JIS University

M.Sc. in Physics

(Faculty of Science)

Contents **Page No**

ABOUT THE DEPARTMENT

The department of Physics of JIS University always gives priority to provide quality teaching along with state of the art research facilities to ensure proper learning and encouraging innovative ideas in Physics and allied areas. The core elective and open elective courses are designed for more specialized and/or interdisciplinary content to equip students with a broader knowledge base. The diverse qualifications of the faculty members ensure expertise in all aspects of Physics as well as in various interdisciplinary areas. Departmental laboratories are planned to equip further with sophisticated instruments. Aware of the wide-ranging needs of the diverse student groups, the Department offers intensive tutorials (on theory and laboratory classes alike) and individual care to enhance their academic level. Project work and seminar presentation are introduced in all courses to get an overview of the on-going research and recent development in the subject. We plan to identify and attract the most promising students to form a dynamic and diverse community, and to shape them into visionary scholars, innovative educators, and creative leaders. The students are groomed in order to become competent enough to face the global challenges from academic fields as well as from different sectors. The objective of the department is to recognize as delivering world class facilities that support outstanding research, teaching and learning. Moreover the M.Sc. course is to lay a solid foundation for further extending the Ph.D. work in the concerned field.

VISION AND MISSION

Vision:

To contribute effectively to the national endeavor of producing quality human resource of world class standard through Physics education to meet the changing needs of the Country, incorporating relevant social concerns and to build an environment for the benefit of the Nation.

Mission:

- To inculcate the importance of basic science and develop the ability to use them for the enrichment of human lives.
- To develop a positive mind set for accepting the challenges in science and technology.

- To create a sense of ethical responsibilities among students, so that they become an active member of the society.
- To grow as a nationally recognized Centre for conducting effective and successful education programs.
- To impart quality education both in theoretical and experimental Physics with special stress on ‘learning by doing’ for socio-economic growth

PROGRAM EDUCATIONAL OBJECTIVES (PEO)

PEO1 The objectives of the M.Sc. Physics program is to start with a comprehensive knowledge through the core courses of Physics *viz.,* Mathematical Physics, Classical and Relativistic Mechanics, Statistical Physics, Quantum Mechanics, Electrodynamics, Solid State Physics, Electronics, Nuclear and Particle Physics and Atomic and Molecular Physics.

PEO2 Innovative ideas are encouraged through tutorials, science documentary and assignments.

PEO3 The department specific elective courses are designed covering applied areas and interdisciplinary content to impart students with a broader knowledge.

PEO4 Experiments are so designed to acquire basic concepts of Physics through hand on practice.

PEO5 The topic of dissertation(s) emphasis on how research leads to new findings.

PEO6 The Physics Program is to lay a solid foundation for higher studies.

PROGRAMME OUTCOMES (PO)

PO 1 Physics knowledge: Knowledge of basic science fundamentals and understanding of major concepts, theoretical principles and experimental findings in Physics and its different subfields like Astrophysics and Cosmology, Material science, Nuclear and Particle Physics, Condensed matter Physics, Atomic and Molecular Physics, Mathematical Physics, including broader interdisciplinary subfields Atmospheric Physics, Computer science, Physics at nanoscale etc.

PO 2 Problem analysis: Develop analytical skills to identify domain of work

PO 3 Development of solutions: Design solutions and evolve procedures that meet the specified needs with appropriate consideration for the public health and safety and environmental considerations.

PO 4 Critical review of solutions: Use of research-based knowledge and research methods including design of analysis and interpretation of data, to provide valid conclusions.

PO 5 Modern analytical tool usage: Select and apply appropriate techniques, resources, and modern analytical tools

PO 6: Skilled communicator: Ability to transmit complex technical information relating all areas in Physics in a clear and concise manner in writing and the ability to present complex and technical concepts in a simple language for better understanding.

PO 7. Sense of inquiry: Capability for asking relevant/appropriate questions relating to the issuesand problems in the field of Physics, and planning, executing and reporting the results of a theoretical or experimental investigation.

PO 8. Leadership skill: Capable of working effectively in diverse teams in both classroom, laboratory, Physics workshop and field-based works.

PO 9. Digitally Efficient*:* Capable of using computers for simulation studies in Physics and computation and appropriate software for numerical and statistical analysis of data, and employing modern e-library search tools like Inflibnet, various websites of the renowned Physics labs to retrieve, and evaluate Physics information.

PO 10. Ethical awareness*:* The students should be capable of demonstrating ability to think and analyze rationally with modern and scientific outlook and identify ethical issues related to one's work, unbiased and truthful actions in all aspects of work.

PO 11. National and international perspective*:* The students are able to develop their career if their own choice in both national and international perspective. They will contribute towards the national development giving our national priorities.

PO 12. Lifelong learners: Student will acquire the capability of self-learning in all areas of Physics.

Program specific objectives

PSO1: Enhance the basic concepts of core areas of Physics especially in Mathematical Physics, Electrodynamics, Classical mechanics, Statistical mechanics, Electronics, Solid state physics Quantum mechanics and Nuclear physics to elucidate the diverse phenomena of nature from fundamental Laws

PSO2: Hand on practice of experiments in basic as well as advanced areas of Physics with appropriate analysis and interpretation of results

PSO3: A research oriented learning to develop skill of analytical and integrative problem solving approaches

PSO4: Industry oriented learning to enhance skill particularly for data interpretation, industrial electronics, radiation safety etc.

Structure of the Course:

<table>
<tr><th>Semester</th><th>Course Type</th><th>Course Code</th><th colspan="2">Course Name</th><th>Credits</th></tr>
<tr><td rowspan="20">I</td><td rowspan="5">Core</td><td>PPH1001</td><td colspan="2">Mathematical Methods</td><td>4</td></tr>
<tr><td>PPH1002</td><td colspan="2">Classical and Relativistic Mechanics</td><td>4</td></tr>
<tr><td>PPH1003</td><td colspan="2">Basic Electronics</td><td>4</td></tr>
<tr><td>PPH1101</td><td colspan="2">Physics Laboratory-I</td><td>4</td></tr>
<tr><td colspan="3">Total Major Core Credits</td><td>16</td></tr>
<tr><td rowspan="5">Elective</td><td colspan="4">Open Elective (One subject will be offered for the students of other departments)</td></tr>
<tr><td>PPH1004</td><td>Renewable Energy and Energy Harvesting</td><td>4</td><td rowspan="2">4</td></tr>
<tr><td>PPH1005</td><td>Material Science</td><td>4</td></tr>
<tr><td colspan="3">Open Elective (One subject will be choose from the subjects offered by other departments of the University)</td><td>4</td></tr>
<tr><td colspan="3">Total Core Credits</td><td>4</td></tr>
<tr><td>Skill Enhancement</td><td>PPH1006</td><td colspan="2">Radiation and Safety</td><td>2</td></tr>
<tr><td colspan="4"></td><td></td></tr>
<tr><td colspan="5">NON CGPA COURSE</td></tr>
<tr><td rowspan="3">Sessional</td><td>JSC1501</td><td colspan="2">Universal Human Values</td><td>1</td></tr>
<tr><td>JSC1502</td><td colspan="2">Seminar/Group Discussion</td><td>1</td></tr>
<tr><td>JSC1503</td><td colspan="2">Skill X</td><td>1</td></tr>
<tr><td colspan="4">Total Credits Semester-I</td><td>22</td></tr>
</table>

<table>
<tr><th>Semester</th><th>Course Type</th><th>Course Code</th><th>Course Name</th><th>Credit</th></tr>
<tr><td rowspan="17">II</td><td rowspan="5">Core</td><td>PPH2001</td><td>Electrodynamics</td><td>4</td></tr>
<tr><td>PPH2002</td><td>Quantum Mechanics</td><td>4</td></tr>
<tr><td>PPH2003</td><td>Nuclear and Particle Physics</td><td>4</td></tr>
<tr><td>PPH2101</td><td>Physics Laboratory-II</td><td>4</td></tr>
<tr><td colspan="2">Total Core Credits</td><td>16</td></tr>
<tr><td rowspan="4">Elective</td><td colspan="2">Open Elective (For the students of other departments)</td><td></td></tr>
<tr><td>PPH2004</td><td>Physics: Large to Small Bodies</td><td>4</td></tr>
<tr><td colspan="2">Open Elective (One subject will be choose from the subjects offered by other departments of the University)</td><td>4</td></tr>
<tr><td colspan="2">Total Elective Credits</td><td>4</td></tr>
<tr><td>Skill Enhancement</td><td>PPH2005</td><td>Industrial Electronics</td><td>2</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="4">NON CGPA COURSE</td></tr>
<tr><td rowspan="2">Sessional</td><td>JSC1502</td><td>Seminar/Group Discussion</td><td>1</td></tr>
<tr><td>JSC1503</td><td>Skill X</td><td>1</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="3">Total Credits Semester-II</td><td>22</td></tr>
</table>

Semester	Course Type	Course Code	Course name	Credit
III	**Core**	PPH3001	Statistical Physics	4
		PPH3002	Solid State Physics	4
		PPH3101	Physics Laboratory-III	4
		PPH3102	Research Project I	4
			Total Core Credits	**16**
	Elective	**Major Elective (Select any one subjects)**		
		PPH3003	Advanced Quantum Mechanics	4
		PPH3004	Advanced Electronics I	4
		PPH3005	Advanced Mathematical Physics	4
		PPH3006	Advanced Nuclear Physics	4
		PPH3007	Advanced Experiments Of Physics	4
		PPH3008	Advanced Optics	4
		PPH3009	Plasma Physics	4
		PPH3010	General Theory of Relativity and Cosmology	4
			Total Elective Credits	**04**
	Skill Enhancement	PPH3011	Data Analysis and Interpretation	**02**
	NON CGPA			
	Sessional	JSC3502	Seminar/Group Discussion	1
		JSC3503	Skill X	1
			Total Credits Semester-III	**22**

