



॥ त्वं ज्ञानमयो विद्वानमयोऽसि ॥

Master of Science Program in Physics

July 2015

Indian Institute of Technology Jodhpur

Master of Science (M.Sc.) Program in Physics Curriculum

Cat.	Course Number, Course Title	L-T-P	Credits		Cat.	Course Number, Course Title	L-T-P	Credits	
I Semester					II Semester				
C	PH511 Mathematical Physics	3-0-0	3		C	PH521 Atomic and Nuclear Physics	3-0-0	3	
C	PH512 Classical Mechanics	3-0-0	3		C	PH522 Condensed Matter Physics	3-0-3	4	
C	PH513 Quantum Mechanics	3-0-0	3		C	PH523 Electrodynamics	3-0-0	3	
C	PH514 Electronics	3-0-3	4		C	PH524 Advanced Quantum Mechanics	3-0-0	3	
C	PH515 Statistical Physics	3-0-0	3		E	Elective I	3-0-0	3	
<i>Total</i>				16	<i>Total</i>				16
III Semester					IV Semester				
T	Thesis		15		T	Thesis		15	
E	Elective II	3-0-0	3		E	Elective III	3-0-0	3	
<i>Total</i>				18	<i>Total</i>				18

Electives

1	Astrophysics	9	Semiconductor device technology
2	Quantum Field Theory	10	Electronic Transport in Mesoscopic Systems
3	Particle Physics	11	Vacuum Systems and Thin Film Technology
4	General Theory of Relativity	12	Quantum Cryptography and Coding
5	Magnetism and Superconductivity	13	Relativistic Quantum Mechanics
6	Principles of Scanning Tunneling Microscope	14	Classical and Quantum Optics
7	Materials and device characterization	15	Computational Physics
8	Quantum Information Processing		

S.No.	Category	Course Category Title	Total Courses	Total Credits	Total Courses
1	C	Compulsory	9	29	13
2	E	Electives	3	9	2
3	T/P	Thesis	1	30	1
<i>Total</i>				68	

Course Title	Mathematical Physics	Course No	PH511
Focus Group	Physics	LTPC	3 0 0 3
Offered for	M.Sc. (Physics) Students	Type	New Compulsory
Pre-requisite	Consent of the Teacher	To take effect from	July 2015

Objectives

To provide students the ability to hone the mathematical skills necessary to approach problems in advanced physics courses.

Learning Outcomes

1. The students will be able to understand and apply the mathematical skills to solve quantitative problems in the study of physics.
2. Will enable students to apply integral transform to solve mathematical problems of interest in physics.
3. The students will be able to use Fourier transforms as an aid for analyzing experimental data.
4. The students should be able to formulate and express a physical law in terms of tensors, and simplify it by use of coordinate transforms.

Course Contents

1. *Linear vector spaces*: Vectors in functional space, Gram-Schmidt Orthogonalization, Real and complex vector spaces, Linear operators and Matrices, Hermitian and unitary operators, Normal matrices and their diagonalization, Direct sum and tensor products, outer product of matrices.
2. *Complex variables*: Analyticity and Cauchy-Reimann Conditions, Cauchy's integral theorem and formula, Taylor's series and Laurent's series expansion, Branch Points and Cuts, Riemann Sheets and surfaces, Residues, Cauchy's Residue theorem, Jordan's Lemma to evaluate infinite integrals, **Evaluation** of definite integrals.
3. *Differential Equations and Special Functions*: Ordinary differential equations, second order homogeneous and inhomogeneous equations, Wronskian, General solutions, Series solution. Gauss hypergeometric and confluent hypergeometric equations, Sturm Liouville problem, Legendre, Hermite and the associated polynomials, Bessel functions, Integral representation of special functions, Applications to electrostatics and quantum mechanics.
4. *Fourier and Laplace Transforms*: Fourier transform, Sine, Cosine and Complex transforms with examples, Definition, Properties and Representations of Dirac Delta Function, Properties of Fourier Transforms, Transforms of derivatives, Parseval's Theorem, Convolution Theorem, Momentum representation, Applications to Partial differential equations, Discrete Fourier transform, Fast Fourier transform, Laplace transform, Convolution theorem and its applications, Laplace transform method of solving differential equations, Applications to electrostatics.
5. *Tensors*: Transformation of coordinates, Summation convention, Scalars, Contravariant and Covariant vectors, Tensors of higher ranks, Symmetric and antisymmetric tensors, Algebraic operations on tensors.

