator in excel, Data tool, Chart, Linking Worksheet, Create hyperlink. Web page design and implementation using html//: Web Pages, Lists, Links, Frames, Scripts.

Module IV: Programming (12 L)

Generation of uniformly distributed random integers, Statistical tests of randomness, Mon te Carlo evaluation of integral and error analysis, Non-uniform probability distributions, Importance sampling,
Software: Use of a package for plotting of data and functions, Curve Fitting, Extrapolation. Programming in MathCAD /MATLAB /MATHEMATICA /Python /C.

Reference/Books:

1. Gottfried, “Programming with C. Schaum series”, McGrow Hill Education
2. Tanenbaum, “Operating system”. Prentice Hall.
3. Sastry, Introductory Methods of Numerical Analysis.
4. Kyayszig, “Advance Engineering Mathematics”. John Willey
5. Tanenbaum, “Computer Network”, Prentice Hall.
6. V. Rajaraman, “Computer Oriented Numerical Methods”, PHI Learning Pvt Ltd
7. J.M. McCulloch and M.G. Salvadori, “Numerical Methods in Fortran”, Printice Hall
8. R. L. Burden and J. D. Faires, “Numerical Methods”, Brooks Cole International Edition

CO-PO Mapping

	Programme Outcomes (PO)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3				2							3
CO 2	3	2			2	1			1			
CO 3	3	1	2									3
CO 4	3				1							3

Course Code	PPH2101			
Course Title	Physics Laboratory II			
Category	Programme Core			
LTP & Credits	L	T	P	Credits
	0	1	3	4
Total Contact Hours	96			
Pre-requisites	None			

Course objectives

The objective of this course is to revise the basic concepts of Modern physics through standard set of experiments to correlate them with the corresponding theory.

Course Outcomes:

CO 1: Understand the mechanical properties of various materiaL

CO 2: Get the practical knowledge of Thermal properties of various materiaL and their applications

CO 3: Analyze the magnetic properties of materiaL and their applications

CO 4: Understand the characteristics of optical fibre

Experiments

1. Michelson Interferometer **[2 days]**
2. Study of Magneto-resistance **[2 days]**
3. To study the Faraday Effect and Verdert constant of the given material. **[2 days]**
4. Study the effect of magneto-striction of a given material **[2 days]**
5. Study of Optical Fiber and determination of Numerical Aperture **[2 days]**
6. Determination of Velocity of Ultrasonic Wave **[2 days]**
7. Calibration of Condenser **[2 days]**
8. Study of Iodine Spectra **[2 days]**
9. Resonant circuits. **[2 days]**
10. Measurement of thermoelectric power. **[2 days]**
11. Propagation of EM waves in a transmission line – Lecher wire. **[2 days]**
12. Study of elliptically polarized light. **[2 days]**

13. Determination of spot size and the angle of divergence of a laser source. **[2 days]**
14. Measurement of absorption coefficient of a material (using laser light. **[2 days]**
15. Verification of Bohr's atomic theory by Franck Hertz Experiment **[2 days]**
16. Magnetic parameters of a magnetic material by hysteresis loop tracer. **[2 days]**

Reference/Text Books:

1. R.A. Dunlap, “Experimental Physics: Modern Methods”, Oxford University Press,
2. E.V. Smith, “Manual for Experiments in Applied Physics”, Butterworths
3. D. Malacara (ed.), “Methods of Experimental Physics”, Series of Volumes, Academic Press

CO-PO Mapping

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO 1	3											3
CO 2	3	2			2				2			3
CO 3	3		2	1								3
CO 4	3											3

Semester 3

Curriculum and Detailed Syllabus

SEMESTER-3							
Sl. No.	**Type**	**Course No.**	**Course Name**	**L**	**T**	**P**	**Credits**
THEORY							
1	CC	PPH3001	Statistical Physics	3	1	0	4
2	CC	PPH3002	Solid State Physics	3	1	0	4
3	CC	PPH3003	Nuclear and Particle Physics	3	1	0	4
THEORY (Student may select one subject from item no 4 - 10)							
4	DSE	PPH3004	Advanced Quantum Mechanics	3	1	0	4
5	DSE	PPH3005	Advanced Electronics I	3	1	0	4
6	DSE	PPH3006	Advanced Mathematical Physics	3	1	0	4
7	DSE	PPH3007	Advanced Nuclear Physics	3	1	0	4
8	DSE	PPH3008	Advanced Experiments of Physics	3	1	0	4
9	DSE	PPH3009	General Theory of Relativity and Cosmology	3	1	0	4
10	DSE	PPH3010	Advanced Optics	3	1	0	4
PRACTICAL							
11	CC	PPH3101	Physics Laboratory- III	0	0	8	4
MANDATORY NON-CGPA COURSE							
12	MNCC	PPH3501	Seminar / Other Academic Activities	0	0	1	0
13	MNCC	PPH3502	SKILLX, NSS/ YOGA	0	0	1	0
			TOTAL	**12**	**4**	**10**	**20**

PC- Core Course, DSE- Discipline Specific Elective, MC- Mandatory Non-CGPA Course

Course Code	PPH3001			
Course Title	Statistical Physics			
Category	Programme Core			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Course Objectives

This course introduces students to statistical mechanics, which is part of the foundation of several branches of physics and has many applications beyond physics. The course demonstrates the profound consequences of an economical set of assumptions about nature known as the postulates of statistical mechanics. In particular, it shows how the postulates explain the general laws of thermodynamics as well as properties of classical and quantum gases, other condensed matter systems in equilibrium, and phase transitions.

Course Outcomes

CO 1: Explain the microstates and macro states of Ideal gas and microstate and macro state in classical systems, and derivation of Maxwell's relations, and thermodynamic laws

CO 2: Applications of these ensembles to classical ideal gas and explaining about types of oscillators.

CO 3: Explanation of postulates of Quantum Statistical Mechanics and types of ensembles and energy distributions

CO 4: Explaining of Thermodynamic behavior of Ideal, Bose, Fermi gases and applications of statistical mechanics, interacting systems and phase transitions

Course Content

Module I: Basics of Thermodynamics **(8 L)**

Review of thermodynamics and topics in probability theory: Quasistatic and nonquasistatic processes, laws of thermodynamics, entropy of a probability distribution, random walks.

Module II: Classical Ensemble Theory **(20 L)**

Classical ensemble theory: Phase space, microstates and macro states; Liouville's equation, Postulates of statistical mechanics, Micro canonical ensemble, Boltzmann relation for entropy, Definition of temperature, derivation of the laws of thermodynamics for macroscopic systems, Sackur-Tetrode equation, Canonical ensemble; partition function; Helmholtz free energy, Grand-canonical ensemble, Equivalence of the various ensembles, Application to various classical systems.

Module III Quantum Statistical Mechanics **(10 L)**

Quantum statistical mechanics: Indistinguishable particles in quantum mechanics. Bosons and Fermions. Bose-Einstein statistics, ideal Bose gas, photons, Bose-Einstein condensation. Fermi-Dirac statistics, Fermi energy, ideal Fermi gas. Density operator, Quantum Liouville equation. Pure and mixed states.

Module IV Interacting Systems and Phase Transitions **(10 L)**

Interacting systems and phase transitions: Interacting spin systems. The Ising model. Exact solution of Ising model in 1-dimension, mean-field solution in higher dimensions. Paramagnetic and ferromagnetic phases. Critical exponents. Order parameter, Landau theory, Universality.

Reference/Text Books:

1. M. Kardar, "Statistical Physics of Particles", Cambridge University Press
2. K. Huang, " Statistical Mechanics", Wiley-India.
3. R.K. PatLia, "Statistical Mechanics", Butterworth-Heinemann
4. L. D. Landau and E. M. Lifshitz, "Statistical Physics,", Elsevier.

CO-PO Mapping

	Programme Outcomes (PO)											
	PO 1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO 1	3	2		1			1					3
CO 2	3	2			1							3
CO 3	3			2			1					3
CO 4	3	2					1					3

Course Code	PPH3002			
Course Title	Solid State Physics			
Category	Programme Core			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Course objectives

The aim of this course is to introduce the important features of solid state physics by covering crystal structure and binding, lattice dynamics, band theory of solids. This also provide the basic knowledge on semiconductors and superconductivity.

Course Outcomes

CO 1: Students will able to understand the basics of conductivity in metal and the Fermi surfaces.

CO 2: Students will gain knowledge on crystal structure and various diffraction techniques to determine the structural parameters.

CO 3: Students will have idea of defects and diffusions in solids and lattice dynamics.

CO 4: To give basic idea of formation of electronic band structure in material. Also provide knowledge about semiconductors and superconductivity.

Course Content

Module I: Basics of Metal (10 L)

Metal: Drude theory, DC conductivity, magneto-resistance, thermal conductivity, thermoelectric effects, Fermi-Dirac distribution, thermal properties of an electron gas, Wiedemann- Franz law, critique of free-electron model.

