CHOICE BASED CREDIT SYSTEM

POST GRADUATION
IN
PHYSICS

UNIVERSITY

With Effect From
2020-2021

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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.

PG Course Structure (Physics)

SR. NO.	NAME	NO. OF PAPERS	CREDIT PER PAPER	TOTAL CREDIT
1.	CORE COURSE THEORY	10	4	40
2.	CORE COURSE PRACTICAL	3	4	12
3.	DISCIPLINE SPECIFIC ELECTIVE	3	4	12
4.	GENERAL ELECTIVE	2	4	8
5.	PROJECT/ TERM PAPER	1	6	6
6.	GRAND VIVA	1	2	2
TOTAL CREDIT				**80**
NON-CGPA				
1.	SEMINAR / MOOC's/OTHER ACADEMIC ACTIVITIES	4	1	4
2.	SKILLX, NSS/ YOGA	4	1	4
GRAND TOTAL CREDIT				**88**

LIST OF CORE COURSE PAPERS (CREDIT: 04 EACH)

PPH1001: MATHEMATICAL METHODS

PPH1002: CLASSICAL AND RELATIVISTIC MECHANICS

PPH1003: ELECTRONICS

PPH2001: ELECTRODYNAMICS

PPH2002: QUANTUM MECHANICS

PPH2003: COMPUTATIONAL PHYSICS

PPH3001: STATISTICAL PHYSICS

PPH3002: SOLID STATE PHYSICS

PPH3003: NUCLEAR AND PARTICLE PHYSICS

PPH 4001: ATOMIC AND MOLECULAR PHYSICS

PPH1101: PHYSICS LABORATORY I

PPH 2101: PHYSICS LABORATORY II

PPH3101: PHYSICS LABORATORY III

DISCIPLINE SPECIFIC ELECTIVE PAPERS: (CREDIT: 04 EACH)

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

PPH3004: ADVANCED QUANTUM MECHANICS

PPH3005: ADVANCED ELECTRONICS I

PPH3006: ADVANCED MATHEMATICAL PHYSICS

PPH3007: ADVANCED NUCLEAR PHYSICS

PPH3008: ADVANCED EXPERIMENTS OF PHYSICS

PPH3009: GENERAL THEORY OF RELATIVITY AND COSMOLOGY

PPH3010: ADVANCED OPTICS

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

PPH4002: ENERGY SOURCES, STORAGE AND HARVESTING

PPH4003: ADVANCED ELECTRONICS II

PPH4004: RADIATION PHYSICS AND SAFETY

PPH4005: ATMOSPHERIC PHYSICS

PPH4006: GROUP THEORY

PPH4007: PHYSICS AT THE NANO SCALE

PPH4008: PLASMA PHYSICS

PPH4009: ASTROPHYSICS

PPH 4101: PROJECT/TERM PAPER **(**Any advance topic in the domain of science.)

GENERAL ELECTIVE PAPER: (for the other departments)

CREDIT: 04 EACH

PPH1004: RENEWABLE ENERGY AND ENERGY HARVESTING

PPH2004: PHYSICS: LARGE TO SMALL BODIES

DEPARTMENT OF PHYSICS SEMESTER WISE CREDIT/MARKS DISTRIBUTION FOR PG COURSE										
SEMESTER 1										
COURSE	Name	L	T	P	Working 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)					4	20	30	50	100
PPH1101	Physics Laboratory I	0	2	6	8	4	20	-	80	100
					25	20				500
NON-CGPA										
PPH1501	SEMINAR / MOOC's/OTHER ACADEMIC ACTIVITIES	0	0	2	2	1	-	-	-	25
PPH1502	SKILLX , NSS/Yoga					1	-	-	-	25
	Total					2				50
Grand Total					27	22				550

SEMESTER 2										
COURSE	Name	L	T	P	Working 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	Computational Physics	3	1	0	4	4	20	30	50	100
	CBCS (from other dept)					4	20	30	50	100
PPH 2103	Physics Laboratory II	0	2	6	8	4	20	-	80	100
	Total				25	20				500
NON-CGPA										
PPH2501	SEMINAR /MOOC's/ other academic activities	0	0	2	2	1	-	-	-	25
PPH2502	SKILLX , NSS/Yoga					1	-	-	-	25
Grand Total					27	22				550