References

1. Arfken George, B. and Weber Hans, J., (2012), *Mathematical Methods for Physicists*, Academic Press
2. Boas Mary, L., (2005), *Mathematical Methods in the Physical Sciences*, John Wiley & Sons
3. Mathews Jon, Walker Robert, L. and Benjamin, W. A., (1970), *Mathematical Methods of Physics*

Course Title	Classical Mechanics	Course No	PH512
Focus Group	Physics	LTPC	3 0 0 3
Offered for	M.Sc. (Physics) Students	Type	New Compulsory
Pre-requisite	Consent of Teacher	To take effect from	July 2015

Objectives

The course aims to develop an understanding of Lagrangian and Hamiltonian formulation which allow for simplified treatments of many complex problems in classical mechanics and provides the foundation for the modern understanding of dynamics.

Learning Outcomes

1. The students will be able to apply the Variational principles to real physical problems.
2. The students will be able to model mechanical systems, both in inertial and rotating frames, using Lagrange and Hamilton equations.

Course Content

1. *Survey of elementary principles:* review of the Newtonian mechanics, constraints, D'Alembert's principle, Lagrange's equation, Its application to simple problems.
2. *Central force problem:* The equation of motion, the equivalent one-dimensional problem, classification of orbits, Virial theorem, Differential equation for the orbit, inverse square law of force, scattering in central force field.
3. *Variational Principles and Lagrange's equations:* calculus of variations, Hamilton's principle, derivation of Lagrange's equation from Hamilton's principle, its application, conservation and symmetry property.
4. *Small oscillations:* formulation of the problem, eigenvalue equation, principal axis transformation, normal coordinates, triatomic molecule free vibration, forced and damped vibrations.
5. *Rigid body motion:* orthogonal transformation, the Eulerian angles, Euler's theorem, infinitesimal rotation, tensors and dyadics, force free motion of rigid body, the heavy symmetrical top.
6. *Hamilton's equation of motion:* Legendre transformations and Hamilton's equation, cyclic coordinates, Routh's procedure, physical significance of Hamiltonian.
7. *Canonical Transformation:* Examples of canonical transformations, Lagrange and Poisson Brackets, symmetry group of mechanical systems.
8. *Introduction to Non Linear Dynamics:* Fixed points, stability; determination of fixed points; limit cycles; periodic conditions and linear maps; chaotic motion and non-linear maps.

References

1. Goldstein, H., (2011), *Classical Mechanics*, Pearson New
2. Rana, N. C. and Joag, P. S., (1991), *Classical Mechanics*, Tata McGraw Hill
3. Landau, L. D. and Lifshitz, E. M., (1960), *Mechanics*, Pergamon Press
4. Meirovitch, L., (1999), *Methods of Analytical Dynamics*, McGraw Hill
5. Srinivasa Rao, K. S., (2003), *Classical Mechanics*, Universities press
6. Jose, J. V. and Saletan, E. J., (2002), *Classical Dynamics: A Contemporary Approach*, Cambridge University Press,

Course Title	Quantum Mechanics	Course No	PH513
Focus Group	Physics	LTPC	3 0 0 3
Offered for	M.Sc. (Physics) Students	Type	New Compulsory
Pre-requisite	Consent of the Teacher	To take effect from	July 2015

Objectives

1. To provide an understanding of the formalism and language of non-relativistic quantum mechanics.
2. To understand the concepts of time-independent perturbation theory and their applications to physical situations.

Learning Outcomes

1. The students will be able to formulate and solve problems in quantum mechanics using Dirac representation.
2. The students will be able to grasp the concepts of spin and angular momentum, as well as their quantization and addition rules.
3. The students will be familiar with various approximation methods applied to atomic, nuclear and solid-state physics.