Semester	Course Type	Course Code	Course Name	Credit
IV	**Core**	PPH4001	Atomic and Molecular Physics	4
		PPH4002	Computational Physics	4
		PPH4101	Research Project II	4
			Total Core Credits	**12**
	Elective	**Major Elective (Select any Two subjects)**		
		PPH4003	Advanced Electronics II	4
		PPH4004	Fundamentals of Energy Physics	4
		PPH4005	Atmospheric Physics	4
		PPH4006	Group Theory	4
		PPH4007	Physics at the Nano Scale	4
		PPH4008	Astrophysics	4
		PPH4009	Advanced Solid State Physics	4
		PPH4010	Applied Physics	4
			Total Elective Credits	**08**
		PPH4102	**Comprehensive Viva**	**02**
		NON CGPA		
	Sessional	JSC3502	Seminar/Group Discussion	1
		JSC3503	Skill X	1
	Total Credits Semester-IV			**22**
Grand Total Credit in M.Sc (Physics)				**88**

LIST OF CORE COURSE PAPERS (CREDIT: 04 EACH)

PPH1001: MATHEMATICAL METHODS

PPH1002: CLASSICAL AND RELATIVISTIC MECHANICS

PPH1003: BASIC ELECTRONICS

PPH1101: PHYSICS LABORATORY I

PPH2001: ELECTRODYNAMICS

PPH2002: QUANTUM MECHANICS

PPH2003: NUCLEAR AND PARTICLE PHYSICS

PPH 2101: PHYSICS LABORATORY II

PPH3001: STATISTICAL PHYSICS

PPH3002: SOLID STATE PHYSICS

PPH3101: PHYSICS LABORATORY III

PPH3102: RESEARCH PROJECT I

PPH 4001: ATOMIC AND MOLECULAR PHYSICS

PPH4002: COMPUTATIONAL PHYSICS

PPH4101: RESEARCH PROJECT II

ELECTIVE PAPERS: (CREDIT: 04 EACH)

(Student may select one paper from the following in third semester)

PPH3003: ADVANCED QUANTUM MECHANICS

PPH3004: ADVANCED ELECTRONICS I

PPH3005: ADVANCED MATHEMATICAL PHYSICS

PPH3006: ADVANCED NUCLEAR PHYSICS

PPH3007: ADVANCED EXPERIMENTS OF PHYSICS

PPH3008: ADVANCED OPTICS

PPH3009: PLASMA PHYSICS

PPH3010: GENERAL THEORY OF RELATIVITY AND COSMOLOGY

(Student may select two paper from the following in forth semester)

PPH4003: ADVANCED ELECTRONICS II

PPH4004: FUNDAMENTALS OF ENERGY PHYSICS

PPH4005: ATMOSPHERIC PHYSICS

PPH4006: GROUP THEORY

PPH4007: PHYSICS AT THE NANO SCALE

PPH4008: ASTROPHYSICS

PPH4009: ADVANCED SOLID STATE PHYSICS

PPH4010: APPLIED PHYSICS

GENERAL ELECTIVE PAPER: (for the other departments)

CREDIT: 04 EACH

PPH1004: RENEWABLE ENERGY AND ENERGY HARVESTING

PPH 1005: MATERIALS SCIENCE

PPH2004: PHYSICS: LARGE TO SMALL BODIES

SKILL ENHANCEMENT PAPER

CREDIT: 02 EACH

PPH1006: RADIATION AND SAFETY

PPH2005: INDUSTRIAL ELECTRONICS

PPH3005: DATA ANALYSIS AND INTERPRETATION

COMPREHENSIVE VIVA
CREDIT: 02

DEPARTMENT OF PHYSICS SEMESTER WISE CREDIT/MARKS DISTRIBUTION FOR PG COURSE										
SEMESTER 1										
COURSE	**Name**	**L**	**T**	**P**	**Total hour**	**Credit**	**Internal Marks**	**Mid Sem**	**End Sem**	**Total Marks**
PPH1001	**Mathematical Methods**	**3**	**1**	**0**	**4**	**4**	**20**	**30**	**50**	**100**
PPH1002	**Classical and relativistic Mechanics**	**3**	**1**	**0**	**4**	**4**	**20**	**30**	**50**	**100**
PPH1003	**Electronics**	**3**	**1**	**0**	**4**	**4**	**20**	**30**	**50**	**100**
	CBCS (from other dept)	**3**	**1**	**0**	**4**	**4**	**20**	**30**	**50**	**100**
PPH1101	**Physics Laboratory I**	**0**	**2**	**6**	**8**	**4**	**50**	**-**	**50**	**100**
PPH1006	**Radiation and Safety**	**1**	**1**	**0**	**2**	**2**	**20**	**30**	**50**	**100**
					26	**22**				**600**
NON-CGPA										
JSC1501	**Universal Human Values**	**1**	**0**		**2**	**1**	**-**	**-**	**-**	**100**
JSC1502	**Seminar/Group Discussion**	0	0	1	2	**1**	**-**	**-**	**-**	**100**
JSC1503	**SKILL X**	**0**	**0**	**1**	**2**	**1**				**100**
Grand Total (Semester I)						**22**				**600**

SEMESTER II										
COURSE	**Name**	**L**	**T**	**P**	**Total hour**	**Credit**	**Internal Marks**	**Mid Sem**	**End Sem**	**Total Marks**
PPH 2001	**Electrodynamics**	**3**	**1**	**0**	**4**	**4**	**20**	**30**	**50**	**100**
PPH 2002	**Quantum Mechanics**	**3**	**1**	**0**	**4**	**4**	**20**	**30**	**50**	**100**
PPH 2003	**Nuclear and Particle Physics**	**3**	**1**	**0**	**4**	**4**	**20**	**30**	**50**	**100**
	CBCS (from other dept)	**3**	**1**	**0**	**4**	**4**	**20**	**30**	**50**	**100**

PPH 2103	Physics Laboratory II	0	2	6	8	4	50	-	50	100
PPH2005	Industrial Electronics	1	1	0	2	2	20	30	50	100
Total					26	22				600
NON-CGPA										
JSC2501	Seminar/Group Discussion	1	0		2	1	-	-	-	100
JSC2502	SKILL X	0	0	1	2	1	-	-	-	100
Grand Total (Semester II)						22				600

SEMESTER 3										
COURSE	Name	L	T	P	Total Hour	Credit	Internal Marks	Mid Sem	End Sem	Total Marks
PPH3001	Statistical Physics	3	1	0	4	4	20	30	50	100
PPH3002	Solid State Physics	3	1	0	4	4	20	30	50	100
PPH3101	Physics Laboratory III		2	6	8	4	50	-	50	100
PPH3102	Research Project I		2	6	8	4	50	-	50	100
	DSE	3	1	0	4	4	20	30	50	100
PPH3011	Data Analysis and Interpretation	1	1	0	2	2	20	30	50	100
Total					30	22				600
NON-CGPA										
JSC3501	Seminar/Group Discussion	0	0	2	2	1	-	-	-	100
JSC3502	SKILL X	0	0	2	2	1	-	-	-	100
Grand Total						22				600

SEMESTER 4										
COURSE	Name	L	T	P	Total hour	Credit	Internal Marks	Mid Sem	End Sem	Total Marks
PPH4001	Atomic and Molecular Physics	3	1	0	4	4	20	30	50	100
PPH4002	Computational Physics	3	1	0	4	4	20	30	50	100
	DSE	3	1	0	4	4	20	30	50	100
	DSE	3	1	0	4	4	20	30	50	100
PPH4101	Research Project II	0	0	8	8	4	50	-	50	100
PPH4102	Grand viva					2	50	-	50	100
Total					26	22				600
NON-CGPA										
JSC4501	Seminar/Group Discussion	0	0	2	2	1	-			100
JSC4502	SKILL X	0	0	2	2	1	-			100
Grand Total	(Semester IV)					22				600

Course Code	PPH1001				
Course Title	Mathematical Methods				
Category	Programme Core				
LTP & Credits	L	T	P	Credits	
	3	1	0	4	
Total Contact Hours	48 hours				
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:

CO1	Linear Vector Space is applied to understand systems behavior in different coordinate systems.
CO2	Students will get an idea of probability distributions and their applications
CO3	Students will able to understand complex functions
CO4	Differential equations and special functions will help students to study states of the physical systems and able to apply mathematical tools in solving problems

Module I **(18 Lectures)**

Statistics: Collection and presentation of datain 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. Descriptiv e 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 **(10 lectures)**

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

Module III **(10 Lectures)**

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 **(10 lectures)**

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 polynomials. Fourier Series and Fourier Transform.

Reference Books

1. Mathematical Physics, V. Balakrishnan (1st Ed., Ane Books, 2018)
2. Mathematical Methods for Physicists, G. Arfken (7th Ed., Elsevier, 2012)
3. Advanced Engineering Mathematics, E. Kreyzig (2nd Ed., Pearson, 2002)
4. Mathematical Method of Physics A.K. Ghatak, I.C. Goyal, S.J. Chua,(Laxmi Publications Private Limited;2017)
5. Probability and Statistics for Scientists and Engineers Paperback by Rao V Dukkipati , New Age International Publisher (2010)
6. Applied Multiway Data Analysis by Pieter M. Kroonenberg, (Wiley Series in Probability and Statistics), 2008
7. P.M. Morse and H. Feshbach, Methods of Theoretical Physics (Vol. I & II), Feshbach Publishing
8. M.R. Spiegel, Complex Variables, McGraw-Hill

CO-PO Mapping

Course Outcomes	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
CO1	3	2	2		2							3
CO2	3	1	2		2							3
CO3	3	2	2		2							3
CO4	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 hours			
Pre-requisites	None			

Course Objectives:

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

Course Outcomes:

CO1	Student will have detail idea about Lagrangian formalism and Hamilton's equations and will be able to solve dynamical systems.
CO2	Students will get the knowledge of rigid dynamics and will be able to analyze the dynamics of rigid bodies.
CO3	Students able to understand the basic necessity and principles of the special theory of relativity
CO4	Students may get knowledge about Poincare and Minkowski's 4-dimensional formulation

Module I: (15 Lectures)

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: (15 Lectures)

Non inertial frames of reference, Pseudo forces, Foucault's pendulum. Central force motion, General equation of an orbit, Keplers law's 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: (10 Lectures)

Inertial frames, Michaelson 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: **(8 Lectures)**

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.