SEMESTER 3										
COURSE	Name	L	T	P	Working 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
PPH3003	Nuclear and Particle Physics	3	1	0	4	4	20	30	50	100
	DSE	3	1	0	4	4	20	30	50	100
PPH3101	Physics Laboratory III		2	6	8	4	20	-	80	100
Total					24	20				500
NON-CGPA										
PPH3501	SEMINAR /MOOC's/ other academic activities	0	0	2	2	1	-	-	-	25
PPH3502	SKILLX , NSS/Yoga					1	-	-	-	25
Grand Total					26	22				550

SEMESTER 4										
COURSE	Name	L	T	P	Working hour	Credit	Internal Marks	Mid Sem	End Sem	Total Marks
PPH4001	Atomic and Molecular Physics	3	1	0	4	4	20	30	50	100
	DSE	3	1	0	4	4	20	30	50	100
	DSE	0	2	4	6	4	20	-	80	100
PPH4101	Dissertation	0	0	12	12	6	50	-	100	150
PPH4102	Grand viva					2				50
Total					26	20				500
NON-CGPA										
PPH4501	SEMINAR / MOOC's/ other academic activities	0	0	2	2	1	-			-
PPH4502	SKILLX , NSS/Yoga					1	-			-
Total						2				50
Grand Total					28	22				550

SEMESTER -1

PPH1001: Mathematical Methods
Credit 04
(45Th +15 T) Class Hours

Module I **(20 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 **(05 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.

Tutorial 15 classes

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 Ghatak.
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

Course Outcomes

At the end of the course, students will be able

CO1 To acquire knowledge of different Mathematical methods for studying different courses of physics.

CO2 To enhance conceptual understanding and independent problem solving ability using several mathematical tools.

CO3 To develop mathematical skills to solve both theoretical and analytical problems in different branches of Physics.

PPH1002: Classical and Relativistic Mechanics
Credit 04
(45Th +15 T) Class Hours

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: (5 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.

Tutorial 15 classes

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

At the end of the course students will be able to

CO1 Understand the basic conservation laws and the concept of phase portrait in physics
CO2 Apply the different equations of classical mechanics to simple dynamical systems
CO4 Apply the theory of rigid body dynamics to analyze the motion of rigid bodies

PPH1003: Electronics
Credit 04
(45Th +15 T) Class Hours

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 (10 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 **(10 lectures)**

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

Tutorial 15 classes

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)

A student of this course is expected to be able

CO1 To understand the design and working of electronic circuits using different semiconductor devices.

CO2 the student will acquire knowledge about the characteristics of semiconductor devices in analog & digital circuits using analog and digital signals.

PPH2001: Electrodynamics
Credit 04
(45Th +15 T) Class Hours

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 III (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 (5 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.

Tutorial 15 classes

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

Course Outcomes

After completion of the course, students will be able to

CO1 Understand energy and momentum associated with electromagnetic waves and the propagation of electromagnetic waves in linear medium
CO2 Apply the concept of propagation of em waves in wave guides
CO3 Understand the physical basis of simple dipole radiation and radiation reaction

CO4 Apply the concepts of relativistic principles to understand electrodynamics and modern experimental techniques

PPH2002: Quantum Mechanics
Credit 04
(45Th +15 T) Class Hours

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 **(10 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 **(7 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.

Tutorial 15 classes

Course Outcome (CO)

At the end of the course students will be able to

CO1 Understand and familiarize the mathematical background (Hilbert space) in which the basic and applied quantum mechanics are framed.

CO2 Apply the various postulates of quantum mechanics to one and three dimensional problems.

CO3 Understand the basic concepts of angular momentum and improve their problem solving Skills

CO4 Apply WKB approximation in applied area

PPH2003: Computational Physics

Credit 04

60 (30Th +30 T) Class Hours

Module I **(10 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 **(10 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 **(15 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 **(10 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

Tutorial 15 classes

Course Outcomes

After completion of the course students will be able to

CO1 Analyze a Physics problem using computation.