Course Content

1. *Formalism:* Measurements, observables and the uncertainty relations, Change of basis, Momentum representations, Equations of motion in Schrödinger and Heisenberg pictures, One dimensional potential problems, Linear harmonic oscillator, Creation and annihilation operators.
2. *Theory of Angular Momentum:* Angular momentum operators, Eigenvalues and Eigen functions of L^2 , Spherical harmonics Relation between rotation and angular momentum, Rotational symmetry and conservation of angular momentum, Matrix representations, addition of angular momenta and Clebsch-Gordon coefficients, Wigner-Eckart theorem, Pauli spin matrices.
3. *Approximation methods for stationary problems:* Time independent perturbation theory for non-degenerate and degenerate states, Dalgarno's method, Zeeman and Stark effects, WKB approximation and its applications, Variational method and its applications to helium atom.
4. *Classical limit of quantum mechanics:* Planck and Bohr formulations of the correspondence principle, classical limit of a particle in a box, linear harmonic oscillator and hydrogen atom, quantum decoherence and quantum chaos.

References

1. Das, A., (2003), Lectures on Quantum Mechanics, Hindustan Book Agency
2. Sakurai, J. J., (1994), Modern Quantum Mechanics, Addison-Wesley Publishing Company
3. Shankar, R., (1994), Principles of Quantum Mechanics, Plenum Press
4. Griffiths, D. J., (2012), Introduction to Quantum Mechanics, Pearson
5. Merzbacher, E., (2014), Quantum Mechanics, Wiley

Course Title	Electronics	Course No	PH 514
Focus Group	Physics	Structure (L-T-P:C)	3 0 0 3
Offered for	M.Sc. (Physics) Students	Status	Compulsory
Pre-requisite	Consent of the Teacher		

Objectives

To develop an understanding of fundamentals of electronics in order to deepen the understanding of electronic devices that are part of the technologies that surround us

Learning Outcome

The Students will be able to use techniques for analyzing analogue and digital electronic circuits; and formulate the concepts of operational amplifier and Field Effect Transistors (FET); identify its major properties and main types of FET and op-amps circuits.

Contents

1. *Introduction:* Voltage, current and resistance, voltage dividers, voltage and current sources, Thevenin's equivalent circuits, signals, sinusoidal signals, decibels, signal sources, capacitors and RC circuits, differentiators and integrators, inductors and transformers, impedance and reactance, diodes and diode circuits, rectification, power supply filtering, regulators, circuit applications of diode, electromechanical devices, indicators, optoelectronics devices
2. *Transistors:* Transistor switches, current mirrors, some amplifier building blocks, some typical transistor circuits, field effect transistors, FET circuits, FET switches
3. *Feedback and operational amplifiers:* Introduction, basic op-amp circuits, an op-amp sorgan board, op-amp behaviors and their circuits, op-amp with power supply, comparator and schmitt trigger, feedback amplifiers, feedback amplifier and frequency compensation, active filters and oscillators
4. *Digital electronics:* Basic logic concept, TTL and CMOS, combinational logic, sequential logic, monostable multivibrators, registers, counters, comparators, D/A and A/D converter, microprocessor and microcontroller basics
5. *Transducers:* Temperature, light level, strain and displacement, acceleration, pressure, force, velocity, magnetic field, vacuum gauges, particle detectors, filtering and noise reduction, shielding and grounding, modulation techniques, high frequency devices, generators and detectors

Experiments

1. Network Analysis – Thevenin and Norton's equivalent circuit
2. Design of a Regulated Power Supply & CE, CB & CC Transistor Amplifier, Transistor Biasing and Stability
3. Experiments based on operational amplifier, Differential Amplifiers, Integrator, etc.
4. Experiments on FET and MOSFET characterization and application as an amplifier
5. Solving Boolean Expressions, Study of logic circuits TTL, NAND & NOR gates
6. Study of Combinational logic circuits, Study of flip-flops
7. Astable, Monostable and Bistable Multivibrator, Experiment of Bias Stability, Negative Feedback (Voltage series/shunt and current series/ shunt)
8. Analog logic circuits related experiments
9. Microwave based diffraction experiments