References :

1. H. Goldstein, Classical Mechanics, 2nd Edition, Narosa Pub. House (1989).
2. I. Percival and D. Richards, Introduction to Dynamics, Cambridge University Press (1987)
3. Mechanics, L. D. Landau and E. M. Lifshitz (3rd Ed., Pergamon, 1976).
4. Classical Mechanics, N. C. Rana and P. S. Jaog (McGraw-Hill, 1991).
5. D. Rindler, Special Theory of Relativity, Oxford University Press (1982).
6. A.P. French, *Special Relativity*, W.W. Norton

CO-PO Mapping

Course Outcomes	**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**
CO1	3	2		2								3
CO2	3	1		2			2					3
CO3	3	2		-	2		2					3
CO4	3	-		2								3

Course Code	PPH1003			
Course Title	Basic Electronics			
Category	Programme Core			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48 hours			
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:

CO1	Understand the working of active and passive systems.
CO2	Understand the working of Different Semiconductor devices
CO3	Understand the basic Analog circuits
CO4	Understand the basic s of communication systems

Module I **(15 lectures)**

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 **(15 lectures)**

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 **(10 lectures)**

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 **(8 lectures)**

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

References

1. Network Analysis and Synthesis, F.F. Kuo (2nd Ed., Wiley, 2010)
2. Network Analysis with Applications, W.D. Stanley (4th Ed., Pearson, 2003)
3. Electronic Devices and Circuits, J. Millman and C. C. Halkias and S. Jit McGraw-Hill, 2015)
4. Integrated Electronics, J. Millman, C. C. Halkias and C. D. Parikh (2nd Ed., McGraw- Hill, 2011)
5. Communication Systems, Simon Haykins (5th Ed., Wiley, 2009)
6. Digital Signal Processing, J. G. Proakis and D. G. Manolakis (4th Ed., Pearson, 2007)
7. Solid State Electronic Devices, B.G. Streetman (7th Ed., Pearson, 2015)
8. Introduction to Semiconductor Materials and Devices, M. S. Tyagi (1st Ed., Wiley, 2012)
9. Digital Design, M. Mano (5th Ed., Pearson, 2013)
10. Digital principles and Applications, A.P. Malvino and D.P.Leach (8th Ed., McGraw-Hill, 2014)

CO-PO Mapping

Course Outcomes	**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**
CO1	3	2										3
CO2	3			2							2	3
CO3	3	2							2			3
CO4	3			1							2	3

Course Code	PPH1101
Course Title	Physics Laboratory I
Category	Programme Core
LTP & Credits	L T P Credits 0 1 3 4
Total Contact Hours	8 hours/week
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:

CO1	Learn the basics of gates.
CO2	Construct basic combinational circuits and verify their functionalities
CO3	Apply the design procedures to design basic sequential circuits
CO4	To design current control oscillator, power supply and stabilizer

Working Hours 08/week

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

12. SCR – Characteristics and its application as a switching device.

13. Power supply-regulation and stabilization.

14 Study of Gaussian and Poisson distributions using radioactive source and GM counter

15. Multi stage and tuned amplifiers.

16. A/D and D/A converters.

CO-PO Mapping

Course Outcomes	**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**
CO1	3											3
CO2	3				1							3
CO3	3		2			1			2			3
CO4	3	1							1			3

Course Code	PPH1006				
Course Title	RADIATION AND SAFETY				
Category	Elective paper				
LTP & Credits	L	T	P	Credits	
	3	1	0	2	
Total Contact Hours	24 hours				
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 principles underlying the operation of nuclear detection/dosimetry instruments, awareness of the need and methods for safety protocols for radioactive material and environmental safety.

Course Outcomes:

CO1	Students able to understand basic nuclear processes
CO2	Students will get an idea of radiation doses and Radiation Effects on Biological Systems
CO3	Students will able to know about radiation measuring devices
CO4	Awareness about the management of radioactive material, and adherence to safety protocols will develope

Module I **(6 Lectures)**

Basic Nuclear Processes: Characteristics of nuclear radiations, radioactivity decay chains. Passage of Radiation through Matter , Stopping power of charge particles-Qualitative discussion of the Bethe-Bloch formula, Interaction of photons, neutrons and charges particles.

Module II **(6 Lectures)**

Dosimetric Units: 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),International Commission of Radiological Protection and its recommendations, Annual Limit of Intake (ALI) and Derived Air Concentration (DAC).

Module III **(6 Lectures)**

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 **(6 Lectures)**

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 Books:

1. A Primer in Applied Radiation Physics: F.A. Smith.
2. Introduction to Experimental Nuclear Physics: R.M. Singru.
3. Radiation Biophysics: E.L. Alpen.
4. Atom, Radiation and Radiation Protection: J. Turner.
5. AERB Safety Guide (Guide No. AERB/RF-RS/SG-1), Security of radioactive sources in radiation facilities.
6. AERB Safety Standard No. AERB/SS/3 (Rev. 1), Testing and Classification of sealed
7. Radiation detection and measurement, G.F. Knoll (John Wiley & Sons, Inc. 3rdEd.,2000)
8. Physics and Engineering of Radiation Detection by Syed Naeem Ahmed(Academic Press 2007)

CO-PO Mapping

Course Outcomes	Programme Outcomes (PO)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3				3						2	3
CO2	3						1				1	3
CO3	3						1				2	3
CO4	3				2							3

Course Code	PPH2001			
Course Title	Electrodynamics			
Category	Programme Core			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48 hours			
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:

CO1	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
CO2	Students able to update their knowledge about the differential equations of magneto statics, vector potential, magnetic fields of a localized current distribution Singularity
CO3	Students able to understand about Formal solution of electrostatic boundary value problem with Green function, total power radiated by accelerating charge
CO4	Students may apply relativistic electrodynamics to solve problems

Module I **(15 Lectures)**

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-magnetsim, magnetic field from localized current distributions; Ohm's law, Faraday's law of induction; energy densities of electric and magnetic fields.

Module II **(15 Lectures)**

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

Module **(10 Lectures)**

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

Module IV **(8 Lectures)**

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

References:

1. J.D. Jackson: Classical Electrodynamics
2. W.K.H. Panofsky and M. Phillips: Classical Electricity and Magnetism
3. J.R.Reitz, F.J. Milford and R.W. Christy: Foundations of Electromagnetic theory
4. D.J. Griffiths: Introduction to Electrodynamics
5. L.D. Landau and E.M. Lifshitz: (i) Electrodynamics of Continuous Media (ii) Classical theory of fields
6. C.A. Brau, Modern Problems in Classical Electrodynamics

CO-PO Mapping

Course Outcomes	**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**
CO1	3		2									3
CO2	3	2					3					3
CO3	3		1									3
CO4	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 hours				
Pre-requisites	None				

Course Objectives

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

Course Outcomes:

CO1	Students will learn the mathematical formalism of Hilbert space and will be able to apply the postulates of quantum mechanics to solve problems.
CO2	Understanding the concept of quantum mechanical operators and eigen value equation.
CO3	Understand the concept of approximation methods
CO4	Acquire knowldge of scattering theory and solve problems related to scattering.

Module I **(20 Lectures)**

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; Tunnelling problem. Hilbert Space and Observables; Operator method in Quantum Mechanics; Uncertainty principle for two arbitrary operators; Schr¨odinger, Heisenberg and interaction pictures.. Eigenvalues and eigenfunctions: Commutativity and simultaneous eigenfunctions; Complete set of eigenfunctions; Dirac Notation. Schrodinger eqution 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 **(12 Lectures)**

WKB Approximation: Quantisation rule, tunnelling 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; egenerate perturbation theory; Application to one-electron system – Relativistic mass correction, Spin-orbit coupling (L-S and j-j), Zeeman effect and Stark effect.

Variational 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 wavefunctions; Slater determinant; Symmetric and antisymmetric spin wavefunctions of two identical particles; Collisions of identical particles.

Module III **(8 Lectures)**

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

Module IV **(8 Lectures)**

Scattering theory: Laboratory and centre 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;

References:

1. S. Gasiorowicz : Quantum Physics
2. P.M. Mathews and K. Venkatesan: A Text Book of Quantum Mechanics
3. E. Merzbacher: Quantum Mechanics 4. J.J. Sakurai : Modern Quantum Mechanics
4. L.I. Schiff: Quantum Mechanics
5. J.J. Sakurai: Modern Quantum Mechanics
6. P.M. Mathews and K. Venkatesan: A Text Book of Quantum Mechanics
7. Messiah: Quantum Mechanics, Vol. II
8. David Griffiths : Introduction to Quantum Mechanics – Pearson Education.