Module II: Crystal Lattices (10 L)

Diffraction of electromagnetic waves by crystal: X-rays, Electrons and Neutrons, Symmetry operations and classification of Bravais lattices, common crystal structures, reciprocal lattice, Brillouin zone, X-ray diffraction, Bragg's law, Von Laue's formulation, diffraction from non-crystalline systems. Geometrical factors of SC, FCC, BCC and diamond lattices; Basis of quasi crystal. Bond classifications – types of crystal binding, covalent, molecular and ionic crystal, London theory of van der Waal, hydrogen bonding, cohesive and Madelung energy.

Module III: Lattice Dynamics **(12 L)**

Defects and Diffusion in Solids: Point defects: Frenkel defects, Schottky defects, examples of colour centres, line defects and dislocations.
Lattice Dynamics: Failure of the static lattice model, adiabatic and harmonic approximation, vibrations of linear monoatomic lattice, one-dimensional lattice with basis, model of three dimensional lattices, quantization of lattice vibrations, Einstein and Debye theories of specific heat, phonon density of states, neutron scattering.

Module IV: Band Theory **(16 L)**

Band theory of Solids: Periodic potential and Bloch's theorem, weak potential approximation, density of states in different dimensions, energy gaps, Fermi surface and Brillouin zones. Origin of energy bands and band gaps, effective mass, tight-binding approximation and calculation of simple band-structures. Motion of electrons in lattices, Wave packets of Bloch electrons, semi-classical equations of motion, motion in static electric and magnetic fields, theory of holes, cyclotron resonance.
Semiconductors: General properties and band structure, carrier statistics, impurities, intrinsic and extrinsic semiconductors, drift and diffusion currents, mobility, Hall effect. Superconductors: Phenomenology, review of basic properties, thermodynamics of superconductors, London's equation and Meissner effect.
Type-I and Type-II superconductors, BCS theory of superconductors.

Reference/Text Books:

1. C. Kittel , "Introduction to Solid State Physics", Wiley
2. N. W. Ashcroft and N. D. Mermin, " Solid State Physics", Cengage Learning,
3. J. M. Ziman, "Principles of the Theory of Solids", Cambridge University Press
4. A. J. Dekker , "Solid State Physics", Macmillan India,.
5. G. Burns, " Solid State Physics", Academic Press.
6. M. P. Marder " Condensed Matter Physics", Wiley

CO-PO Mapping

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO 1	3	1		1								3
CO 2	3	1	2		3		1					3
CO 3	3	2		2			2					3
CO 4	3	1			2		2					3

Course Code	PPH3003			
Course Title	Nuclear and Particle Physics			
Category	Programme Core			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Course Objectives

The main objectives of this course are to impart the understanding of fundamental forces by studying nuclear and weak forces. Understanding of nuclear structure and reaction dynamics will provides knowledge of nuclear-nucleon interaction.

Course Outcomes

CO 1: Students will apply the model describing the basic nucleon and nuclear properties

CO 2: Properties and decay principles of Beta and Gamma rays will be reviewed, their selection rules will be understood.

CO 3: They are able to enhance their concepts in nuclear model

CO 4: Understand and identify the basic aspiration of elementary particles

Course Content

Module I: Properties of Nuclei **(12 L)**

Static properties of Nuclei: Nuclear Mass & size determination, Mott scattering, nuclear form- factors. Angular momentum, spin, parity, iso-spin and moments of nuclei (Electric and Magnetic).

Two Nucleon Systems & Nuclear Forces: Dipole and quadruple moments of the deuteron, Central and tensor forces, Evidence for saturation property, Neutron-proton scattering, exchange character, spin dependence (ortho and para-hydrogen), charge independence and charge symmetry. S-wave effective range theory. Proton-proton scattering (qualitative idea only). Evidence for hardcore potential. Meson theory.

Module II: Nuclear Model **(16 L)**

Nuclear Model: Concept of Liquid drop model, Magic nuclei, nucleon separation energy, Single particle shell model (including Mean filed approach, spin orbit coupling), Physical concepts of the unified model (Collective Model)

Nuclear Decays and Reactions: Electromagnetic decays: selection rules, Fermi theory of beta decay. Kurie plot. Fermi and Gamow-Teller transitions. Logeft value, Parity violation in beta-decay. Gamma decay, selection rules, Introduction to Nuclear Reactions (Conservation Laws, kinematics of reactions, Q-value, reaction rate, reaction cross section), Concept of Direct and compound nuclear reaction.

Module III: Elementary Particles **(10 L)**

Elementary Particles: Relativistic kinematics, Various Interactions, Parity, Charge Conjugation and Time Reversal, Classification: spin and parity determination of pions and strange particles. Gell-Mann Nishijima scheme. Properties of quarks and their classification. Elementary ideas of SU(2) and SU(3) symmetry groups and hadron classification. Introduction to the standard model. Electroweak interaction-W & Z Bosons.

Module IV: Nuclear Detectors **(10 L)**

Nuclear Detectors: Interaction of radiation with matter (qualitative idea), Basics of Solid state detectors, Scintillation and gas detectors for particle and electromagnetic radiation detection, idea of Calorimeter, Hybrid detectors and arrays.

Reference/Text Books:

1. K. S. Krane, “ Introducing Nuclear Physics”, Wiley India.
2. R.R. Roy & B.P. Nigam, “Nuclear Physics – Theory & Experiments”, New Age
3. International.
4. C. A. Bertulani, “Nuclear Physics in A Nutshell”, Princeton University Press
5. B. L. Cohen, “Concept of Nuclear Physics”, McGraw – Hill
6. S. N. Ghoshal, “ Nuclear Physics”, S. Chand Publication
7. Introduction to Elementary Particles, Academic Press.
8. S. Naeem Ahmed, “ Physics and Engineering of Radiation Detection” Academic Press
9. Nuclear and Particle Physics , A.B. Bhattacharya, R. Bhattacharya and R. Raha, NCBA
10. G.F. Knoll, “ Radiation detection and measurement”, John Wiley Sons, Inc.

CO-PO Mapping

	Programme Outcomes (PO)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3				2							3
CO 2	3		2	1								3
CO 3												3
CO 4	3				2							3

Course Code	PPH3004			
Course Title	Advanced Quantum Mechanics			
Category	Elective Paper			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Course objectives

The primary objective is to teach the students various approximation methods in quantum mechanics and how to use perturbation theory to obtain corrections to energy Eigen-states and Eigen-values when an external electric or magnetic field is applied to a system

Course Outcomes:

CO 1: Students able to apply symmetry in quantum mechanics to solve different problems

CO 2: Relativistic quantum mechanics will provide an exposure to how special relativity in quantum theory leads to intrinsic spin angular momentum as well as anti-particles

CO 3: Students able to understand Dirac equations and its applications

CO 4: Non relativistic problems solutions using quantum rules

Course Content

Module 1: Symmetries in Quantum Mechanics **(15 L)**

Symmetries in quantum mechanics Conservation laws and degeneracy associated with symmetries; Continuous symmetries — space and time translations, rotations; Rotation group, homomorphism between SO(3) and SU(2); Explicit matrix representation of generators for j = 1 2 and j = 1; Rotation matrices; Irreducible spherical tensor operators, Wigner-Eckart theorem; Discrete symmetries

Module II: Relativistic Quantum Mechanics **(15 L)**

Relativistic Quantum Mechanics Klein-Gordon equation, Feynman-St¨uckelberg interpretation of negative energy states and concept of antiparticles

Module III: Dirac Equation **(10 L)**

Dirac equation, covariant form, adjoin equation; Plane wave solution and momentum space spinners; An electron in an electromagnetic field; Spin and magnetic moment of the electron; solutions Dirac equation for the hydrogen atom. Spin-orbit coupling and fine structure.

Module IV: Nonrelativistic Reduction (8 L)

Nonrelativistic reduction; Helicity and chirality; Properties of γ matrices; Charge conjugation time reversal and other symmetries.; Normalisation and completeness of spinors

Reference/Text Books:

1. J.D. Bjorken and S.D. Drell, “ Relativistic Quantum Mechanics”, MC Graw Hill
2. W. Greiner, “ Relativistic Quantum Mechanics”, Spinger
3. A. Lahiri and P.B. Pal, “ A First Book of Quantum Field Theory”, Narosa
4. A. Schweber, “ Relativistic Quantum Field Theory”, Dover Publications

CO-PO Mapping

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO 1	3	2	1									3
CO 2	3				1							3
CO 3	3	2	1									3
CO 4	3											3

Course Code	PPH3005			
Course Title	Advanced Electronics I			
Category	Elective Paper			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Course Objectives

To enhance the understanding of basic design principles and constructional detaiL of specialized semiconductor devices used for high frequency applications in modern communication networks and systems**.**

Course Outcomes:

CO 1: Students will able to explain the operation of 8085 microprocessor
CO 2: Students will able to explain the operation of 8086 microprocessor
CO 3: Students will able to explain the operation of advanced microprocessor
CO 4: Students may apply microprocessors in different circuits

Course Content

Module I: Intel 8085 (14 L)

Internal operation of Intel 8085. Instructions, Opcodes, operands and mnemonics. Constructing machine language codes for instructions, Instruction execution timing diagram. Instruction word size and addressing modes, Instruction set. Stacks subroutines and Interrupts, Machine and assembly language programming.