References

1. Harowitz, P., Hill W. , (1989), *The Art of Electronics*, Cambridge University Press
2. Boyelstad, R. and Nashelsky, L., (2009), *Electronic Devices and Circuit Theory*, Pearson
3. Milman, J., Halkias, C. C., and Jit, S., (2010), *Electronic Devices and Circuits*, McGraw Hill

Course Title	Statistical Physics	Course No	PH 515
Focus Group	Physics	Structure (L-T-P:C)	3 0 3 4
Offered for	M.Sc. (Physics) Students	Status	Compulsory
Pre-requisite	Consent of the Teacher		

Objectives

1. To have an appreciation for the modern aspects of equilibrium and non-equilibrium statistical physics
2. To describe the features and examples of Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics

Learning Outcome

The students will be able to work out equations of state and thermodynamic potentials for elementary systems of particles; and use and develop mean field theory for first and second order phase transitions.

Contents

1. *Thermodynamics*: Basics, first and second laws; extensive functions.
2. *Conditions for Phase Equilibrium and Stability*: Multiphase equilibrium; stability.
3. *Statistical Mechanics*: Ensembles; non-interacting ideal systems.
4. *Critical Phenomena*: Mean field theory; Landau's theory; renormalization group.
5. *Quantum Statistics*: Bose-Einstein and Fermi-Dirac distributions; black body radiation; Debye model.
6. *Monte Carlo Simulations*: Introduction.
7. *Irreversible Processes*: Transport coefficients, dissipation and entropy production, hydrodynamics of simple fluids; Boltzmann equation.
8. *Non-equilibrium Statistical Physics*: Basics of linear response; Langevin and Fokker-Planck equations.

References

1. Landau, L. D. and Lifshitz, E.M., (1980), *Statistical Physics*, Part 1, Pergamon Press
2. Chandler, D., (1987), *Introduction to Modern Statistical Mechanics*, Oxford University Press
3. Huang, K., (1987), *Statistical Mechanics*, John Wiley and Sons

Course Title	Nuclear and Atomic Physics	Course No	PH521			
Focus Group	Physics	LTPC	3	0	0	3
Offered for	M.Sc. (Physics) Students	Type	Core <input checked="" type="checkbox"/>			
Pre-requisite		To take effect from				

Objectives

1. To learn Atomic Physics with problem solving approach towards spectroscopy.
2. To provide an understanding of the static properties of nuclei, nuclear force and nuclear models.

Learning Outcomes

1. The students will have an understanding of the structure of the nucleus, radioactive decay, nuclear reactions and the interaction of nuclear radiation with matter.
2. The students will have an understanding of quantum behavior of atoms in external electric and magnetic fields.

Course Content

Nuclear Physics

1. *Nuclear Models*: Liquid drop model, Bether-Weizsacker formula, Nuclear shell model, Collective model.
2. *Nuclear Reactions*: Cross section of nuclear reactions, Principle of detailed balance, Compound nucleus, Breit-Wigner formula, Evaporation model, Optical model.
3. *Nuclear forces*: Deuteron problem, Low energy neutron-proton scattering, Spin dependence of neutron-proton interaction, Non-central force, Low energy proton-proton scattering, High-energy neutron-proton & proton-proton scattering, Meson theory of nuclear force, Nature of two nucleon potential.

Atomic Physics

1. *Hydrogen atom*: Review of the Bohr atom model, solution of the Schrodinger equation, spectra of hydrogen and hydrogen-like atoms. Review of time-independent perturbation theory.
2. *Fine structure of the hydrogen atom*: spin-orbit coupling and relativistic correction to the kinetic energy. Review of the Dirac equation. Dirac equation in the non-relativistic limit. Zeeman and Stark Spectroscopy Hyperfine interaction in atomic Hydrogen. Spectroscopy with the 21 cm emission line. Review of time-dependent perturbation theory. Interaction of electromagnetic radiation with a two-level atom. Rabi flopping. The dipole approximation, electric dipole, magnetic dipole and electric quadrupole transitions. Selection rules. Transition probabilities and intensity of spectral lines. Line broadening mechanisms. Spontaneous and stimulated emissions and Einstein coefficients, masers and lasers. Lamb shift. Quantization of the electromagnetic field. The Raman effect. Introduction to NMR and ESR. Review of Pauli's exclusion principle. The spin-statistics theorem. The Helium spectrum.
3. *Many electron systems*: Electron configurations and spectroscopic notation, equivalent and non-equivalent electrons and Hund's rules. Hartree-Fock SCF method, proof of Koopmans theorem, Slater's approximation to exchange. Total Hamiltonian of a molecule.
4. Born-Oppenheimer approximation. Rotational and Vibrational Spectra of molecules.