CO-PO Mapping

Course Outcomes	**Programme Outcomes (PO)**											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO1 0**	**PO1 1**	**PO1 2**
CO1	3		2	3			2					3
CO2	3	2		2			1					3
CO3	3	1	2	2								3
CO4	3	1		1			1					3

Course Code	PPH2003				
Course Title	Nuclear and Particle Physics				
Category	Programme Core				
LTP & Credits	L	T	P	Credits	
	3	1	0	4	
Total Contact Hours	48 hours				
Pre-requisites	None				

Course Objectives

The main objectives of this course is 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:

CO1	Students will apply the models describing the basic nucleon and nuclear properties
CO2	Properties and decay principles of Beta and Gamma rays will be reviewed, their selection rules will be understood.
CO3	They also able to enhance their concepts in nuclear models
CO4	Understand and identify the basic aspiration of elementary particles

Module I **(15 lectures)**

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 quadrupole 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 **(15 lectures)**

Nuclear Models: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 **(10 lectures)**

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 **(8 lectures)**

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 Books

1. Introducing Nuclear Physics, K. S. Krane (Wiley India., 2008).
2. Nuclear Physics – Theory & Experiments, R.R. Roy & B.P. Nigam (New Age International, 2005)
3. Nuclear Physics in A Nutshell, C. A. Bertulani (1st Ed., Princeton University Press, 2007)
4. Concept of Nuclear Physics, B. L. Cohen (McGraw – Hill, 2003)
5. Nuclear Physics, S. N. Ghoshal (First edition, S. Chand Publication)
6. Nuclear & Particle Physics : An Introduction, B. Martin (Willey, 2006)
7. Introduction to Elementary Particles, D. Griffiths (Academic Press, 2nd Ed. 2008)
8. Physics and Engineering of Radiation Detection by Syed Naeem Ahmed(Academic Press 2007)
9. Nuclear and Particle Physics , A.B. Bhattacharya, R. Bhattacharya and R. Raha, NCBA, 2018
10. Radiation detection and measurement, G.F. Knoll (John Wiley & Sons, Inc. 3rdEd.,2000)

CO-PO Mapping

Course Outcomes	**Programme Outcomes (PO)**											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO1	3				2		2					3
CO2	3	2		1			1					3
CO3												3
CO4	3				2							3

Course Code	PPH2101
Course Title	Physics Laboratory II
Category	Programme Core
LTP & Credits	L: 0, T: 1, P: 3, Credits: 4
Total Contact Hours	8 hours/week
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:

CO1	Understand the mechanical properties of various materials
CO2	Get the practical knowledge of Thermal properties of various materials and their applications
CO3	Analyze the magnetic properties of materials and their applications
CO4	Understand the characteristics of optical fibre

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

14. Measurement of absorption coefficient of a material (supplied) using laser light.
15. Verification of Bohr's atomic theory by Franck Hertz Experiment
16. Magnetic parameters of a magnetic material by hysteresis loop tracer.

CO-PO Mapping

Course Outcomes	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
PPH 2101.1	3											3
PPH 2101.2	3	2			2				2			3
PPH 2101.3	3		2	1								3
PPH 2101.4	3											3

Course Code	PPH2005
Course Title	Industrial Electronics
Category	Programme Elective
LTP & Credits	L: 1, T: 1, P: 0, Credits: 2
Total Contact Hours	24 hours
Pre-requisites	None

Course Objectives

The objective of this course aims to introduce IoT, IoT protocols, basics of communication and Aurdino knowledge

Course Outcomes

CO1	Understand IoT and IoT protocols
CO2	Understand Communication technology
CO3	Understand Aurdino and programming
CO4	Develop ability to apply principles of electronics, automation, and control systems

Module I **(6 Lecture)**

Definition and characteristics of IoT, Technical Building blocks of IoT, Devices, Communication Technologies, Physical design of IoT, IoT enabling technologies, IoT Issues and Challenges-Planning,Costs and Quality, Security and Privacy, Risks

Module II **(6 Lecture)**

MQTT, CoAP, XMPP and AMQT, IoT communication models, IoT Communication technologies: Bluetooth, BLE, Zigbee, Zwave,NFC, RFID, Zigbee etc

Basics of Digital Communication: Introduction, digital trans receiver, Information capacity, bits, bit rate, baud rate and m-ary coding.

Module III **(6 Lecture)**

Introduction to Arduino : Introduction to microcontroller and microprocessors, role of embedded systems, open source embedded platforms, Introduction to Arduino IDE-features, IDE overview, fundamentals of embedded C Programming concepts: variables, functions, conditional statements, Concept of GPIO in Atmega 328 based

Arduino board, digital input and output

Module IV **(6 Lecture)**

Peripheral Interface and Programming : Interfacing of Atmega328 based Arduino board with LED and LCD, serial communication using Arduino IDE, Concept of ADC in Atmega328 based Arduino board and different wave shape generation, interfacing of Atmega328 based Arduino board with temperature sensor (LM35), LVDT, strain gauge, Stepper motor.

Reference Books

1. Internet of Things–A hands on approach, Arshdeep Bahga, Vijay Madisetti, Universities Press,
2. IoT Fundamentals: Networking Technologies, Protocols and Use Cases for the Internet of Things, David Hanes, Cisco Press,
3. The Internet of Things: Applications to the Smart Grid and Building Automation, Olivier Hersent, Omar Elloumi and David Boswarthick, Wiley,
4. The Internet of Things –Key applications and Protocols, Olivier Hersent, David Boswarthick,Omar Elloumi ,Wiley, Electronic Communication Systems Fundamentals through advanced,Wayne Tomasi, Pearson Education Press
5. Wirelerss communications, Andrea Goldsmith, Cambridge University Press
6. Fundamentals of Wireless Communication, D. Tse and P. Viswanathan, Cambridge University Press.
7. Deshmukh Ajay : Microcontroller Theory and applications", Tata Mcgraw hill.
8. Barret Steven : Arduino Microcontroller processing for everyone" Morgan and ClaypoolPublishers.
9. Massimo Banzi : "Getting started with Arduino" Maker Media INC.
10. Brad Kendall : " Getting started with Arduino : Beginers Guide

CO-PO Mapping

Course Outcomes	**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**
CO1	3				2				2			3
CO2	3				2				2			3
CO3	3				2				2			3
CO4	3				2				2			3

Course Code	PPH3001				
Course Title	Statistical Physics				
Category	Programme Core				
LTP & Credits	L	T	P	Credits	
	3	1	0	4	
Total Contact Hours	48 hours				
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:

CO1	Explain the microstates and macro states of Ideal gas and microstate and macrostate in classical systems, and derivation of Maxwell's relations, and thermodynamic laws
CO2	Applications of these ensembles to classical ideal gas and explaining about types of oscillators.
CO3	Explanation of postulates of Quantum Statistical Mechanics and types of ensembles and energy distributions
CO4	Explaining of Thermodynamic behavior of Ideal, Bose, Fermi gases and applications of statistical mechanics, interacting systems and phase transitions

Module I **(6 Lectures)**

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

Module II **(20 Lectures)**

Classical ensemble theory: Phase space, microstates and macrostates; Liouville's equation, Postulates of statistical mechanics, Microcanonical 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 **(10 Lectures)**

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 **(12 Lectures)**

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.

References:

1. Statistical Physics of Particles, Mehran Kardar (Cambridge University Press, 2007).
2. Statistical Mechanics, Kerson Huang (2ndEdition, Wiley-India, 2008).
3. Statistical Mechanics, R.K. Pathria (Butterworth-Heinemann, 1996).
4.. Statistical Physics, Vol. 5 in Course in Theoretical Physics, L. D. Landau and E. M. Lifshitz, Elsevier.
5. Fundamentals of Statistical and Thermal Physics, F. Reif, McGraw-Hill International Edition (1985).

CO-PO Mapping

Course Outcomes	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**
CO1	3	2		1			1					3
CO2	3	2			1							3
CO3	3			2			1					3
CO4	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 hours				
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:

CO1	Students will able to understand the basics of coductivity in metals and the Fermi surfaces.
CO2	Students will gain knowledge on crystal structure and various diffraction techniques to determine the structural parameters.
CO3	Students will have idea of defects and diffusions in solids and lattice dynamics.
CO4	To give basic idea of formation of electronic band structure in materials. Also to provide knowledge aobut semiconductors and superconductivity.

Module I **(10 Lectures)**

Metals: 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 **(10 Lectures)**

Crystal Lattices: Diffraction of electromagnetic waves by crystals: 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 crystals.

Crystal Binding: Bond classifications – types of crystal binding, covalent, molecular and ionic crystals, London theory of van der Waals, hydrogen bonding, cohesive and Madelung energy.

Module III **(12 Lectures)**

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, models of threedimensional lattices, quantization of lattice vibrations, Einstein and Debye theories of specific heat, phonon density of states, neutron scattering.

Module IV **(16 Lectures)**

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.

References

1. Introduction to Solid State Physics, C. Kittel (8th Ed., Wiley, 2012)
2. Solid State Physics,N. W. Ashcroft and N. D. Mermin (Ist Ed., Cengage Learning, 2003)
3. Principles of the Theory of Solids, J. M. Ziman (2nd Ed., Cambridge University Press, 1972)
4. Solid State Physics, A. J. Dekker (1st Ed., Macmillan India, 2000)
5. Solid State Physics, G. Burns (1st Ed., Academic Press, 1985)
6. Condensed Matter Physics, M. P. Marder (Wiley, 2010)

CO-PO Mapping

Course Outcomes	**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**
CO1	3	1		1								3
CO2	3	1	2		3		1					3
CO3	3	2		2			2					3
CO4	3	1			2		2					3

Course Code	PPH3101			
Course Title	Physics Laboratory II			
Category	Programme Core			
LTP & Credits	L	T	P	Credits
	0	1	3	4
Total Contact Hours	8 hours/week			
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:

CO1	Understand the lattice dynamics
CO2	Get the practical knowledge of dynamics of materials
CO3	Analyze the dielectric properties of materials
CO4	Understand the characteristics of laser, Acousto-optical effect

1. Determination of e/m of an electron

2. Determination of Planck's Constant

3.Determination of Band-Gap of a

Semiconductor

4. Determination of Lande g - factor

5. Study of Lattice Dynamics

6. Study of Hall Effect at elevated temperatures

7. Study of Dielectric constant and determination of Curie temperature

8. Determination of numerical aperture of a fiber by measuring the diameter of laser beam

9. G.M. Counters – characteristics, dead time and counting statistics

10. Beta ray absorption – end point energy of beta particles.

11. Lifetime of a short lived radioactive source.

12. Electron Spin Resonance.

13. Nuclear Magnetic Resonance.

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

CO-PO Mapping

Course Outcomes	**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**
CO1	3											3
CO2	3		1		1							3
CO3	3	2										3
CO4	3											3

Reference Books

1. R.A. Dunlap, Experimental Physics: Modern Methods, Oxford University Press, New Delhi (1988).
2. E.V. Smith, Manual for Experiments in Applied Physics, Butterworths (1970).
3. D. Malacara (ed.), Methods of Experimental Physics, Series of Volumes, Academic Press Inc. (1988).
4. B.K. Jones, Electronics for Experimentation and Research, Prentice-Hall (1986).
5. P.B. Zbar, A.P. Malvino and M.A. Miller, Basic Electronics: A Text-Lab Manual, Tata Mc-Graw Hill, New Delhi (1994).
6. Kenneth L. Ashley, Analog Electronics with LabVIEW, Pearson Education (2003).