CO2 Able to write a programme to solve a Physics problem.

PPH3001: Statistical Physics
Credit 04
(45Th +15 T) Class Hours

Module I **(5 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 **(10 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.

Tutorial 15 classes

Course Outcomes

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

CO1 Apply basic knowledge of Thermodynamics co-ordinates and potentials to systems
CO2 Understand the concept of micro canonical ensembles and relations between partition function and thermo dynamical potentials
CO3 Apply statistical relations in phase transition problems of Liquid – Vapor phase

PPH3002: Solid State Physics
Credit 04
(45Th +15 T) Class Hours

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 (10 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 (15 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.

Tutorial 15 classes

On completion of the course students will be able to

CO1 Acquire knowledge on Bravais lattices, symmetry, defects in crystals and the concepts of reciprocal lattice and diffraction

CO2 Comprehensive understanding on the basic approaches to the formation of electronic Band structure of materials and the Fermi surfaces

CO3 Describe the behavior of the carriers in semiconductors, doping, formation of Junctions and their characteristics.

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)

PPH3003: Nuclear and particle Physics
Credit 04
(45Th +15 T) Class Hours

Module I (10 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 **(10 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.

Tutorial 15 classes

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)

Course Outcomes

After completion of the course student should be able to:

CO1: Understand the key points of nuclear physics.

CO2: Understand various nuclear models and solve various problems related to nuclear structure.

CO4: Understand basic aspects of particle physics

PPH4001: Atomic and Molecular Physics

Credit 04

(45Th +15 T) Class Hours

Module I **(10 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 **(10 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 **(15 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.

Tutorial 15 classes

Reference Books:

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

After completion of the course student should be able to:

CO1: Understand the key ideas and terminologies of nuclear physics.

CO2: Understand various nuclear models and solve various problems related to nuclear structure.

CO3: Analyze and solve problems related to nuclear reactions.

CO4: Understand basic aspects of particle physics

PPH1101: Physics Laboratory I
Credit 04
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.

Course Outcomes

At the end of this course, students should be able

CO1 To verify or reproduce the concepts and results learnt in theory by doing the corresponding experiments.

CO2 To develop various skills on observation, analysis, graphical representation of the Data etc.

PPH2101: Physics Laboratory II
Credit 04
Working Hours 08/week

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.

Course Outcomes

At the end of this course, students should be able

CO1 To verify or reproduce the concepts and results learnt in theory by doing the corresponding experiments.

CO2 To develop various skills on observation, analysis, pictorial representation of the Data etc.

PPH3101: Physics Laboratory III
Credit 04
Working Hours 08/week

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

Course Outcomes

At the end of this course, students should be able

CO1 To verify or reproduce the concepts and results learnt in theory by doing the corresponding experiments.

CO2 To develop various skills on observation, analysis, graphical representation of the Data etc.

DISCIPLINE SPECIFIC ELECTIVE PAPERS: (CREDIT: 04 EACH)
(One paper will be selected by the students from MPY 01 – MPY 08)

PPH3004: ADVANCED QUANTUM MECHANICS
CREDIT: 4
(45L+15T) HOURS

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: **(5 Lectures)**
Nonrelativistic reduction; Helicity and chirality; Properties of γ matrices; Charge conjugation time reversal and other symmetries.; Normalisation and completeness of spinors

Tutorial 15 Classes

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

Students will learn how to

CO1 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.

CO2 Scattering theory will teach them how to use projectiles to infer details about target quantum system.

CO3 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

PPH3005: ADVANCED ELECTRONICS I
CREDIT: 4
(45L+15T) HOURS

Module I: **(15 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: **(10 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: **(10 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: **(10 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

A student of this course is expected

CO1 to have enhanced awareness of the constant evolution in the physics of semiconductor devices and materials,

CO2 the basic device design along-with the standard technological procedures adapted in the semiconductor industry for IC manufacturing

CO3 acquire knowledge about microprocessor based measurement and control

PPH3006: ADVANCED MATHEMATICAL PHYSICS
CREDIT: 4
(45L+15T) HOURS

Module I **(15 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 **(10 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 **(10 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 **(10 lectures)**

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

Tutorial 15 classes

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).