Anharmonicity, Franck-Condon principle, Electronic. Infrared and Raman Spectra analysis.

References

1. Burcham, W. E. and Jobes, M., (1995), Nuclear and Particle Physics, John Wiley & Sons Inc
2. Tayal, D. C., Nuclear Physics, Himalaya Publishing House
3. Bransden, B.H. and Joachain, C.J., (2004), *Physics of Atoms and Molecules*, Prentice Hall, 2nd Edition, Pearson Education, Delhi
4. Condon, E. U. and Shortley, G. H., (1951), *The Theory of Atomic spectra*, Cambridge University Press

Course Title	Condensed Matter Physics	Course No	PH 522
Focus Group	Physics	Structure (L-T-P:C)	3 0 0 3
Offered for	M.Sc. (Physics) Students	Status	Compulsory
Pre-requisite	Consent of the Teacher		

Objectives

1. To provide extended knowledge of principles and techniques of solid state physics
2. To provide an understanding of structure, thermal and electrical properties of matter

Learning Outcome

The students will be able to formulate basic models for electrons and lattice vibrations for describing the physics of crystalline materials; and develop an understanding of relation between band structure and the electrical/optical properties of a material.

Contents

1. *Crystallography*: Structural description of liquids and solids, External symmetry elements, Point groups, Direct periodic lattice, Basic concept of aperiodicity, Reciprocal lattice and diffraction conditions and its relation with Brillouin zones, Intensity of Bragg scattering from a unit cell and extinction conditions.
2. *Lattice Vibrations*: Elastic waves, Enumeration of modes, Density of states of a continuous medium, Specific heat models of Einstein and Debye, The phonon, Lattice waves, Lattice dynamics of crystals with up to two atoms per primitive basis, Density of states of a lattice, Thermal Conductivity, Scattering of X-rays, neutrons and light by phonons.
3. *Electronic Properties of Solids*: Electrons in periodic potential, Band Theory, Tight Binding, Cellular and Pseudo potential methods, Symmetry of energy bands, density of states, Fermi surface, De Haas von Alfen effect, Elementary ideas of quantum Hall effect, Cyclotron resonance and magneto resistance.
4. *Superconductivity*: Zero resistance, Meissner effect, Thermodynamics of the superconducting transition, Electrodynamics of superconductivity, BCS theory of superconductivity, Josephson effect.

References

1. Kittel, C., (2004), *Introduction to Solid State Physics*, John Wiley & Sons
2. Ashcroft, W. N., and Mermin, D.N., (1976), *Solid State Physics*, Cengage Learning
3. Omar, M. A., (2009), *Elementary Solid State Physics*, Pearson

Course Title	Electrodynamics	Course No	PH523			
Focus Group	Physics	LTPC	3	0	0	3
Offered for	M.Sc. (Physics) Students	Type	Core <input checked="" type="checkbox"/>			
Pre-requisite		To take effect from				

Objectives

1. To evaluate fields and forces in Electrodynamics and Magneto dynamics using basic scientific method.
2. To provide concepts of relativistic electrodynamics and its applications in branches of Physical Sciences.

Learning Outcomes

1. To explain and solve advanced problems based on classical electrodynamics using Maxwell's equation.
2. The students will be able to analyze s radiation systems in which the electric dipole, magnetic dipole or electric quadruple dominate.
3. The students will have an understanding of the covariant formulation of electrodynamics and the concept of retarded time for charges undergoing acceleration.