Course Code	PPH3102			
Course Title	Research Project I			
Category	CORE			
LTP & Credits	L	T	P	Credits
	1	1	2	4
Total Contact Hours	6 class/week			
Pre-requisites	None			

Any advance topic in the domain of science.

At the end of this course, students will be able to

CO1	Understand and practice of scientific reviewing and reporting
CO2	Find out the scope of reaearch under the topic of their choice
CO3	Enhance presentation and communication skills.

CO-PO Mapping

Course Outcomes	**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**
CO1	**3**	**2**	**2**	**1**		**2**			**1**	**1**	**1**	**3**
CO2	**3**	**1**	**2**	**2**		**2**	**2**		**1**	**1**	**1**	**3**
CO3	**3**					**2**						**3**

Course Code	PPH3003				
Course Title	Advanced Quantum Mechanics				
Category	Elective paper				
LTP & Credits	L	T	P	Credits	
	3	1	0	4	
Total Contact Hours	48 hours				
Pre-requisites	None				

Course objectives

The primary objective is to teach the students various approximation methods in quantum mechanics andhow 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:

CO1	Students able to apply symmetry in quantum mechanics to solve different problems
CO2	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
CO3	Students able to understand Dirac equations and its applications
CO4	Non relativistic problems solutions using quantum rules

Module 1: **(15 Lectures)**

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: **(15 Lectures)**

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

Module III: **(10 Lectures)**

Dirac equation, covariant form, adjoint equation; Plane wave solution and momentum space spinors; 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: **(8 Lectures)**

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

Reference Books:

1. J.D. Bjorken and S.D. Drell: Relativistic Quantum Mechanics
2. W. Greiner: Relativistic Quantum Mechanics
3. A. Lahiri and P.B. Pal: A First Book of Quantum Field Theory
4. Schweber : Relativistic Quantum Field Theory – Harper and Row

CO-PO Mapping

Course Outcomes	**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**
CO1	3	2	1									3
CO2	3				1							3
CO3	3	2	1									3
CO4	3											3

Course Code	PPH3004
Course Title	Advanced Electronics I
Category	Elective paper

<table>
<tr><td>Course Code</td><td colspan="4">PPH3004</td></tr>
<tr><td>Course Title</td><td colspan="4">Advanced Electronics I</td></tr>
<tr><td>Category</td><td colspan="4">Elective paper</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 hours</td></tr>
<tr><td>Pre-requisites</td><td colspan="4">None</td></tr>
</table>

Course Objectives

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

Course Outcomes:

CO1	Students will able to explain the operation of 8085 microprocessor
CO2	Students will able to explain the operation of 8086 microprocessor
CO3	Students will able to explain the operation of advanced microprocessor
CO4	Students may apply microprocessors in different circuits

Module I: **(12 Lectures)**

Intel 8085:
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: **(12 Lectures)**

Intel 8086:
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: **(12 Lectures)**

Advanced Microprosessors:
Multitasking, Architecture and memory management of microprocessor 80286, Brief idea about

architecture of microprocessor 80386, 80486 and Pentium, Introduction to Microcontroller.

Module IV: **(12 Lectures)**

Microprocessor based Measurement/Control Circuits:
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 Books:

1. Fundamentals of Microprocessors and Microcomputers: B. Ram.
2. Microprocessor System the 8086 /8088 Family: Liu and Gibson.
3. Microprocessor, Architecture, Programming and Application: R.S. Goonkar.
4. Introduction to Microprocessor: A.P. Mathur.
5. Microprosessor and Interfacing: D.V. Hall

CO-PO Mapping

Course Outcomes	**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**
CO1	3											3
CO2	2	2	2		2				1			3
CO3	3	2										3
CO4	1				2							3

Course Code	PPH3005			
Course Title	Advanced Mathematical Physics			
Category	Elective paper			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48 hours			
Pre-requisites	None			

Course Objectives

To introduce students to methods of mathematical physics and to develop advanced mathematical skills to solve problems in quantum mechanics, electrodynamics and other fields of theoretical physics.

Course Outcomes:

CO1	Group theory is applied to understand systems behavior in different coordinate systems.
CO2	Students will get an idea of probability distributions and their applications
CO3	Students will able to apply integral equations in different physical systems
CO4	Boundary value problems will help students to study states of the physical systems

Module I **(12 lectures)**

Finite discrete Group: Group Theory: 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 **(12 lectures)**

Continuous Group: 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 **(12 lectures)**

Integral Equations: Conversion of ordinary differential equations into integral equations, Fredholm and Volterra integral equations, separable kernels, Fredholm theory, eigen values and eigen functions.

Module IV **(12 lectures)**

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

Reference Books

1. Elements of Group Theory for Physicists, A.W. Joshi (John Wiley, 1997).
2. Groups and Symmetry,M. A. Armstrong(Springer, 1988).
3. Advanced Method of Mathematical Physics, R. S. Kaushal & D. Parashar (Narosa, 2008).
4. Group Theory and Its Applications to Physical Problems, M. Hamermesh (Dover, 1989).
5. Chemical Applications of Group Theory, F. Albert Cotton (John Wiley, 1988).
6. Mathematical Methods for Physicists,G. Arfken, H. Weber, & F. Harris (Elsevier, 2012).
7. Linear Integral Equations, W. V. Lovitt (Dover, 2005).
8. Introduction to Integral Equations with Applications, A. J. Jerri (Wiley-Interscience, 1999).

CO-PO Mapping

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3											3
CO2	3	2	1		2							3
CO3	3											3
CO4	3											3

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

Course Objectives

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

Course Outcomes:

CO1	Students will enhance their knowledge in nuclear reactions
CO2	Students will get an idea of different nuclear models
CO3	Students will able to understand rotational and vibrational spectra
CO4	Students will understand the ISOL and Fragmentation techniques for the production of exotic nuclei

Module I **(12 lectures)**

Nuclear Reaction: 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 models, Coulomb excitation and its applications.

Module II **(12 lectures)**

Nuclear Structure: 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 **(12 lectures)**

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

Module IV **(12 lectures)**

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 Books

1. Theory of Nuclear Structure, M.K. Pal (Affiliated East-Wast Press,1982)
2. Nuclear Structure from a Simple Perspective, R. F. Casten (Press, 2nd Ed., Oxford Univ. 2000)
3. Nuclear and Particle Physics , A.B. Bhattacharya, R. Bhattacharya and R. Raha, NCBA, 2018
4. Theoretical Nuclear Physics, Vol. I, Nuclear Structure, DeShalit & Feshbach (Wiley Interscience , 1998)
5. Nuclear Reaction and Nuclear Structure, P.E. Hodgson (Clarendon Press, 1971)
6. Heavy ion reactions, Vol. I & II, R. A. Broglia & Aage Winther (Benjamin/Cummings, 1981)

CO-PO Mapping

Course Outcomes	**Programme Outcomes (PO)**											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3											3
CO2	3	1	2		1							3
CO3	3				2							3
CO4	3											3

Course Code	PPH3007				
Course Title	Advanced Experiments Of Physics				
Category	Elective paper				
LTP & Credits	L	T	P	Credits	
	0	4	0	4	
Total Contact Hours	48 hours				
Pre-requisites	None				

Course Objectives

This course will familiarize students with some landmark experiments in physics

Course Outcomes:

CO1	Students will get an idea how basic experiments are designed
CO2	Students will able to understand experiments of different fields of Physics
CO3	Students will able how an experiment approaches to a success one

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

- ✓ Mössbauer effect
- ✓ Pound-Rebka experiment to measure gravitational red shift
- ✓ Parity violation experiment of Wu
- ✓ Superfluidity of 3He
- ✓ Cosmic microwave background radiation
- ✓ Helicity of the neutrino
- ✓ Quantum Hall effect - integral and fractional
- ✓ Laser cooling of atoms
- ✓ Ion traps
- ✓ Bose-Einstein condensation
- ✓ Josephson tunneling
- ✓ Atomic clocks
- ✓ Interferometry for gravitational waves
- ✓ Quantum entanglement experiments: Teleportation experiment, Aspect's experiment on Bell's inequality
- ✓ Inelastic neutron scattering

- ✓ CP violation
- ✓ Verification of predictions of general theory of relativity by binary-pulsar and other experiments
- ✓ Precision measurements of magnetic moment of electron
- ✓ Scanning tunnelling microscope
- ✓ Discovery of the Higgs particle
- ✓ Discovery of Neutrino oscillation

References

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

CO-PO Mapping

Course outcomes	**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**
CO1	3											3
CO2	3			2								3
CO3	3											3

Course Code	PPH3008			
Course Title	Advanced Optics			
Category	Elective paper			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48 hours			
Pre-requisites	None			

Course objectives

The objective of this course is to give idea about the nonlinear optics and to introduce basic concepts governing optical waveguides, fibres, and lasers.