After completion of the course, students will be able to

CO1 Solve second order differential equations with series solutions

CO2 Understand the basics and applications of Legendre polynomials

CO3 Understand the concepts of complex analysis

CO4 Familiarize various mathematical methods used in advanced physics

PPH3007: ADVANCED NUCLEAR PHYSICS
CREDIT: 4
(45L+15T) HOURS

Module I **(15 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 **(10 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 **(10 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 **(10 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)

Course Outcomes:

After completion of the course students should be able to

CO1: Get familiarize with the key ideas and application of scattering theory.

CO2: Developed analytical skills to solve problem related to nuclear reactions.

CO3: Learn basic principles related to deformed nucleus

CO4: A brief idea about present challenges in modern nuclear physics including, exotic nuclei and their production will be imparted.

PPH3008: ADVANCED EXPERIMENTS OF PHYSICS
CREDIT: 4
60 CLASS HOURS

This course will familiarize students with some landmark experiments in physics 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.

Student will able
CO1 to learn land mark experiments in Physics

PPH3009: GENERAL THEORY OF RELATIVITY AND COSMOLOGY
CREDIT: 4
45 CLASS HOURS

Module I **(15 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 **(10 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 **(10 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 **(10 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;

Tutorial 15 classes
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)

Course Outcomes:

After completing the course, the student should be able to:

CO1 Demonstrate an understanding of the basic necessity and principles of the special theory of relativity in four dimensional Minkowski space-time.

CO2 Apply tensor notation in relativity theory and perform basic calculations in relativistic kinematics and dynamics

CO3 Understanding of covariant formulation of classical theories like electromagnetism & fluid dynamics

CO 4 Develop critical/logical thinking, scientific reasoning, and problem solving skills in the area of astrophysics and cosmology.

PPH 3010: ADVANCED OPTICS
CREDIT: 4
45 CLASS HOURS

Module 1: (15 Lectures)

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

Module 1I: (10 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 III: (10 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)

Module IV: (5 Lectures)

Detection of optical radiation: thermal detector (bolometer, pyro-electric), photon detector (photoconductive detector, photo voltaic detector and photoemissive detector), p-i-n photodiode, APD photodiode

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

By completion of the course, the student will able to

CO1 Acquire knowledge on laser production and applications

CO2 Acquire knowledge on the fiber classification and characteristics of optical fibers.

CO3 Describe the optical fiber fabrication process, theory of different modes and the modulators.

CO4 Understand and Gain knowledge on the passive and active components of fiber optic technology and the methods to determine the fiber quality.

CO5 This kind of specialization is expected to provide a larger scope for research in the various related and interdisciplinary areas.

PPH4002: ENERGY SOURCES, STORAGE AND HARVESTING
CREDIT: 4
45 CLASS HOURS

Module I (15 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 **(15 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 **(15 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 **(15 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

Course Outcomes

At the end of the course the students will be able

CO1 To acquire knowledge of new and renewable energy

CO2 To describe different energy sources

CO3 Understand the basics of semiconductor physics and working principle of solar photovoltaic.

CO4 To enhance knowledge of energy storage and harvesting

PPH4003: ADVANCED ELECTRONICS II
CREDIT: 4
45 CLASS HOURS

Module I **(15 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 **(10 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 **(10 lectures)**

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

Module IV **(10 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)

A student of this course is expected

CO1 to have enhanced their knowledge in physics of semiconductor devices and materials, CO 2 The basic device design along-with the standard technological procedures adapted in the semiconductor industry for IC manufacturing and mass production of semiconductor devices.