Module II: Intel 8086 (14 L)

Architecture, Pin description for minimum and maximum modes, Internal operation, Instruction execution timing diagram, Addressing modes. Instruction format for constructing machine language codes for different instructions. Introduction to assembly language. Instruction set and directives, Stacks, Procedures, Macros and interrupts. Flow chart of standard programming structures. I/O interfacing and data transfer scheme.

Module III: Advanced Microprocessors (10 L)

Multitasking, Architecture and memory management of microprocessor 80286, Brief idea about architecture of microprocessor 80386, 80486 and Pentium, Introduction to Microcontroller.

Module IV: Microprocessor based Measurement/Control Circuits (10 L)

Transducers, D/A and A/D Converters, PPI 8255 Data acquisition and storage, Microprocessor based traffic light controller, Temperature and water label indicator/ controller. DC and steper motor speed measurements, Waveform generation and frequency measurement.

Reference/ Text Books

1. B. Ram, "FundamentaL of Microprocessors and Microcomputers", Dhanpat Rai publications
2. Y.C.Liu and G.A. Gibson, "Microprocessor System the 8086 /8088 Family" , PHI publications
3. R.S. Goonkar, "Microprocessor, Architecture, Programming and Application", PENRAM
4. A.P. Mathur, "Introduction to Microprocessor", McGrow Hill
5. D.V. Hall , "Microprocessor and Interfacing", McGrow Hill

CO-PO Mapping

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO 1	3											3
CO 2	2	2	2		2				1			3
CO 3	3	2										3
CO 4	1				2							3

Course Code	PPH3006			
Course Title	Advanced Mathematical Physics			
Category	Elective Paper			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Course Outcomes:

CO 1: Group theory is applied to understand systems behavior in different coordinate systems.

CO 2: Students will get an idea of probability distributions and their applications

CO 3: Students will able to apply integral equations in different physical systems

CO 4: Boundary value problems will help students to study states of the physical systems

Course Content

Module I: Finite discrete Group **(16 L)**

Finite discrete Group: Abstract groups: subgroups, classes, cosets, factor groups, normal subgroups, direct product of groups; Examples: cyclic, symmetric, matrix groups, regular n-gon. Mappings: homomorphism, isomorphism, automorphism. Representations: reducible and irreducible representation, unitary representations, Schur's lemma and orthogonality theorems, characters of representation, direct product of representations.

Module II: Continuous Group **(12 L)**

Review of the continuous groups: Lie groups, rotation and unitary groups. Applications: point groups, translation and space groups, representation of point groups; introduction to symmetry group of the Hamiltonian.

Module III: Integral Equations **(10 L)**

Conversion of ordinary differential equations into integral equations, Fredholm and Volterra integral equations, separable kerneL, Fredholm theory, Eigen values and Eigen functions.

Module IV: Green Function **(10 L)**

Boundary Value Problems: boundary conditions: Dirichlet and Neumann; self-adjoint operators, Sturm-Liouville theory, Green's function, Eigen function expansion.

Reference/Text Books:

1. A.W. Joshi, “Elements of Group Theory for Physicists”, John Wiley.
2. M. A. Armstrong , “Groups and Symmetry”, Springer.
3. R. S. Kaushal & D. Parashar ,“Advanced Method of Mathematical Physics”, Narosa.
4. M. Hamermesh , “Group Theory and Its Applications to Physical Problems”, Dover.
5. F. Albert Cotton , “Chemical Applications of Group Theory”, John Wiley.
6. G. Arfken, H. Weber, & F. Harris, “Mathematical Methods for Physicists”, ELevier.
7. W. V. Lovitt , “Linear Integral Equations”, Dover.
8. J. Jerri ,“Introduction to Integral Equations with Applications”, Wiley-Interscience.

CO-PO Mapping

	Programme Outcomes (PO)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3											3
CO 2	3	2	1		2							3
CO 3	3											3
CO 4	3											3

Course Code	PPH3007			
Course Title	Advanced Nuclear Physics			
Category	Elective Paper			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Course Objectives

The course will provide a understanding about behavior of the nuclei by studying nuclear reaction and nuclear structure model. A physical understanding of nuclear process has been introduced with appropriate mathematical basics.

Course Outcomes

CO 1: Students will enhance their knowledge in nuclear reactions

CO 2: Students will get an idea of different nuclear modeL

CO 3: Students will able to understand rotational and vibrational spectra

CO 4: Students will understand the ISOL and Fragmentation techniques for the production of exotic nuclei

Module I: Nuclear Reaction (16 L)

Types of reaction, Briet-Winger and Resonances, Direct reaction, elastic and inelastic scattering, Transfer reaction (semi-classical approach), Fusion, Breakup, coupled channel approach, Compound nuclear reaction and statistical modeL, Coulomb excitation and its applications.

Module II: Nuclear Structure (10 L)

Shell model: Review of shell Model, magic numbers, single particle shell model, Self-consistent approach, basic concept of Hartee-Fock and Hartee-Fock- Bogallibog methods, Shell correction, Quasi-particle, Seniority Scheme, M and J- scheme, Transformation from M-scheme to J-Scheme, D-Matrix, Collective Model of Nucleus.

Module III: Rotational and Vibrational Spectra (10 L)

Rotational and Vibrational Spectra (brief derivation). Beta and Gamma vibration, Nuclear moment of inertia, band head & back bending, Variable moment of inertia ModeL for normal and deformed nuclei, NiLson ModeL and NiLson Diagram, Particle Rotor Model, Deformed and Rotational Alignment, Nuclear isomers.

Module IV: Exotic Nuclei (12 L)

Exotic Nuclei: Nuclear landscape and drip lines, Production of exotic nuclei – ISOL and

Fragmentation technique, Super Heavy Element (SHE) production, Structure of exotic nuclei and application in astrophysics, break down of magic numbers, exotic shapes, Halo nuclei, neutron skin, GDR and soft dipole resonance (reaction point of view).

Reference/Text Books:

1. M.K. Pal, “Theory of Nuclear Structure, East-West Press
2. R. F. Casten, “ Nuclear Structure from a Simple Perspective”, Oxford Univ.
3. A.B. Bhattacharya, R. Bhattacharya and R. Raha,, “Nuclear and Particle Physics” , NCBA
4. P.E. Hodgson, “Nuclear Reaction and Nuclear Structure’, Clarendon Press

CO-PO Mapping

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO 1	3											3
CO 2	3	1	2		1							3
CO 3	3				2							3
CO 4	3											3

Course Code	PPH3008			
Course Title	Advanced Experiments of Physics			
Category	Elective Paper			
LTP & Credits	L	T	P	Credits
	0	4	0	4
Total Contact Hours	48			
Pre-requisites	None			

Course Objectives

This course will familiarize students with some landmark experiments in physics

Course Outcomes

CO 1: Students will get an idea how basic experiments are designed

CO 2: Students will able to understand experiments of different fields of Physics

CO 3: Students will able how an experiment approaches to a success one

Course Content

A student will prepare write up followed by power point presentation of any eight experiments from the list given below:

1. Mössbauer effect **[3 days]**
2. Pound-Rebka experiment to measure gravitational red shift **[3 days]**
3. Parity violation experiment of Wu **[3 days]**
4. Superfluidity of 3He **[3 days]**
5. Cosmic microwave background radiation **[3 days]**
6. Helicity of the neutrino **[3 days]**
7. Quantum Hall effect - integral and fractional **[3 days]**
8. Laser cooling of atoms **[3 days]**
9. Ion traps **[3 days]**
10. Bose-Einstein condensation **[3 days]**
11. Josephson tunneling **[3 days]**
12. Atomic clocks **[3 days]**

13.Interferometry for gravitational waves **[3 days]**

14.Inelastic neutron scattering **[3 days]**

15.CP violation **[3 days]**

16.Verification of predictions of general theory of relativity by binary-pular and other experiments **[3 days]**

17.Precision measurements of magnetic moment of electron **[3 days]**

18.Scanning tunneling microscope **[3 days]**

19.Discovery of the Higgs particle **[3 days]**

20.Discovery of Neutrino oscillation **[3 days]**

References:

The original papers, review articles and Nobel constitute the resource material for this course.