Course Outcomes:

CO1	Understanding and explaining the various lasers systems and their applications
CO2	Illustrating the various mechanism in nonlinear optics
CO3	Fundamental properties of optical fibers, types of optical fibers and their related information
CO4	Apply the skills necessary to solve practical and design problems for fiber optic communication systems.

Module 1: (15 Lectures)

Basic Laser Theory: Absorption, spontaneous and stimulated emission, population inversion, Properties of Laser, Metastablestate, Gain, Absorption coefficient, Einstein's coefficient Pumping methods : Pumping mechanisms (Two, Three andFour), Threshold pump power, g-parameters of laser cavity, stability curve, Gaussian beam and their properties. Line broadening mechanisms. Measurements of laser power, energy, wavelength, frequency, line width.

Module II: (10 Lectures) (10 Lectures)

Types of Lasers and its Applications: Principle, Construction, Energy level diagram and working - Solid State, Gas, Liquid, and Semiconductor Lasers with examples

Module III: (8 Lectures)

Nonlinear Optics: Origin of nonlinearity, susceptibility tensor, phase matching, second harmonic generation, methods of enhancement, frequency mixing processes, nonlinear optical materials. 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, Pockels cell

Module IV: **(15 Lectures)**

Fibre optics: 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 fibre waveguides (step index, graded index, single mode), attenuation in fibre, couplers and connectors, LED, injection laser diode (double heterostructure, distributed feedback)

Reference Books:

1. Principles of lasers- O Svelto
2. Solid State Laser Engineering- W Koechner
3. Methods of Experimental Physics Vol. 15B ed. By C L Tang
4. Industrial Application of Lasers – J F Ready
5. Handbook of Nonlinear Optics- R L Sautherland
6. Laser and electrooptics- C C Davis
7. Fibre optic communication- Joseph C Palais
8. Introduction to Fiber Optics – A. Ghatak, K. Thyagarajan- Cambridge University Press
9. Introduction to Laser Theory And Application – M.N. Avdhanulu, S. Chand Publication

CO-PO Mapping

Course Outcomes	**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**
CO1	3											3
CO2	3				2							3
CO3	3						1					3
CO4	3	2										3

Course Code	PPH3009			
Course Title	Plasma Physics			
Category	Elective paper			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48 hours			
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:

CO1	Students will able to explain basic concepts of Plasma Physics
CO2	Students will get an idea of KDV equation and its applications
CO3	Students will able to understand Magneto-hydrodynamic instabilities
CO4	Students may apply the concepts of Plasma Physics to solve different problems.

Module I **(12 Lectures)**

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 **(12 Lectures)**

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 **(12 Lectures)**

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 **(12 Lectures)**

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

Reference Books

1. Introduction to Plasma physics, F. F. Chen (Plenum Press, 1984)
2. Principles of Plasma Physics, N. A. Krall and Trivelpiece (San Fransisco Press, 1986)
3. Physics of High temperature Plasmas, G. Schimdt (2nd Ed., Academic Press, 1979)
4. The framework of Plasma Physics, R.D. Hazeltine & F.L. Waelbroeck (Perseus Books, 1998)
5. Introduction to Plasma Physics, R.J. Goldston and P.H. Rutherford (IOP, 1995)
6. Plasma Physics via Computer Simulation, C.K. Birdsall, A.B Langdon (CRC Press 2004)
7. Plasma Physics and Engineering, A. Fried and L.A. Kennedy (Taylor and Francis Group-2011).

CO-PO Mapping

Course Outcomes	**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**
CO1	3											3
CO2	3	2					2					3
CO3	3											3
CO4	3											3

Course Code	PPH3010			
Course Title	General Theory Of Relativity and Cosmology			
Category	Elective paper			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48 hours			
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:

CO1	Students able to understand , Energy-momentum tensor
CO2	Students will able to enhance their knowledge in general theory of relativity
CO3	Students will get an idea of black hole
CO4	Students will able to understand basic concepts of cosmology

Module I **(12 Lectures)**

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

Module II **(12 Lectures)**

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 **(12 Lectures)**

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 **(12 Lectures)**

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 Books:

1. Gravity- An introduction to Einstein's general relativity – James B. Hartle (Addison-Wesley, 2003)
2. Adler, Bazin and Schiffer : Introduction to General Relativity - McGraw Hill Kogakusha.
3. Bergmann : Theory of Relativity - Prentice Hall.
4. NarlikerJV : General Relativity and Cosmology - Macmillan
5. Dirac P M A : Introduction to general Relativity
6. S. Weinberg Gravitation and Cosmology - (Wiley, 1972)

CO-PO Mapping

Course Outcomes	**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**
CO1	3											3
CO2	3	2			1							3
CO3	3	1										3
CO4	3											3

Course Code	PPH3011
Course Title	Data Analysis and Interpretation
Category	Elective paper for other departments (M.Sc Students)
LTP & Credits	L: 1, T: 1, P: 0, Credits: 2
Total Contact Hours	24 hours
Pre-requisites	None

Course Objectives

To explore real-world applications of data interpretation and analysis in different domains.

Course Outcomes:

CO1	Understand the importance of data interpretation and analysis in decision-making processes.
CO2	Apply statistical techniques to analyze data
CO3	Collect, organize, and clean data for analysis
CO4	Interpret and communicate the results of data analysis to stakeholders.

Module I **(6 Lectures)**

Data Collection and Preparation: Introduction, Types of data and data sources, Designing data collection methods , Data cleaning and pre-processing, Handling missing data and outliers

Module II **(6 Lectures)**

Probability distribution:Normal Probability Curve and its Applications, Inferential statistics: Standard errors, confidence limits, Hypothesis testing- type I and type II errors, Test of significance, two tailed and one tailed tests , Parametric and Non Parametric Test: Concept and Assumptions

Module III **(6 Lectures)**

Data Analysis: Analysis of variance (ANOVA), Multivariate analysis, Time series analysis, Principal component analysis, Factor Analysis, Correlational Analysis, The Goodness of Fit, Kruskal-Wallis H Test, Regression and prediction, Discriminant analysis

Module IV **(6 Lectures)**

Interpretation and Communication of Results : Overview of computer software for data analysis Interpreting statistical findings, Presenting data analysis results, Communicating insights to stakeholders

Reference Books

1. "A Practical Guide to Scientific Data Analysis" by David J. Livingstone.
2. "Data Analytics Made Accessible" by Dr. Anil Maheshwari

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 hours			
Pre-requisites	None			

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 fundamentals and properties of a coherent light source as Laser (various types) will also be taught.

Course Outcomes:

CO1	Students will able to explain the electronic structure in atoms using different spectra
CO2	Students able to study of molecular energy levels using rotational and vibrational spectroscopy
CO3	Students may explain of Raman effect of rotational, vibrational and polyatomic molecules
CO4	Student will get basic idea of Laser.

Module I **(12 Lectures)**

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-LS 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 **(12 Lectures)**

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.
Molecular orbital and valence bond methods for □2 H and H2. Morse potential. Basic concepts of correlation diagrams for heteronuclear molecules.

Module III **(12 Lectures)**

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 **(12 Lectures)**

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 Books:

1. Physics of Atoms and Molecules, B. H. Bransden and C. J. Jochain (2nd Ed., Pearson
2. Education, 2003)
3. Atomic Spectra and Atomic Structure, G. Herzberg (Dover Publications, 2003)
4. Molecular Spectra and Molecular Structure, G. Herzberg (Van Nostrand, 1950)
5. Atoms, Molecules and Photons, W. Demtroder (Springer, 2006)
6. Fundamentals of Molecular Spectroscopy, C. N. Banwell (McGraw Hill, 1983)
7. Basic atomic & Molecular Spectroscopy, J. M. Hollas (Royal Society of Chemistry, 2002)
8. Principles of Lasers, O. Svelto (5th Ed., Springer, 2010)
9. Laser Spectroscopy, W. Demtroder (3rd Ed., Springer, 2003)

CO-PO Mapping

Course Outcomes	**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**
CO1	3											3
CO2	3				1							3
CO3	3											3
CO4	3	2			2							3

Course Code	PPH4002				
Course Title	Computational Physics				
Category	Programme Core				
LTP & Credits	L	T	P	Credits	
	3	1	0	4	
Total Contact Hours	48 hours				
Pre-requisites	None				

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:

CO1	Students able to Analyze the C characters, operators, analytic expression, arrays, functions and simple programs, Python interpreter and interactive mode.
CO2	Students able to describe and apply the basics of MATLAB to solve linear systems and interpolation
CO3	Students able to apply MATLAB to solve linear equation, non- linear equation and simultaneous equations
CO4	Describe and Apply C language and MATLAB to solve interpolations, numerical differentiation and integration

Module I **(12 Lectures)**

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 **(12 Lectures)**

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 **(12 Lectures)**

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 tools, Chart, Linking Worksheet, Create hyperlink.
Web page design and implementation using html//: Web Pages, Lists, Links, Frames, Scripts.

Module IV **(12 Lectures)**

Generation of uniformly distributed random integers, Statistical tests of randomness, Mon te Carlo evaluation of integrals and error analysis, Non-uniform probability distributions, Importance sampling,

Softwares: Use of a package for plotting of data and functions, Curve Fitting, Extrapolation. Programming in MathCAD /MATLAB /MATHEMATICA /Python /C.