Course Content

1. *Electrostatics, Magnetostatics and Electrodynamics:* Gauss's law, Boundary value problems, Multipoles, dielectrics, Biot and Savart law, Ampere's law, Faraday's law, Displacement current, Maxwell's equations, Wave propagation in Conductors and Dielectrics. Boundary Value Problems (as a specific problem from Maxwell's equation, Helmholtz condition)
2. *Special Theory of Relativity:* Minkowski Space and Four vectors, Concepts of Four-velocity, Four Acceleration and higher rank tensors, Action principle and Electromagnetic energy momentum Tensor.
3. *Plane Electromagnetic Waves and Wave Propagation:* Plane Waves in Non-conducting Medium Linear and Circular Polarization, Stokes Parameter, Reflection and Refraction of Electromagnetic Waves at a Plane Interface between Dielectrics, Fresnel Equation, Group Velocity Dispersion (GVD), Light-Matter Interaction : Classical Kramers-Kronig Relations.
4. *Wave Guides and Resonant Cavities:* Fields at the surface of and within a Conductor; Cylindrical Cavities and Wave Guides, Resonant Cavities, Power losses in a Cavity and Q of a Cavity.
5. *Simple Radiating Systems and Diffraction:* Fields of Radiation of localized oscillating Source, Electric Dipole fields and radiation and its application to radio waves.
6. *Radiation by moving Charges:* Gauge Transformation, Lienard-Wiechard Potentials and Fields for a Point Charge, Total power Radiated by an Accelerating charge, Larmor's formula, Relativistic formation of electrodynamics.

References

1. Jackson, J. D., (2007), Classical Electrodynamics, Wiley India Pvt. Ltd.
2. Lorrain, P. and Corson, D., (2003), Electromagnetic Fields and Waves, CBS Publishers
3. Griffiths, D.J., (2012), Introduction to Electrodynamics, PHI Learning

Course Title	Advanced Quantum Mechanics	Course No	PH524
Focus Group	Physics	LTPC	3 0 0 3
Offered for	M.Sc. (Physics) Students	Type	New Compulsory
Pre-requisite	Consent of the Teacher	To take effect from	July 2015

Objectives

1. To understand the concepts of the time-dependent perturbation theory and their applications to physical situations.
2. To understand the basics of scattering theory.

Learning Outcomes

1. The students will be able to grasp the concepts of spin arising naturally from the Dirac equation.
2. The students will be familiar with various approximation methods applied to atomic, nuclear and solid-state physics.

Course Content

1. *Approximation methods for time-dependent problems:* Time dependent perturbation theory, Fermi's Golden rule, The adiabatic approximation, The sudden approximation, Semi classical theory of interaction of atoms with radiation.
2. *Scattering Theory:* Differential and total scattering cross-sections, Partial wave analysis, Born approximation and its applications, Lippmann-Schwinger equation, Scattering of identical particles.
3. *Symmetries in Quantum Mechanics:* Symmetry and conservation laws. Continuous and discrete symmetries, Parity, Charge Conjugation and Time reversal symmetry.
4. *Introduction to Dirac Equation:* Concept of relativistic quantum mechanics, introduction to spinors, properties of Dirac gamma matrices, spin of electron.

References

1. Das, A., (2003), Lectures on Quantum Mechanics, Hindustan Book Agency
2. Sakurai, J. J., (1943), Advanced Quantum Mechanics, Addison-Wesley Publishing Company
3. Shankar, R., (1994), Principles of Quantum Mechanics, Plenum Press
4. Griffiths, D. J., (2012), Introduction to Quantum Mechanics, Pearson
5. Merzbacher, E., (2014), Quantum Mechanics, Wiley

Course Title	Atomic and Molecular Physics	Course No	PH 611
Focus Group	Physics	Structure (L-T-P:C)	3 0 0 3
Offered for	M.Sc. (Physics) Students	Status	Compulsory
Pre-requisite	Consent of the Teacher		

Objectives

1. To provide an understanding of the fundamental aspects of atomic and molecular physics
2. To study spectroscopy of the multi-electron atoms and diatomic molecules

Learning Outcome

The students will have an understanding of quantum behavior of atoms in external electric and magnetic fields; and become familiar with the working principle of laser.