CO-PO Mapping

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO 1	3											3
CO 2	3			2								3
CO 3	3											3

Course Code	PPH3009
Course Title	General Theory of Relativity and Cosmology
Category	Elective Paper
LTP & Credits	L: 0, T: 4, P: 0, Credits: 4
Total Contact Hours	48
Pre-requisites	None

Course Objectives

The primary objective is to teach the students the physical and mathematical basis of Einstein's relativistic theory of gravitation

Course Outcomes

CO 1: Students able to understand , Energy-momentum tensor

CO 2: Students will able to enhance their knowledge in general theory of relativity

CO 3: Students will get an idea of black hole

CO 4: Students will able to understand basic concepts of cosmology

Course Content

Module I: Basics of Relativity (12 L)

Riemannian space, Contravariant and covariant vectors, Summation convention, Metrics and Geodesics, Clistoffel's symbol and Levicivita symbol, Covariant differentiation , Riemann- Clistoffel curvature tensor, Bianchi identities, Ricci tensor, Parallel displacement and Affine connections, Energy-momentum tensor.

Module II: Principles of Relativity (12 L)

Introduction to General Relativity: Mach's principle, E¨otv¨os experiment and the equivalence principle, Einstein's Field Equations, Schwarzschild Solution, Killing vector, Birkhoff's theorem, Experimental tests of General relativity: Perihelion shift of Mercury, Bending of light, Gravitational red shift, Shapiro time delay, Einstein's Field Equations in non empty space, Gravitational waves.

Module III: Black Holes (12 L)

Black holes, Singularity.Schwarzschild Black holes, Kruskal-Szekeres coordinates Kerr Black hole. Ergosphere, Penrose process, Reissner – Nordstrom Solution, Event Horizon, Kerr Neumann Metric. No hair theorem, Cosmic Censorship Hypothesis.

Module IV: Introduction to Cosmology (12 L)

Introduction to Cosmology, Cosmological Principle and Weyl postulate, Large scale homogeneity and isotropy of the universe, Robertson-Walker metric, Friedmann's equations, Expanding universe and Hubble's law., Radiation and matter-dominated phases, Cosmological red shift. Some problems of Standard Cosmology. Qualititative discussions on Early Universe: Big Bang, Inflationary paradigm; Slow roll model, Constituents of the universe; Dark matter and dark energy, Primordial Nucleosysnthesis, CMBR anisotropy as a hint to large scale structure formation;

Reference/ Text Books

1. J. B. Hartle, " Gravity- An introduction to Einstein's general relativity", Addison-Wesley
2. R. Adler, M. Bazin and M.Schiffer , "Introduction to General Relativity" McGraw Hill.
3. P.G. Bergmann , "Theory of Relativity" , Prentice Hall.
4. J.V.Narliker, " General Relativity and Cosmology" Macmillan Press
5. P. M. A. Dirac," Introduction to general Relativity", Princeton University Press
6. S. Weinberg, "Gravitation and Cosmology" Wiley

CO-PO Mapping

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO 1	3											3
CO 2	3	2			1							3
CO 3	3	1										3
CO 4	3											3

Course Code	PPH3010			
Course Title	Advanced Optics			
Category	Elective Paper			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Course objectives

The objective of this course is to give idea about the nonlinear optics and its applications

Course Outcomes

CO 1: Understanding and explaining the various lasers systems and their applications

CO 2: Illustrating the various mechanism in nonlinear optics

CO 3: Fundamental properties of optical fibers, types of optical fibers and their related information

CO 4: Students will able to compare different optical radiation detectors

Course Content

Module 1: Basic Laser Theory (15 L)

Historical background, Einstein coefficients, population inversion , Solid State Laser: Host material and its characteristics, doped ions, Nd:YAG laser, Liquid laser: Dye laser, Semiconductor laser. Laser beam propagation, properties of Gaussian beam, resonator, stability, various types of resonators, resonator for high gain and high energy lasers, Gaussian beam focusing.

Module 1I: Nonlinear Optics (15 L)

Origin of nonlinearity, susceptibility tensor, phase matching, second harmonic generation, methods of enhancement, frequency mixing processes, nonlinear optical material. Holography: Importance of coherence, Principle of holography and characteristics, Recording and reconstruction, classification of hologram and application, non-destructive testing. Transient effect: Q- switching, different methods of Q-switching, electro-optic Q-switching, Pockel cell

Module III: Fibre Optics (15 L)

Dielectric slab waveguide, modes in the symmetric slab waveguide, TE and TM modes,

modes in the asymmetric slab waveguide, coupling of the waveguide (edge, prism, grating), dispersion and distortion in the slab waveguide, integrated optics components (active, passive), optical fiber waveguides (step index, graded index, single mode), attenuation in fibre, couplers and connectors, LED, injection laser diode (double heterostructure, distributed feedback)

Module IV: Detection of Optical Radiation (3 L)

Thermal detector (bolometer, pyro-electric), photon detector (photoconductive detector, photo voltaic detector and photo emissive detector), p-i-n photodiode, APD photodiode

Reference/Text Books:

1. W Koechner, " Solid State Laser Engineering" , Springer
2. C L Tang , "Methods of Experimental Physics Vol. 15B, Ultrasonic
3. J F Ready , "Industrial Application of Lasers" Elsevier
4. R L Sautherland ,"Handbook of Nonlinear Optics" , Marcel Dekker INC
5. C C Davis ,"Laser and electrooptics" Cambridge University Press
6. J. C Palais , "Fibre optic communication" McGrow Hill
7. A. Svelto, " Principles of lasers" , Springer

CO-PO Mapping

	Programme Outcomes (PO)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3											3
CO 2	3				2							3
CO 3	3						1					3
CO 4	3	2										3

Course Code	PPH3101			
Course Title	Physics Laboratory III			
Category	Programme Core			
LTP & Credits	L	T	P	Credits
	0	1	3	4
Total Contact Hours	96			
Pre-requisites	None			

Course objectives

The objective of this course is to revise the basic concepts of lattice dynamics, laser theory, dielectric properties etc. through standard set of experiments to correlate them with the corresponding theory.

Course Outcomes

CO 1: Understand the lattice dynamics
CO 2: Get the practical knowledge of dynamics of material
CO 3: Analyze the dielectric properties of material
CO 4: Understand the characteristics of laser, Acousto-optical effect

Experiments

1. Determination of e/m of an electron **[2 days]**
2. Determination of Planck's Constant **[2 days]**
3. Determination of Band-Gap of a Semiconductor **[2 days]**
4. Determination of Lande g – factor **[2 days]**
5. Study of Lattice Dynamics **[2 days]**
6. Study of Hall Effect at elevated temperatures. **[2 days]**
7. Study of Dielectric constant and determination of Curie temperature. **[2 days]**
8. Determination of numerical aperture of a fiber. **[2 days]**
9. G.M. Counters – characteristics, dead time and counting statistics. **[2 days]**
10. Beta ray absorption – end point energy of beta particles. **[2 days]**
11. Lifetime of a short lived radioactive source. **[2 days]**
12. Electron Spin Resonance. **[2 days]**
13. Nuclear Magnetic Resonance. **[2 days]**

14. Crystal structure by x-ray diffraction powder photograph method. **[2 days]**
15. Band spectrum in liquids. **[2 days]**
16. Acousto-optical effect using piezo-electric crystal. **[2 days]**

Reference/Text Books:

1. R.A. Dunlap, "Experimental Physics: Modern Methods", Oxford University Press,
2. E.V. Smith, "Manual for Experiments in Applied Physics", Butterworths
3. D. Malacara (ed.), "Methods of Experimental Physics", Series of Volumes, Academic Press

CO-PO Mapping

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO 1	3											3
CO 2	3		1		1							3
CO 3	3	2										3
CO 4	3											3

Semester 4

Curriculum and Detailed Syllabus

SEMESTER-4							
Sl. No.	**Type**	**Course No.**	**Course Name**	**L**	**T**	**P**	**Credits**
THEORY							
1	CC	PPH4001	Atomic and Molecular Physics	3	1	0	4
THEORY (Student may select two subjects from item no 2 - 9)							
2	DSE	PPH4002	Energy Sources, Storage and Harvesting	3	1	0	4
3	DSE	PPH4003	Advanced Electronics II	3	1	0	4
4	DSE	PPH4004	Radiation Physics and Safety	3	1	0	4
5	DSE	PPH4005	Atmospheric Physics	3	1	0	4
6	DSE	PPH4006	Group Theory	3	1	0	4
7	DSE	PPH4007	Physics at the Nano Scale	3	1	0	4
8	DSE	PPH4008	Plasma Physics	3	1	0	4
9	DSE	PPH4009	Astrophysics	3	1	0	4
PRACTICAL							
10	CC	PPH4101	Project/Term Paper	0	0	12	6
11	CC	PPH 4102	Grand Viva	0	0	0	2
MANDATORY NON-CGPA COURSE							
12	MNNC	PPH4501	Seminar / Other Academic Activities	0	0	1	0
13	MNNC	PPH4502	SKILLX, NSS/ YOGA	0	0	1	0
TOTAL				**12**	**4**	**10**	**20**

CC- Physics Core, DSE- Discipline Specific Elective, MNNC- Mandatory Non-CGPA Course

Course Code	PPH4001			
Course Title	Atomic and Molecular Physics			
Category	Programme Core			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Course Objective

The main objective is to teach the students the basic atomic and molecular (diatomic) structures with quantum mechanical approach leading to their fundamental spectroscopies. The fundamental and properties of a coherent light source as Laser (various types) will also be taught.