References:

1. Gottfried, Programming with C. Schaum series.
2. Tanenbaum, Operating system. Prentice Hall.
3. Sastry, Introductory Methods of Numerical Analysis.
4. Kyayszig, Advance Engineering Mathematics. John Willey, 9th Ed.
5. Tanenbaum, Computer Network, Prentice Hall.
6. V. Rajaraman: Computer Oriented Numerical Methods
7. J.M. McCulloch and M.G. Salvadori: Numerical Methods in Fortran
8. R. L. Burden and J. D. Faires : Numerical Methods

CO-PO Mapping

Course Outcomes	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
CO1	3				2							3
CO2	3	2			2	1			1			
CO3	3	1	2									3
CO4	3				1							3

Course Code	PPH4101			
Course Title	Research Project II			
Category	CORE			
LTP & Credits	L	T	P	Credits
	1	1	2	4
Total Contact Hours	6 class/week			
Pre-requisites	None			

Continuation of Research Project I

At the end of this course, students will be able to

CO1	Ability to choose methods appropriate to research aims
CO2	Understand the limitation of the research method
CO3	Develop skills in data analysisand preseeeeeentation
CO4	Develop critical thinking skills

CO-PO Mapping

Course Outcomes	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
CO1	3	2	2	1		2			1	1	1	3
CO2	3	1	2	2		2	2		1	1	1	3
CO3	3					2						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 hours				
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:

CO1	Students will able to understand microwavedevices
CO2	Students will get an idea of photonic devices
CO3	Students will able to understand the function of MOSFET, CMOS and different memory devices
CO4	Students able to explain Piezoelectric sensors and actuators and their applications

Module I **(12 lectures)**

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

Module II **(12 lectures)**

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 cells.

Module III **(12 lectures)**

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

Module IV **(12 lectures)**

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 Books

1. Physics of Semiconductor Devices, S. M. Sze and K. K. Ng (3rd Ed., Wiley, 2008)
2. Semiconductor devices Physics and Technology, S. M. Sze (2nd Ed., Wiley, 2008)
3. Microwave Devices and Circuits, S. Y. Liao (3rd Ed., Pearson, 2003)
4. Electronic Instrumentation and Measurement Techniques, W. D. Cooper and A. D.Helfrick (2nd Ed., Phi Learning, 2008)

CO-PO Mapping

Course Outcomes	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
CO1	3											3
CO2	3						2		2			3
CO3	3										1	3
CO4	3								2			3

<table>
<tr><td>Course Code</td><td colspan="4">PPH4004</td></tr>
<tr><td>Course Title</td><td colspan="4">Fundamentals of Energy Physics</td></tr>
<tr><td>Category</td><td colspan="4">Elective paper</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 hours</td></tr>
<tr><td>Pre-requisites</td><td colspan="4">None</td></tr>
</table>

Course Objective

To enhance knowledge of energy storage and harvesting

Course Outcomes:

CO1	Students will understand the basic concepts of energy
CO2	Students will get an idea of the use of nonrenewable energy sources
CO3	Students will able to understand the potential of solar energy and energy harvesting
CO4	Hydrogen energy and devices will help students to design energy harvesting systems

Module I **(12 lectures)**

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 **(12 lectures)**

Fossil fuels – 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 **(12 lectures)**

Sun as source of energy, Passive Solar energy, Solar thermal energy, solar collectors, solar ponds; Fundamentals of photovoltaic Energy Conversion Physics Solar photovoltaic cells, Types of Solar Cells, 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 Cells, Elementary Ideas of Advanced Solar Cells e.g. Tandem Solar cells, Solid Liquid Junction Solar Cells, Nature of Semiconductor, Principles of Photo-electrochemical Solar Cells.

Module IV **(12 Lectures)**

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 Cells, Various type of Fuel Cells, Applications of Fuel Cell, Elementary concepts of other Hydrogen- Based devices

Field Visits: Power Plants

Reference Books:

1. Solar Cell Devices-Physics :Fonash
2. Fundamentals of Solar Cells Photovoltaic Solar Energy :Fahrenbruch & Bube
3. Phoptoelectrochemical Solar Cells: Chandra
4. Hydrogen as an Energy Carrier Technologies Systems Economy : Winter & Nitch (Eds.)
5. Hydrogen as a Future Engery Carrier : Andreas Zuttel, Andreas Borgschulte and Louis Schlapbach

CO-PO Mapping

Course Outcomes	**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**
CO1	3										3	3
CO2	3	3					2				3	3
CO3	3										2	3
CO4	3										3	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 hours			
Pre-requisites	None			

Course Objectives

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

Course Outcomes:

CO1	Students able to understand the basic thermal structure of atmosphere
CO2	Students able to understand the atmospheric thermodynamics
CO3	Students will able to understand atmospheric scales of motion
CO4	Students able to understand the techniques of measuring atmospheric parameters

Module I **(12 Lectures)**

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 Green house 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 **(12 Lectures)**

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 **(12 Lectures)**

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

(12 Lectures)

Techniques and measurements for atmospheric Physics: Radar band designations, Radar block diagram, radar equation, detection of signals in noise and signal to noise ratio, integration of radar pulses, 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

Reference Books:

1. Solar activity and Earth's climate – R.E. Benestad (Blindun, Norway)
2. Basic of Atmospheric Science A. Chandashekhar
3.The Atmosphre an introduction to Meteorology Frederick, K.Autgens, Edward J. Tarbuck, Pearson Publishing House
4. Physics of the environment and Climate Gerand Guyo (John Wiley and Sons).
5. Atmospheric dynamics John Gaun (Cambridg Univ. Press)
6. Atmospheric Science Wallace and Hobbs, Academic Press
7. An Introduction to Dynamic Meteorology James R. Holton and G. J. Hakim , Academic Press

CO-PO Mapping

Course Outcomes	**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**
CO1	3											3
CO2	3			2							2	3
CO3	3						2					3
CO4	3						1				1	3

Course Code	PPH4006			
Course Title	Group Theory			
Category	Elective paper			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48 hours			
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:

CO1	Students will get basic concepts of group theory
CO2	Students will get an idea of probability distributions and their applications
CO3	Students will be able to explain group theory in different groups
CO4	Students will be able to apply of group theory in quantum mechanics

Module I **(12 Lectures)**

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 **(12 Lectures)**

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 **(12 Lectures)**

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 **(12 Lectures)**

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

Reference Books

1. A.W. Joshi: Elements of Group Theory for Physicists
2. M. Tinkham: Group Theory and Quantum Mechanics
3. Zee : Group Theory in a Nutshell for Physicists

CO-PO Mapping

Course Outcomes	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
CO1	3	2										3
CO2	3		2		1							3
CO3	3	1										3
CO4	3		1									3

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

Course Objectives

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

Course Outcomes:

CO1	Understand the importance quantum mechanics, energy bands and electronic statistics
CO2	Understand heterostructures, quantum wells, dots, wires.
CO3	Optical properties and radiative processes.
CO4	Students able to understand the Characterization techniques

Module I **(12 Lectures)**

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

Module II **(12 Lectures)**

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 nanocrystals. Quantitative treatment of quasiparticles and excitons. Charging effects.

Module III **(12 Lectures)**

Optical properties: Optical properties and radiative processes: General formulationabsorption, 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 **(12 Lectures)**

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

Reference Books

1. Nanostructures-Theory & Modelling, C. Delerue and M. Lannoo (Springer, 2004)
2. Nanostructure, V. A. Shchukin, N. N. Ledentsov and D. Bimberg (Springer, 2004)
3. Characterization of Nanophase Materials, Z. L. Wang (Ed.) (Wiley-VCH, 2000)
4. Semiconductor Nanocrystal Quantum Dots, A. L. Rogach (Ed.) (Springer Wien NY, 2008)
5. Introduction to Nanotechnology, C. P. Poole Jr. & F. J. Owens (Wiley-Interscience, 2003)

CO-PO Mapping

Course Outcomes	**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**
CO1	3											3
CO2	3	2	2									3
CO3	3		1				1					3
CO4	3	1										3

Course Code	PPH4008			
Course Title	Astrophysics			
Category	Elective paper			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48 hours			
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:

CO1	Students will able to get basic concepts of Astrophysics
CO2	Students will get an idea of stellar structure and Gamma Ray Bursts
CO3	Students will able to understand Stellar Nucleo sysnthesis
CO4	Students will able to understand concepts of black hole and Quasars

Module I: **(12 Lectures)**

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, Rosseland mean, Opacity, Formation of spectral lines, Photon diffusion inside sun.

Module II: **(12 Lectures)**

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, HR 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. Pulsars, Magnetars, , Gamma Ray Bursts.

Module III: **(12 Lectures)**

Stellar Nucleosysnthesis: 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: **(12 Lectures)**

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 Books:

1. Textbook of astronomy an astrophysics with elements of cosmology, V.B.Bhatia, Narosa publishing house, 2001.
2. Astrophysics – Stars and Galaxies, K. D. Abhyankar, University Press, 2001.
3. Theoretical Astrophysics (Vols.I,II,III) – T. Padmanavan (CUP)
4. Black Holes, White Dwarfs and Neutron Stars – S.L.Shapiro and S.A.Teukolsky (John Wiley, 1983)
5. An introduction to astronomy and astrophysics - Pankaj Jain
6. An Introduction to Modern Astrophysics - Carroll and Ostlie
7. .Astrophysical concepts – Harwitt
8. An introduction to stellar astrophysics - Francis LeBlanc

CO-PO Mapping

Course Outcomes	**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**
CO1	3											3
CO2	3			2			2				1	3
CO3	3											3
CO4	3			2								3

Course Code	PPH4009				
Course Title	Advanced Solid State Physics				
Category	Elective paper				
LTP & Credits	L	T	P	Credits	
	3	1	0	4	
Total Contact Hours	48 hours				
Pre-requisites	None				

Course Objectives

This course intends to provide knowledge of conceptual advanced level solid-state physics. In addition, this course aims to provide a general introduction to theoretical and experimental topics in solid state physics by covering electrical transport, dielectric, optical, and magnetic properties of solids.

Course Outcomes:

CO1	Understand Transport Properties of solid
CO2	Understand dielectric and optical properties of solid
CO3	Understand superconductivity
CO4	Elucidate the important features of advanced topics in solid state physics

Module I **(10 Lectures)**

Transport Properties of Solids: Boltzmann transport equation, resistivity of metals and semiconductors, Fermi surfaces – determination, Landau levels, de Hass van Alphen effect, Quantum Hall effect- Integral quantum Hall effect and. Magnetoresistance.