Contents

1. *Atomic Physics*: Dipole selection rules (examples with derivation), Width and shape of spectral lines, Spin-orbit coupling, Lamb shift and Rutherford experiment, Hyperfine structure of lines, Normal and specific mass shifts, excitation and ionization processes in electron-atom collisions, experimental determination of collision cross section, Principle of NMR, Principle of ESR with experimental setup, chemical shift. Radiative transitions, photoionization, auto ionization, electron-atom scattering. Fundamentals of atoms and molecules in a radiation field
2. *Molecular Physics*: Molecular Orbital and Electronic configuration of Diatomic molecules: H₂, C₂, O₂, NO and CN; Vibrational structure and vibrational analysis, Frank Condon Principle, Dissociation Energy, Rotational Raman spectra and influence of nuclear spin
3. *Lasers*: Requisites for producing laser light, Role of Plane and Confocal cavity resonators, Longitudinal and transverse cavity modes, Mode selection, Q-switching and Mode locking, Generation of Ultra short Pulses

References

1. Hertzberg, G., (1994), *Atomic Spectra & Atomic Structure*, Dover Publication, New York
2. Bransden, B.H. and Joachain, C. J., (2004), *Physics of Atoms and Molecules*, Prentice Hall, 2nd Edition, Pearson Education, Delhi

Course Title	Nuclear Physics	Course No	PH 612
Focus Group	Physics	Structure (L-T-P:C)	3 0 0 3
Offered for	M.Sc. (Physics) Students	Status	Compulsory
Pre-requisite	Consent of the Teacher		

Objectives

1. To provide an understanding of static properties of nuclei, nuclear decay modes, nuclear force and nuclear models
2. To provide broad understanding of basic experimental nuclear-detection techniques

Learning Outcome

The students will have an understanding of the structure of the nucleus, radioactive decay, nuclear reactions and the interaction of nuclear radiation with matter; and develop an insight into the building block of matter along with the fundamental interactions of nature.

Contents

1. *General Properties of Nuclei*: Mass, radius, angular momentum, Magnetic dipole and electric quadrupole moment, Parity, Isospin.
2. *Radioactivity*: Radioactive disintegration and displacement law, α -particles, Geiger-Nuttall law, Quantum theory of α -decay, General properties of β -decays, Continuous β -spectrum, Neutrino hypothesis, Fermi theory of β -decay, Selection rules for β -decay, Electron capture, Parity violation in β -decays, Propagation of γ -rays through matter.
3. *Nuclear Detectors and Accelerators*: Interaction of charged particles and radiation with matter, Gaseous and Solid state detectors, Cyclic and Linear accelerators, Fixed target accelerators, Colliding beam machines
4. *Nuclear Models*: Liquid drop model, Bether-Weizsacker formula, Nuclear shell model, Collective model
5. *Nuclear Reactions*: Cross section of nuclear reactions, Principle of detailed balance, Compound nucleus, Breit-Wigner formula, Evaporation model, Optical model.
6. *Nuclear Fission and Fusion*: Neutron physics, Energy release in fission, Bohr-Wheeler theory, Cross section of neutron induced fission, Nuclear fusion and thermo-nuclear reaction, Source of energy in stars, Nucleo-synthesis, Peaceful use of nuclear fission, Fission reactors, Biological effects of nuclear radiations, Fusion reactors.
7. *Nuclear Forces*: Deuteron problem, Low energy neutron-proton scattering, Spin dependence of neutron-proton interaction, Non-central force, Low energy proton-proton scattering, High-energy neutron-proton & proton-proton scattering, Meson theory of nuclear force, Nature of two nucleon potential.
8. *Elementary Particles*: Kinematics of high energy collisions, Pi mesons, Muons and their properties, Strange mesons, Hyperons, Resonance particles, Fundamental interactions in nature, Quark hypothesis of elementary particles, Classification of elementary particles, Conservation laws.

References

1. Burcham, W. E. and Jobes, M., (1995), *Nuclear and Particle Physics*, John Wiley & Sons Inc.
2. Tayal, D. C., *Nuclear Physics*, Himalaya Publishing House, Mumbai

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