Course Outcomes

CO 1: Students will able to explain the electronic structure in atoms using different spectra

CO 2: Students able to study of molecular energy leveL using rotational and vibrational spectroscopy

CO 3: Students may explain of Raman effect of rotational, vibrational and polyatomic molecules

CO 4: Student will get basic idea of Laser.

Course Content

Module I: Atomic Physics **(10 L)**

Atomic Physics : Fine structure of hydrogenic atoms, Mass correction, spin-orbit term, Darwin term. Intensity of fine structure lines. Effect of magnetic and electric fields:Zeeman, Paschen-Bach and Stark effects. The ground state of two-electron atoms –perturbation theory and variational methods. Many-electron atoms – Central Field Approximation-L and jj coupling schemes, Lande interval rule. The Hartrec- Fock equations. The spectra of alkalis using quantum defect theory. Selection rules for electric and magnetic multipole radiation. Auger process.

Module II: Molecular Structure **(10 L)**

Molecular Structure: Born-Oppenheimer approximation for diatomic molecules, rotation, vibration and electronic structure of diatomic molecules. Spectroscopic terms. Centrifugal distortion. Electronic structure-Molecular symmetry and the states. concepts of correlation diagrams for heteronuclear molecules.

Module III: Molecular Spectra **(14 L)**

Molecular Spectra : Rotational spectra of diatomic molecules-rigid and non-rigid rotors, isotope effect, Vibrational spectra of diatomic molecules- harmonic and anharmonic vibrators, Intensity of spectral lines, dissociation energy, vibration-rotation spectra ,Electronic spectra of diatomic molecules- vibrational structure of electronic transitions (coarse structure)-progressions and sequences. Rotational structure of electronic bands (Fine structure)-P,Q,R branches. Fortrat diagram. Intensities in electronic bands-The Franck-Condon principle.The electron spin and Hund's cases. Raman Effect. Electron Spin Resonance. Nuclear Magnetic Resonance.

Module IV: Lasers **(14 L)**

Lasers : Life time of atomic and molecular states. Multilevel rate equations and saturation.Coherence and profile of spectral lines. Rabi frequency. Laser pumping and population inversion. He-Ne Laser, Solid State laser, Free-electron laser. Non-linear phenomenon.Harmonic generation. Liquid and gas lasers, semiconductor lasers.

Reference/Text Books:

1. B. H. Bransden and C. J. Jochain, "Physics of Atoms and Molecules", Pearson
2. G. Herzberg, "Atomic Spectra and Atomic Structure", Dover Publications
3. G. Herzberg, "Molecular Spectra and Molecular Structure", Van Nostrand
4. W. Demtroder , "Atoms, Molecules and Photons", Springer.
5. C. N. Banwell, "FundamentaL of Molecular Spectroscopy", McGraw Hill
6. J. M. Hollas, " Basic atomic & Molecular Spectroscopy", Royal Society of Chemistry.
7. O. Svelto , "Principles of Lasers", Springer

CO-PO Mapping

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO 1	3											3
CO 2	3		1		1							3
CO 3	3											3
CO 4	3	2			2							3

Course Code	PPH4002			
Course Title	Energy Sources, Storage and Harvesting			
Category	Elective Paper			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Course Objective

To enhance knowledge of energy storage and harvesting

Course Outcomes

CO 1: Students will understand the basic concepts of energy

CO 2: Students will get an idea of the use of nonrenewable energy sources

CO 3: Students will able to understand the potential of solar energy and energy harvesting

CO 4: Hydrogen energy and devices will help students to design energy harvesting systems

Course Content

Module I: Basic Concept of Energy **(12 L)**

Basic concepts and forms of energy; Principles of energy conversion; Global energy use and supply; Energy use pattern in different parts of the world, Electrical energy-generation, transmission and storage; energy in transportation

Module II: Power Plants **(12 L)**

Fossil fuel – classification, composition, physio-chemical characteristics and energy content of coal, petroleum and natural gas; Fossil fueled power plants and their Environmental impact, Hydro-power and their Environmental impacts, Radioactivity, nuclear-fission and fusion and nuclear fueled power plants, Nuclear fuel cycle and radioactive waste

Module III: Solar Energy **(12 L)**

Sun as source of energy, Passive Solar energy, Solar thermal energy, solar collectors, solar ponds; Fundamental of photovoltaic Energy Conversion Physics Solar photovoltaic cell, Types of Solar Cell, p-n junction solar cell, Transport Equation, Current Density, Open circuit voltage and short circuit current, Brief description of single crystal silicon and organic and Polymer Solar Cell, Elementary Ideas of Advanced Solar Cell e.g. Tandem Solar cell, Solid Liquid Junction Solar Cell, Nature of Semiconductor, Principles of Photo-electrochemical Solar Cell.

Module IV: Hydrogen Energy (12 L)

Hydrogen Energy: Physics of material characteristics for production of Solar Hydrogen. Brief discussion of various storage processes, Various factors relevant to safety, use of Hydrogen as Fuel, Use in Vehicular transport, Hydrogen for Electricity Generation, Fuel Cell, Various type of Fuel Cell, Applications of Fuel Cell, Elementary concepts of other Hydrogen- Based devices

Field Visits: Power Plants

Reference/Text Books:

1. S. J. Fonash , "Solar Cell Devices-Physics", Elsevier
2. A. FaLenbruch and R. Bube, 'FundamentaL of Solar CelL Photovoltaic Solar Energy' Elsevier
3. S. Chandra and R.K Pandey , "Phopto electrochemical Solar CelL", Willy
4. C.J. Winter (Editor), JJ. Nitsch (Editor),"Hydrogen as an Energy Carrier Technologies Systems Economy", Springer
5. A. Zuttel, A. Borgschulte and L. Schlapbach, " Hydrogen as a Future Engery Carrier, Willey

CO-PO Mapping

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO 1	3										3	3
CO 2	3	3					2				3	3
CO 3	3										2	3
CO 4	3										3	3

Course Code	PPH4003			
Course Title	Advanced Electronics II			
Category	Elective Paper			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Course objectives

The basic device design along-with the standard technological procedures adapted in the semiconductor industry for IC manufacturing and mass production of semiconductor devices.

Course Outcomes

CO 1: Students will able to understand microwave devices

CO 2: Students will get an idea of photonic devices

CO 3: Students will able to understand the function of MOSFET, CMOS and different memory devices

CO 4: Students able to explain Piezoelectric sensors and actuators and their applications

Course Content

Module I: Microwave Devices **(16 L)**

Microwave Devices: Vacuum tube devices: Reflex klystron and magnetron. Transfer electron devices: Tunnel and Gunn diode, Avalanche Transit time devices (Read, IMPATT diodes, and parametric devices).

Module II: Photonic Devices **(10 L)**

Photonic Devices: Radiative transition and optical absorption, LED, semiconductor lasers, heterostructure and quantum well devices, charge coupled devices, photodetector, Schottky barrier and p-i-n photodiode, avalanche photodiode, photomultiplier tubes, Solar cell.

Module III: Memory Devices **(10 L)**

Memory Devices: MOSFET (n-MOS, p-MOS) and CMOS. Static and dynamic RAM, nonvolatile memories. Optical and magnetic memories.

Module IV: Other Devices **(12 L)**

Other Devices: Piezoelectric sensors and actuators, Transducers (temperature, pressure, vacuum, magnetic field, vibration, particle detector). OLED, solid state battery and LCD.IC fabrication technology: MOSFET fabrication process. Substrate, dielectric, conducting and resistive layers. Lithography. Diffusion of impurities and deposition techniques.

Reference /Text Books

1. S. M. Sze and K. K. Ng , "Physics of Semiconductor Devices", Wiley
2. S. M. Sze ,"Semiconductor devices Physics and Technology", Wiley
3. , S. Y. Liao , "Microwave Devices and Circuits" Pearson
4. 4, W. D. Cooper and A. D.Helfrick," Electronic Instrumentation and Measurement Techniques", PHI Learning,

CO-PO Mapping

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO 1	3											3
CO 2	3						2		2			3
CO 3	3										1	3
CO 4	3								2			3

Course Code	PPH4004			
Course Title	Radiation Physics			
Category	Elective Paper			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Course Objectives

This course is aimed to introduce the student to practical aspects of nuclear radiation with an understanding of basic quantities and doses, the role of fundamental processes involved in the interaction of X- rays, gamma-rays, charged particles and neutrons with matter, the principles underlying the operation of nuclear detection/dosimetry instruments, areas of applications, awareness of the need and methods for safety protocol for radioactive material and environmental safety.