Module II **(10 Lectures)**

Dielectric Properties of Solids: Dielectrics and ferroelectrics, macroscopic electric field, local field at an atom, dielectric constant and polarizability, ferroelectricity, antiferroelectricity, piezoelectric crystals, ferroelasticity, electrostriction.

Module III **(10 Lectures)**

Optical properties: Optical constants and their physical significance, Reflectivity in metals, plasmonic properties of metals, determination of band gap in semiconductors: direct and indirect band gap, defect mediated optical transitions, excitons, photoluminescence, Electroluminesence

Module IV **(10 Lectures)**

Magnetism: Types of magnetic materials, Quantum theory of paramagnetism, Hund's rule, Ferromagnetism, antiferromagnetism: molecular field, Curie temperature. Domain theory, Magnetic Anisotropy, Magnetic interactions, Heitler-London method, exchange and superexchange, magnetic moments and crystal-field effects, spin-wave excitations and thermodynamics, antiferromagnetism, Magnetostriction.

Module V **(8 Lectures)**

Superconductivity: Phenomenological theories of superconductivity, BCS theory, two fluid and Pippard's theory, London equations Flux quantization, BCS ground state and energy gap, Cooper pairs, coherence, vortex states Ginzburg-Landau theory, Josephson effect, SQUID, introduction to high-temperature superconductors.

Reference Books

1. Solid State Physics, N. W. Ashcroft and N.D. Mermin(Ist Ed., Cengage Learning, 2003)
2. Elementary Excitations in Solids, D. Pines (CRC press, 1999)
3. The Wave Mechanics of Electrons in Metals, S. Raimes (North-Holland, 1970) 4.
4. Lecture Notes on Electron Correlation & Magnetism, P. Fazekas (World Scientific, 1999)
5. Introduction to Superconductivity,M. Tinkham (Dover Publications Inc., 2004)
6. Condensed Matter Physics,M. Marder(2nd Ed., John Wiley & Sons, 2010)
7. Principles of Condensed Matter Physics,P.M. Chaikin and T.C. Lubensky (Cambridge University Press, 1995)

CO-PO Mapping

Course Outcomes	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
CO1	3											3
CO2	3			2			2				1	3
CO3	3											3
CO4	3			2								3

Course Code	PPH4010				
Course Title	Applied Physics				
Category	Elective paper				
LTP & Credits	L	T	P	Credits	
	3	1	0	4	
Total Contact Hours	48 hours				
Pre-requisites	None				

Course Objectives

Course intends to impart knowledge of conceptual physics and its applications relevant to various streams of engineering and technology.

CO1	able to comprehend basic physics principles used in emerging technological devices like transducer, sensors
CO2	able to comprehend basic physics principles used in emerging technological devices like cryogenics and energy harvesting
CO3	Enriched knowledge on physics of materials will be used in different engineering and technological applications.

Module I **(12 lectures)**

Transducers: Fundamentals of transducer, classifications and general characteristics; displacement transducers, strain gauges, pressure and force transducers, torque transducers, flow transducers, transducers for biomedical applications. Microelectromechanical systems (MEMS); microfabrication and micromachining, advanced lithography techniques, diffusion & ion implantation, and high aspect ratio processes.

Module II **(12 lectures)**

Sensors: Resistive, capacitive, inductive, electromagnetic, thermoelectric, piezoelectric, piezoresistive, photosensitive and electrochemical sensors; Toxic gas monitoring; thermal conductivity analyzers, colorimetric determination, sorption type dosimeters; non-dispersive infrared and ultraviolet sensors; flame ionisation detectors; semiconductor sensors. Lasers for optical communication system – Applications of optical fibre - Fibre optic communications.

Module III **(12 lectures)**

Cryogenics: Production of vacuum and measurements. Measurement of low pressure, calibration of vacuum gauges, general principle of mass flow measurement and control. Basic cryogenics science, cryostat design properties of material at low temperature. Measurement system for low temperatures; Applications of cryogenics – PPMS and MPMS; principle and working. Safety in handling of cryogens.

Module IV **(12 lectures)**

Alternate Energy Storage and Harvesting: Electrochemical energy storage devices - EMF, reversible and irreversible cells, free energy, thermodynamic calculation of the capacity of a battery, calculations of energy and power density of cells. Types of batteries, factors affecting battery capacity, voltage and current level; types of discharge: Applications of lithium ion batteries in electronic devices, and electric vehicle. Supercapacitors and fuel cells: basics of fuel cells, types of fuel cells and technology development. Solid and polymer electrolyte and solid oxide fuel cells. Basics of solar energy; brief history of solar energy utilization; various approaches of utilizing solar energy. Formation of solar cell and its equation; fill factor and maximum power; silicon solar cell; tandem solar cell; dye sensitized solar cell; organic solar cell.

CO-PO Mapping

Course Outcomes	**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**
CO1	3	2										3
CO2	3		2		1							3
CO3	3	1										3
CO4	3		1									3

Course Code	PPH4102			
Course Title	Grand Viva			
Category	CORE			
LTP & Credits	L	T	P	Credits
	0	2	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 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 hours			
Pre-requisites	None			

Course Objectives

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

Course Outcomes:

CO1	Students will understand the concepts of Renewable and nonrenewable energy
CO2	Students will enhance their knowledge about solar energy harvesting
CO3	Students will understand how to harness wind enrgy
CO4	Students will able to know ocean energy, geothermal energy and energy harvesting

Module I **(8 Lectures)**

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

Module II **(10 Lectures)**

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 models and equivalent circuits, and sun tracking systems.

Module III **(10 Lectures)**

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 **(10 Lectures)**

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 **(10 Lectures)**

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

Reference Books:

1. Non-conventional energy sources - G.D Rai - Khanna Publishers, New Delhi

2. Solar energy - M P Agarwal - S Chand and Co. Ltd.
3. Solar energy - Suhas P Sukhative Tata McGraw - Hill Publishing Company Ltd.
4. Godfrey Boyle, "Renewable Energy, Power for a sustainable future", 2004, Oxford University Press, in association with The Open University.
5. Dr. P Jayakumar, Solar Energy: Resource Assesment Handbook, 2009
6. J.Balfour, M.Shaw and S. Jarosek, Photovoltaics, Lawrence J Goodrich (USA).

CO-PO Mapping

Course Outcomes	**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**
CO1	3											3
CO2	3	2			2						2	3
CO3	3						1					1
CO4	3						1				2	3

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

Course Objectives:
To understand the basic structure and crystal arrangement of materials using modern learning strategies.

Course Outcomes:

CO1	Analyze the Structure of materials at different levels, basic concepts of crystalline materials
CO2	Acquire knowledge about polymer, ceramics and composite materials, types, manufacturing methods and its applications
CO3	Acquire knowledge and understand the key principles of nanotechnology including the relationship between Nano and various sciences and mathematics
CO4	Analyze the properties using modern techniques and design various nanocomposite materials for various industrial applications.

Module I: (12 lectures)

Applied crystallography in materials science : Noncrystalline and semicrystalline states, Lattice. Crystal systems, unit cells. 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 crystals. Lattice imperfections: Point defect, line defect, plane defect, volume defect, dislocation, stacking faults, application, Burger vectors.

Module II: (12 lectures)

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

Module III: (12 lectures)

Nanoscale systems: Length scales in physics, Nanostructures: 1D, 2D and 3D nanostructures (nanodots, thin films, nanowires, nanorods), Band structure and density of states of materials at nanoscale, 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: **(12 Lectures)**

Synthesis and Characterization techniques of nanostructure materials:Top down and Bottom up approach of synthesis of nano-structured materials, nanorods, 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 Books:

1. Materials science and Engineering by V. Raghavan, Prentice-Hall Pvt. Ltd.
2. Elements of X-ray diffraction by B. D. Cullity, Addison-Wesley Publishing Co.
3. Elements of crystallography by M. A. Azaroff
4. C.P. Poole, Jr. Frank J. Owens, Introduction to Nanotechnology (Wiley India Pvt. Ltd.).
5. S.K. Kulkarni, Nanotechnology: Principles & Practices (Capital Publishing Company)
6. K.K. Chattopadhyay and A. N. Banerjee, Introduction to Nanoscience and Technology (PHI Learning Private Limited).
7. Richard Booker, Earl Boysen, Nanotechnology (John Wiley and Sons).

CO-PO Mapping

Course Outcomes	**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**
CO1	3											3
CO2	3	2			2						2	3
CO3	3						1					1
CO4	3						1				2	3

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

Course Objectives

To understand basic laws of Physics and its applications

Course Outcomes:

CO1	Students will learn the basics of Particle Physics
CO2	Students able to understand basic laws of motion
CO3	Students will understand Physic of small bodies
CO4	Students will able to hand on practice of basic experiments of Physics

Module I **(14 Lectures)**

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 **(14 Lectures)**

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 **(14 Lectures)**

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 levels and spin. Elementary ideas of Schroedinger'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 **(6 Lectures)**

BASIC Experiments: Verification of Bohr's atomic theory by Franck Hertz Experiment, Determination of e/m of an electron, Determination of g, Determination of Planck's Constant.

Reference Books:

1. An introduction to mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw- Hill.
2. Mechanics, Berkeley Physics, vol.1, C.Kittel, W.Knight, et.al. 2007, Tata McGraw-Hill.
3. Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley.
4. Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.
5. Modern Physics, G.Kaur and G.R. Pickrell, 2014, McGraw Hill
6. Modern Physics, J.R. Taylor, C.D. Zafiratos, M.A. Dubson, 2004.

CO-PO Mapping

Course Outcomes	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3			2								3
CO2	3	2			1							2
CO3	3			1			1					3
CO4	3	2			2							1