PPH4004: RADIATION PHYSICS AND SAFETY
CREDIT: 4
45 CLASS HOURS

Module I **(15 Lectures)**

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

Module II **(10 Lectures)**

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

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

Module III **(10 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 **(5 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)

Course Learning Outcomes

CO1 A knowledge of the principle of operation of various radiation detectors,

CO2 understanding of radiation dose calculation and permissible doses for different levels of users,

CO3 radiation effects, an understanding of instrumentation in practical situations,

CO4 awareness about the management of radioactive material, and adherence to safety protocols,

PPH4005: ATMOSPHERIC PHYSICS
CREDIT: 4
(45L+15T) HOURS

Module I **(15 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 **(10 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 **(10 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

(10 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

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

Tutorial 15 Classes

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

At the end of this course student will able to

- CO1 demonstrate skills for interpreting and applying atmospheric observations
- CO2 gain knowledge of the atmosphere and its evolution
- CO3 Understand the techniques of observations of vertical profile of atmospheric parameters
- CO4 Analyse meteorological data

PPH 4006: GROUP THEORY

CREDIT: 4

45 CLASS HOURS

Module I **(15 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 **(10 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 **(10 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 **(10 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.A. Zee : Group Theory in a Nutshell for Physicists

The student will able
CO1 To describe the symmetries of a physical system
CO2 The understanding of the classification of finite groups will be achieved
CO3 Use as a powerful tool for research in spectroscopy

PPH4007: PHYSICS AT THE NANOSCALE
CREDIT: 4
45 CLASS HOURS

Module I **(15 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 **(10 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 **(10 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 **(10 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)

Course outcomes:

After completion of the course, students will have knowledge and skills to:

CO 1 Understand the nanoscale interaction of photons and electrons and familiarize with near field optics and microscopy techniques.

CO 2 Apply the knowledge of quantum confinement to understand nanostructures used in photonics.

CO 3 Understand nanocontrol of excitation dynamics and various growth and characterization techniques of nanomaterials.

PPH4008: PLASMA PHYSICS
CREDIT: 4
45 CLASS HOURS

Module I **(10 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 **(10 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 **(10 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 **(10 Lectures)**

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

Tutorial 15 Classes

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).

Course Outcomes:

After completing the course, the student should be able to

CO1 identify, using fundamental plasma parameters, under what conditions an ionised gas consisting of charged particles (electrons and ions) can be treated as a plasma

CO2 distinguish the single particle approach, fluid and kinetic approach to describe different plasma phenomena

CO3 determine the motion of charged particles moving in uniform or slowly varying electric and magnetic fields

CO4 understand the physical mechanism and properties of the electrostatic and electromagnetic waves propagating in magnetised and non-magnetised plasmas

PPH4009: ASTROPHYSICS
CREDIT: 4
45 CLASS HOURS

Module I: **(20 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: **(20 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: **(10 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: **(10 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

Students will be able to demonstrate

CO 1 A basic understanding of various aspects of observational astronomy.

CO 2 To analyze data and to obtain physical properties of a variety of astronomical objects.

PPH4101 : PROJECT/ TERM PAPER
CREDIT: 6
12 CLASS HOURS/week

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, recording and reporting.
CO2 Enhance their knowledge of the use of analytical, theoretical and experimental tools to solve/design/study a problem
CO3 Enhance presentation and communication skills.

PPH4102 : GRAND VIVA

CREDIT: 2

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.

PPH1004: RENEWABLE ENERGY AND ENERGY HARVESTING
Credit 04
60 Class Hours

(This elective is open for M.Sc. students of other departments only)

Module I **(6 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 **(15 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 **(15 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 **(9 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 **(15 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).

At the end of this course the students will able to understand

CO1	Importance of renewable energy
CO2	Need of solar energy harvesting
CO3	Learn different methods of energy harvesting

PPH2004: PHYSICS: LARGE TO SMALL BODIES

Credit 04 (Th: 03, Prac: 01)
75 (Th 45 + Prac 30) Class Hours

(Electives open for M.Sc. students of other departments only)

Module I (15 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 I (15 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 (15 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 30 Lectures

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

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.

At the end of this course students will able to understand

CO1	Basics of Particle Physics,
CO2	Einstein's theory of relativity
CO3	Fundamentals of statistics
CO4	Some basic experiments of Physics