Course Outcomes

CO 1: Students able to understand basic nuclear processes

CO 2: Students will get an idea of radiation doses and Radiation Effects on Biological Systems

CO 3: Students will able to know about radiation measuring devices

CO 4: Awareness about the management of radioactive material, and adherence to safety protocol will develope

Course Content

Module I: Basic Nuclear Processes (15 L)

Basic Nuclear Processes: Characteristics of nuclear radiations, alpha decay, beta decay, electron capture, gamma emission, neutron sources, source activity, radioactivity decay law, decay chains. Passage of Radiation through Matter **,** Stopping power of charge particles-Qualitative discussion of the Bethe-Bloch formula, Radiation length, Range of electrons, Interaction of photons, neutrons and charges particles.

Module II: Dosimetric Units (15 L)

Dosimetric Units: The Roentgen, Absorbed dose, Relative Biological effectiveness (RBE), Equivalent dose, Effective Dose, Typical doses from sources (Natural, Environmental & Medical exposures), Radiation shielding and its safety (Gamma-rays, electrons, positrons, charged particles, Neutrons)

Radiation Effects on Biological Systems: High doses received in a short time, Low-level doses limits, direct ionization of DNA, radiation damage to DNA, Biological effects. International Commission of Radiological Protection and its recommendations, the system of radiological protection, justification of practice, optimization of protection and individual limits, Annual Limit of Intake (ALI) and Derived Air Concentration (DAC).

Module III: Radiation Measurement (10 L)

Devices for radiation measurement and survey: Sensitivity, Detector response, Energy resolution, Response time, Detector efficiency, Dead time, Ionization mechanism and introductory idea about some detectors.

Module IV: Regulations, Monitoring, & Radioactive Waste Management (8L)

Regulations, Monitoring, & Radioactive Waste Management: Radiation accidents and disaster monitoring, Sources & classification of Radioactive waste, permissible limits for disposal of waste, general method of disposal, storage management of radioactive waste in facilities. Responsibilities of operator, regulatory bodies, and government.

Reference/Text Books:

1. F.A. Smith, " A Primer in Applied Radiation Physics" , World Scientific
2. R.M. Singru , "Introduction to Experimental Nuclear Physics" , Willy
3. E.L. Alpen, "Radiation Biophysics", Elsevier
4. J. Turner Atom, "Radiation and Radiation Protection".
5. AERB Safety Standard No. AERB/SS/3 (Rev. 1), Testing and Classification of sealed
6. G.F. Knoll ,"Radiation detection and measurement", John Wiley & Sons,
7. S. N. Ahmed ,"Physics and Engineering of Radiation Detection" Academic Press

CO-PO Mapping

	Programme Outcomes (PO)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO12
CO 1	3				3						2	3
CO 2	3						1				1	3
CO 3	3						1				2	3
CO 4	3				2							3

Course Code	PPH4005			
Course Title	Atmospheric Physics			
Category	Elective Paper			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Course Objectives

To develop skill for interpreting and applying atmospheric observations and analysing of atmospheric data

Course Outcomes

CO 1 Students able to understand the basic thermal structure of atmosphere
CO 2 Students able to understand the atmospheric thermodynamics
CO 3 Students will able to understand atmospheric scales of motion
CO 4 Students able to understand the techniques of measuring atmospheric parameters

Course Content

Module I: The Atmosphere **(16 L)**

The atmosphere: Origin of earth and the solar system - nebula theory, Age of earth – radioactive dating, The evolution of the earth's atmosphere. Formation of ozone layer, Thermal structure of terrestrial systems, Runaway Greenhouse effect – Thermal layers of atmosphere. Influence of solar radiations on earth atmosphere. Diffuse solar radiations - controlling factors, Distribution of sunshine hours , Effect of geomagnetic disturbances.

Module II: Atmospheric Thermodynamics **(10 L)**

Atmospheric thermodynamics: Hydrostatic equation, latent heat, adiabatic processes, concept of air parcel and Radiative Transfer: spectrum of radiation, atmospheric absorption and scattering of solar radiation, The role of Radiative transfer in the Global Energy Balance: energy balance of upper atmosphere, tropospheric energy balance, Atmospheric aerosol, cloud microphysical processes

Module III: Atmospheric Dynamics **(10 L)**

Atmospheric Dynamics: Thermal wind, thermodynamic energy equation, atmospheric scales of motion, Equation of motion for the atmosphere, Tropical motion systems. Global electric circuit. Solar modulation of atmospheric electrification. Global circulation model, Atmospheric stability, Temperature inversion , Dispersion equation.

Module IV: Techniques and Measurements (12L)

Techniques and measurements for atmospheric Physics: Radar band designations, Radar block diagram, radar equation, detection of signal in noise and signal to noise ratio, integration of radar pulse, radar cross section, distributed targets, antenna parameters and system losses, radar clutter, pulse radar, CW radar and Doppler radar, Acoustic remote sensing of the atmosphere_ SODAR, LIDAR – components, platforms and applications

Field Visit: Surface observations, balloon observations, Familiarize with CW and Doppler radar

Reference/Text Books

1. R.E. Benestad , “Solar activity and Earth’s climate”(Blindun, Norway
2. A. Chandashekhar,” Basic of Atmospheric Science” , PHI Learning
3. F. K.Autgens, “The AtmospLe an introduction to Meteorology” Pearson
4. G. Guyo, “Physics of the environment and Climate”, John Wiley and Sons.
5. J. Gaun, “Atmospheric dynamics”, Cambridg Univ. Press
6. M.Wallace and P.V.Hobbs ,”Atmospheric Science” , Academic Press
7. J. R. Holton and G. J. Hakim,” An Introduction to Dynamic Meteorology”, Academic Press

CO-PO Mapping

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO 1	3											3
CO 2	3			2							2	3
CO 3	3						2					3
CO 4	3						1				1	3

Course Code	PPH4006
Course Title	Group Theory
Category	Elective Paper
LTP & Credits	L: 3, T: 1, P: 0, Credits: 4
Total Contact Hours	48
Pre-requisites	None

Course Objectives

The course will introduce to the students basic concepts of finite and infinite groups. Examples from various fields will be considered.

Course Outcomes

CO 1	Students will get basic concepts of group theory
CO 2	Students will get an idea of probability distributions and their applications
CO 3	Students will be able to explain group theory in different groups
CO 4	Students will be able to apply of group theory in quantum mechanics

Course Content

Module I: Abstract Group Theory **(16 L)**

Abstract group theory: Definition. Group postulates. Finite and infinite groups, order of a group, subgroup; rearrangement theorem, multiplication table. Cosets, Lagrange's theorem. Order of an element.. Conjugate elements and classes. Invariant subgroups, factor groups. Generators. Isomorphism and homomorphism. Cyclic and other distinct groups. Permutation and alternating groups. Cayley's theorem.

Module II: Representation Theory **(10 L)**

Representation theory: Definition of representation. Faithful and unfaithful representations. Invariant subspaces and reducible representations. Reducible and irreducible representations. Schur's lemmas, great orthogonality theorem and its geometrical interpretation. Character. First and second orthogonality theorems of characters and its geometrical interpretation. Regular representation, celebrated theorem and its implication. Projection operators; determination of basis functions. Direct product groups and their representations Direct product representations and their reduction. Construction of character tables of simple groups.

Module III: Continuous Group **(10 L)**

Continuous group: Infinite groups. Discrete and continuous groups, mixed continuous group. Topological and Lie groups. Axial rotation group SO(2). Rotation group SO(3).

Special Unitary groups SU(2) and SU(3) and their application in Physics.

Module IV: Application in Physics **(12 L)**

Application in Physics Group of Schrodinger equation. Reduction due to symmetry. Perturbation and level splitting. Selection rules. Zeeman effect.

Reference/Text Books:

1. A.W. Joshi, "Elements of Group Theory for Physicists", New Age International
2. M. Tinkham," Group Theory and Quantum Mechanics", Dover
3. A. Zee ," Group Theory in a Nutshell for Physicists", Princeton

CO-PO Mapping

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO 1	3	2										3
CO 2	3		2		1							3
CO 3	3	1										3
CO 4	3		1									3

Course Code	PPH4007			
Course Title	Physics at the Nano scale			
Category	Elective Paper			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Course Objectives

To introduce knowledge on basics of Nano science and the fundamental concepts behind size reduction in various physical properties. More specifically, the student will be able to understand the different properties of material in reduced scales.

Course Outcomes

CO 1 Understand the importance quantum mechanics, energy bands and electronic statistics

CO 2 Understand heterostructures, quantum welL, dots, wires.

CO 3 Optical properties and radiative processes.

CO 4 Students able to understand the Characterization techniques

Course Content

Module I: Quantum Confined Systems **(16 L)**

Quantum confined systems: Quantum confinement and its consequences, quantum well, quantum wires and quantum dots and artificial atoms. Electronic structure from bulk to quantum dot. Electron states in direct and indirect gap semiconductors Nano crystal. Confinement in disordered and amorphous systems.

Module II: Dielectric Properties **(10 L)**

Dielectric properties: Coulomb interaction in nanostructures. Concept of dielectric constant for nanostructures and charging of nanostructure. Quasi-particles and excitons: Excitons in direct and indirect band gap semiconductor Nano crystal. Quantitative treatment of quasiparticles and excitons. Charging effects.

Module III: Optical Properties **(10 L)**

Optical properties: Optical properties and radiative processes: General formulation absorption, emission and luminescence; Optical properties of heterostructures and nanostructures. Carrier transport in nanostructures: Coulomb blockade effect, scattering and tunneling of 1D particle; applications of tunneling, single electron transistors. Defects and impurities: Deep level and surface defects.

Module IV: Characterization Basics **(12 L)**

Characterization basics: Direct imaging by scanning electron microscope, transmission electron microscope, and scanning probe techniques.

Reference/Text Books:

1. C. Delerue and M. Lannoo, Nanostructures-Theory & Modelling", Springer
2. V. A. Shchukin, N. N. Ledentsov and D. Bimberg," Nanostructure", Springer
3. Z.L. Wang, "Characterization of Nanophase MateriaL", Wiley-VCH
4. Z. L. Wang and A. L. Rogach "Semiconductor Nanocrystal Quantum Dots, Springer
5. C. P. Poole Jr. & F. J. Owens "Introduction to Nanotechnology", Wiley-Interscience,

CO-PO Mapping

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO 1	3											3
CO 2	3	2	2									3
CO 3	3		1				1					3
CO 4	3	1										3

Course Code	PPH4008			
Course Title	Plasma Physics			
Category	Elective Paper			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Course Objectives

The primary learning outcome for this course is for the students to learn the basic principles and main equations of plasma physics, at an introductory level, with emphasis on topics of broad applicability

Course Outcomes

CO 1: Students will able to explain basic concepts of Plasma Physics

CO 2: Students will get an idea of KDV equation and its applications

CO 3: Students will able to understand Magneto-hydrodynamic instabilities

CO 4: Students may apply the concepts of Plasma Physics to solve different problems.

Course Content

Module I: Fluid Description of Plasmas **(12 L)**

Fluid description of plasmas, Moment equations. MHD equations. Generalized Ohm's law, flux conservation, Decay of fields. Pressure balanced and force free fields.

Module II: Alfven Waves **(12 L)**

Alfven waves, Dissipative effect, Magneto-acoustic waves, Hydro-magnetic shocks, KDV equation, Linear and nonlinear ion-acoustic waves, dusty and strongly coupled plasma

Module III: Magneto-Hydrodynamic Instabilities **(12 L)**

Magneto-hydrodynamic instabilities, Energy principle, Normal mode analysis and its application to Rayleigh-Tayler and Kelvin Helmholtz instabilities, Pinch instability, Jean's instability.

Module IV: Plasma Applications **(12 L)**

Plasma applications to medicines, material sciences, waste treatment and Plasma Applications to RF heating and current drive.

Reference/Text Books:

1. F. F. Chen," Introduction to Plasma physics", Plenum Press
2. N. A. Krall and Trivelpiece, "Principles of Plasma Physics, San Fransisco Press
3. G. Schimdt , "Physics of High temperature Plasmas", Academic Press
4. R.D. Hazeltine & F.L. Waelbroeck, "The framework of Plasma Physics, Perseus Books,
5. R.J. Goldston and P.H. Rutherford ,"Introduction to Plasma Physics", ,IOP
6. C.K. Birdsall, A.B Langdon," Plasma Physics via Computer Simulation", CRC Press
7. A. Fried and L.A. Kennedy," Plasma Physics and Engineering", Taylor and Francis

CO-PO Mapping

	Programme Outcomes (PO)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3											3
CO 2	3	2					2					3
CO 3	3											3
CO 4	3											3

Course Code	PPH4009			
Course Title	Astrophysics			
Category	Elective Paper			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Course Objectives

The primary objective is to impart a basic knowledge about the oldest branch of physical science through a conceptual mode, relying less on mathematics and more on physical understanding.

Course Outcomes

CO 1: Students will able to get basic concepts of Astrophysics
CO 2: Students will get an idea of stellar structure and Gamma Ray Bursts
CO 3: Students will able to understand Stellar Nucleo synthesis
CO 4: Students will able to understand concepts of black hole and Quasars

Course Content

Module I: Introduction of Astrophysics (15 L)

Introduction: Astrophysics, Mass, length and time scales in astronomy, Celestial and Galactic coordinate systems, Conversion of Coordinates. Stars: Magnitude and color index, Distance Modulus, Effective temperature, Distance measurement, Radii, Masses, velocity, Stellar Spectral Classification. Stellar Astronomy in different bands of electromagnetic radiation, Theory of radiative transfer, Optical depth, Saha ionization equation, Concept of local thermodynamic equilibrium, Radiative transfer through stellar atmospheres and stellar interior, Limb Darkening, Rosse land mean, Opacity, Formation of spectral lines, Photon diffusion inside sun.

Module II: Basic Equations of Stellar Structure (15 L)

Basic equations of stellar structure, Hydrostatic equilibrium, Virial Theorem, Dynamical- thermal-nuclear time scales, Schwarzschild stability condition, Standard stellar model, Scaling relations, Eddington Luminosity limit. Pre main sequence evolution, Jeans criteria for star formation. Main sequence evolution, post main sequence evolution, Polytropic model: Lane-emden equation, Eddington and

Homologous model, L diagram, Nebulae, Protostars, Brown dwarfs, Red Giants/ Super Giants, White dwarfs; Chandrasekhar limit, mass radius relation. Planetary nebulae, Neutron stars: Tolman- Oppenheimer-Volkoff equation, Mass-radius relation. Pulars, Magnetars, , Gamma Ray Bursts.

Module III: Stellar Nucleo Sysnthesis (10 L)

Stellar Nucleo synthesis: Nuclear reaction rates, pp. chain and CNO cycle, Advanced nuclear burning, Solar neutrino experiments, Stages of stellar evolution, Stellar winds, supernovae, neutron capture: r- and s- processes.

Module IV: Black Holes (8 L)

Black holes, Collapse to a black hole (Oppenheimer and Snyder), event horizon, singularity. Accretion disks: Formation of Accretion Disks, Binary Accretion disks. Accretion onto compact objects. Quasars.

Reference/Text Books:

1. V.B.Bhatia Textbook of astronomy an astrophysics with elements of cosmology, Narosa
2. K. D. Abhyankar, “Astrophysics – Stars and Galaxies” , University Press
3. T. Padmanavan ,”Theoretical Astrophysics (VoL.I,II,III)”, (CUP)
4. S.L.Shapiro and S.A.TeukoLky, “ Black Holes, White Dwarfs and Neutron Stars” John Wiley

CO-PO Mapping

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO 1	3											3
CO 2	3			2			2				1	3
CO 3	3											3
CO 4	3			2								3

Course Code	PPH4101			
Course Title	Project/ Term Paper			
Category	Programme Core			
LTP & Credits	L	T	P	Credits
	1	1	4	6
Total Contact Hours	12 class/week			
Pre-requisites	None			

Course Objective

To enhance the knowledge of the use of analytical, theoretical and experimental tool to solve, design and study a problem

Course Outcome

CO 1: Understand and practice of scientific reviewing, recording and reporting

CO 2: Enhance their knowledge of the use of analytical, theoretical and experimental tool to solve/design/study a problem

CO 3: Enhance presentation and communication skill

Course Content

Any advance topic in the domain of science.

CO-PO Mapping

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO 1	3	2	2	1		2			1	1	1	3
CO 2	3	1	2	2		2	2		1	1	1	3
CO 3	3					2						3

Course Code	PPH4102			
Course Title	**Grand Viva**			
Category	Programme Core			
LTP & Credits	L	T	P	Credits
	0	0	0	2
Total Contact Hours	None			
Pre-requisites	None			

A comprehensive viva-voce will be conducted to assess the general understanding of the student in the courses covering both basic and PG level of physics. This is meant to evaluate the student's grasp on the subject, and also to help students face interviews.

Course Structure of CBCS Paper of Physics

SEMESTER-1							
Sl. No.	**Type**	**Course No.**	**Course Name**	**L**	**T**	**P**	**Credits**
THEORY (Student may choose one subject from Sl. No. 1 ad 2)							
1	OE	PPH1004	Energy Sources and Harvesting Technology	3	1	0	4
2	OE	PPH1005	Material Science	3	1	0	4
TOTAL				**3**	**1**	**0**	**4**
SEMESTER-2							
Sl. No.	**Type**	**Course No.**	**Course Name**	**L**	**T**	**P**	**Credits**
THEORY							
1	OE	PPH2004	Physics: Large To Small Bodies	3	1	0	4
TOTAL				**3**	**1**	**0**	**4**

OE – Open Elective

Course Code	PPH1004			
Course Title	Energy Sources and Harvesting Technology			
Category	Elective Paper for other departments (M.Sc. Students)			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Course Objectives

Importance of renewable energy, Need of solar energy harvesting and Learn different methods of energy harvesting

Course Outcomes

CO 1: Students will understand the concepts of Energy Sources
CO 2: Students will enhance their knowledge about solar energy harvesting
CO 3: Students will understand how to harness different energy
CO 4: Students will able to know methods of energy harvesting

Course Content

Module I: Energy Sources **(8 L)**

Fossil fuel and Alternate Sources of energy: Fossil fuel Nuclear energy, their limitation, need of renewable energy, Non-conventional energy sources. Global and National Energy Scenario.

Module II: Solar Energy **(10 L)**

Solar energy: Solar energy, its importance, Storage of solar energy, Solar pond, Non convective solar pond, Applications of solar pond and solar energy, Solar water heater, Flat plate collector, Solar distillation, Solar cooker, Solar green houses, Solar cell, Absorption air conditioning. Need and characteristics of photovoltaic (PV) systems, PV modeL and equivalent circuits, and sun tracking systems.

Module III: Wind Energy **(10 L)**

Wind energy: Wind energy conversion, Potential, Wind energy potential measurement, Site selection, Types of wind turbines, Wind farms, Wind generation and Control. Nature of the wind, Power in the wind, Factors influencing wind, Wind data and energy estimation, Wind speed monitoring, Classification of wind, Characteristics, Applications of wind turbines, Offshore wind energy – Hybrid systems, Wind resource assessment, Betz limit, Site selection, Wind energy conversion devices. Wind mill component design, Economics and demand side management, Energy wheeling, and Energy banking concepts. Safety and environmental aspects, Wind energy potential and installation in India.

Module IV: Ocean Energy and Geothermal Energy (10L)

Ocean Energy: Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices, Tide characteristics and Statistics, Tide Energy Technologies, Ocean Thermal Energy, Osmotic Power, Ocean Bio-mass. Geothermal Energy: Geothermal Resources, Geothermal Technologies.

Module V: Hydel Power and Piezoelectric Energy (10 L)

Hydro Energy: Hydropower resources, Hydropower technologies, Environmental impact of hydro power sources. Piezoelectric Energy harvesting: Introduction, Physics and characteristics of piezoelectric effect, Material and mathematical description of piezoelectricity, Piezoelectric parameters and modelling piezoelectric generators, Piezoelectric energy harvesting applications, Human power.

Reference/ Text Books

1. G.D Rai ,"Non-conventional energy sources" Khanna Publishers, New Delhi
2. M P Agarwal , "Solar energy " S Chand and Co. Ltd.
3. S P Sukhative , "Solar energy" Tata McGraw - Hill Publishing Company Ltd.
4. G. Boyle, "Renewable Energy, Power for a sustainable future", 2004, Oxford University
5. P Jayakumar, "Solar Energy: Resource Assessment Handbook", 2009, Renewable Energy Corporation Network for the Asia Pacific.
6. J. Balfour, M.Shaw and S. Jarosek,,"Photovoltaic", Lawrence J Goodrich (USA).

CO-PO Mapping

	Programme Outcomes (PO)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3											3
CO 2	3	2			2						2	3
CO 3	3						1					1
CO 4	3						1				2	3

Course Code	PPH1005
Course Title	Material Science
Category	Elective Paper for other departments (M.Sc. Students)
LTP & Credits	L: 3, T: 1, P: 0, Credits: 4
Total Contact Hours	48
Pre-requisites	None

Course Objectives

To understand the basic structure and crystal arrangement of material using modern learning strategies.

Course Outcomes

CO 1: Analyze the Structure of material at different level, basic concepts of crystalline material

CO 2: Acquire knowledge about polymer, ceramics and composite material, types, manufacturing methods and its applications

CO 3: Acquire knowledge and understand the key principles of nanotechnology including the relationship between Nano and various sciences and mathematics

CO 4: Analyze the properties using modern techniques and design various Nano composite material for various industrial applications.

Course Content

Module I: Crystallography (16 L)

Applied crystallography in material science : Non crystalline and semi crystalline states, Lattice. Crystal systems, unit cell. Indices of lattice directions and planes. Coordinates of position in the unit cell, Zones and zone axes. Crystal geometry. Symmetry classes and point groups, space groups. Glide planes and screw axes, space group notations, Stereographic projections. Standard projection of crystaL. Lattice imperfections: Point defect, line defect, plane defect, volume defect, dislocation, stacking faults, application, Burger vectors.

Module II: Material Classification (10 L)

Introduction to material classification of material: Crystalline & amorphous material, high Tc superconductors, alloys & composites, semiconductors, Polymer, Liquid crystal and quasi crystal, Ceramics.

Module III: Nano Scale Systems (10 L)

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

Module IV: Synthesis and Characterization Techniques (12 L)

Synthesis and Characterization techniques of nanostructure material: Top down and Bottom up approach of synthesis of Nano-structured material, Nano rods, nanotubes/wire and quantum dots, Single wall and multiwall nanotubes. Ball milling. Physical vapor deposition (PVD). Chemical vapor deposition (CVD). Sol-Gel. Electro deposition. Spray pyrolysis. Hydrothermal synthesis.
Characterization techniques : X-Ray Diffraction. Optical Microscopy. Scanning Electron Microscopy. Transmission Electron Microscopy. Atomic Force Microscopy. Scanning Tunneling Microscopy.

Reference/ Text Books:

1. V. Raghavan, “Material science and Engineering”, Prentice-Hall Pvt. Ltd.
2. B. D. Cullity, “Elements of X-ray diffraction”, Addison-Wesley Publishing Co.
3. C.P. Poole, Jr. Frank J. Owens, “Introduction to Nanotechnology”, Wiley India Pvt. Ltd..
4. S.K. Kulkarni, “Nanotechnology: Principles & Practices”, Capital Publishing Company
5. K.K. Chattopadhyay and A. N. Banerjee, “Introduction to Nano science and Technology”, PHI Learning Private Limited.
6. R. Booker, E. Boysen, “Nanotechnology” John Wiley and Sons.

CO-PO Mapping

	Programme Outcomes (PO)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3						1					3
CO 2	3	2	1									3
CO 3	3	1	2	2			2				1	3
CO 4	3							2	2		1	3

Course Code	PPH2004
Course Title	Physics: Large To Small Bodies
Category	Elective Paper for other departments (M.Sc Students)
LTP & Credits	L: 3, T: 1, P: 0; Credits: 4
Total Contact Hours	48
Pre-requisites	None

Course Objectives

To understand basic laws of Physics and its applications

Course Outcomes

CO 1: Students will learn the basics of Particle Physics
CO 2: Students able to understand basic laws of motion
CO 3: Students will understand Physic of small bodies
CO 4: Students will able to hand on practice of basic experiments of Physics

Course Content

Module I: Sub Atomic Particles **(15 L)**

Discovery of Subatomic Particles A historical perspective The Discovery of the Electron: cathode Rays, Thomson's Experiment, Measurement of electric charge. The Nucleus: Radioactivity, Rutherford's experiment and the discovery of the nucleus, the Neutron. More particles: Neutrinos, Positrons, Other antiparticles, Muons and Pions, Strange particles, Quarks

Module II: Physics of Large Bodies **(14 L)**

Physics of Large Bodies: Evolution of universe and formation of stars. Newton's law of Gravitation; Planetary motion and Kepler's laws; Galilean relativity and concept of inertial frames. Einstein's theory of special relativity.

Module III: Physics of Small Bodies **(15 L)**

Physics of Small Bodies: Failure of classical ideas with examples of blackbody spectrum and Photoelectric effect; Heisenberg's Uncertainty Principle; Wave-particle duality. Double-slit experiment, Stern-Gerlach experiment. Concepts of discrete energy level and spin. Elementary ideas of Schrodinger's Wave mechanics. Relation between Spin and Statistics; Bose-Einstein and Fermi-Dirac statistics, and Maxwell-Boltzmann statistics as classical limit. Elementary Particles (classification, quantum numbers) and Fundamental Interactions (classification, range, strength).

Module IV: Basic Experiments **(4 L)**

BASIC Experiments: Verification of BoL's atomic theory by Franck Hertz Experiment, Determination of e/m of an electron, Determination of Planck's Constant, Determination of acceleration due to gravity

Reference/Text Books:

1. D. Kleppner, R.J. Kolenkow, "An introduction to mechanics", McGraw- Hill.
2. D.Resnick, R.Halliday and J. Walker "Physics", Wiley.
3. R. Resnick, "Introduction to Special Relativity", John Wiley and Sons.
4. G.Kaur and G.R. Pickrell, "Modern Physics", McGraw Hill
5. J.R. Taylor, C.D. Zafiratos, M.A. Dubson, Modern Physics, Addison-Wesley

CO-PO Mapping

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO 1	3			2								3
CO 2	3	2			1							2
CO 3	3			1			1					3
CO 4	3	2			2							1