SCHEME OF EXAMINATION

&

COURSES OF STUDY

IN

M.Sc. PHYSICS

SCHOOL OF SCIENCE

H N B GARHWAL UNIVERSITY

(*A Central University*)

SRINAGAR GARHWAL -246174

(UTTARAKHAND)

M.Sc. (Physics) Semester I

Paper Code	Paper	Credits	Total Credits
SOP/FOS/PHY/C001	Classical Mechanics	3	18
SOP/FOS/PHY/C002	Mathematical Physics	3	
SOP/FOS/PHY/C003	Electrodynamics & Astrophysics	3	
SOP/FOS/PHY/C004	Electronics	3	
SOP/FOS/PHY/C005	Laboratory Course I (Practical ï I)	3	
SOP/FOS/PHH/C006	Laboratory Course II (Practical ï II)	3	
M.Sc. (Physics) Semester II			
Paper Code	**Paper**	**Credits**	**Total Credits**
SOP/FOS/PHY/C007	Atomic &, Molecular Physics	3	18
SOP/FOS/PHY/C008	Solid State Physics	3	
SOP/FOS/PHY/C009	Statistical Physics	3	
SOP/FOS/PHY/C010	Quantum Mechanics	3	
SOP/FOS/PHY/C011	Laboratory Course I (Practical ï I)	3	
SOP/FOS/PHY/C012	Laboratory Course II (Practical ï II)	3	
M.Sc. (Physics) Semester III			
Paper Code	**Paper**	**Credits**	**Total Credits**
SOP/FOS/PHY/C013	Advanced Quantum Mechanics	3	18
SOP/FOS/PHY/C014	Nuclear Physics	3	
SOP/FOS/PHY/C015	Laboratory Course I (General)	3	
SOP/FOS/PHY/E001	Condensed Matter Physics A	3	
SOP/FOS/PHY/E002	Electronics A	3	
SOP/FOS/PHY/E003	Laser Physics A	3	
SOP/FOS/PHY/E004	High Energy Physics A	3	
SOP/FOS/PHY/E005	Astrophysics A	3	
SOP/FOS/PHY/E006	Laboratory Course II (Circuit Design)	3	
M.Sc. (Physics) Semester IV			
Paper Code	**Paper**	**Credits**	**Total Credits**
SOP/FOS/PHY/C016	Computational Physics	3	18
SOP/FOS/PHY/C017	Particle Physics	3	
SOP/FOS/PHY/C018	Lab Course	3	
SOP/FOS/PHY/E007	Condensed Matter Physics B	3	
SOP/FOS/PHY/E008	Electronics B	3	
SOP/FOS/PHY/E009	Laser Physics B	3	
SOP/FOS/PHY/E010	High Energy Physics B	3	
SOP/FOS/PHY/E011	Astrophysics B	3	
SOP/FOS/PHY/E012	Project	3	

M. Sc. Semester I

SOP/FOS/PHY/C001: CLASSICAL MECHANICS

Unit I

Lagrangian formulation and Variational Principle: Mechanics of particles and system of particles, conversion law , constraints , degree of freedom, generalized coordinates **,** DôAlembertôs principle, Lagrangeôs equations of motion from DôAlembertôs principle, application of Lagrangeôs equation of motion to a particle and system of particles, conservation theorem, Hamiltonôs variational principle, Euler- Lagrangeôs differential equation

Unit II

Hamilton's formalism: Need of Hamiltonôs procedure , Legendreôs transformation and Hamiltonôs equation of motion, physical significance of H cyclic coordinates, Hamiltonôs equation in cylindrical and spherical coordinates and applications, applications of Hamiltonôs equation of motion to a particle and system of particles

Unit III

Principle of least action (no proof): Canonical or contrast transformation, their advantages and examples, condition for a transformation to be canonical, infinitesimal contact transformation (ICT)

Poisson brackets : Definition and properties, Invariance with respect to Cnonical transformation, equation of motion in Poissionôs Bracket form, Jacobianôs form.

Unit IV

Mechanics of Rigid Bodies and Theory of Small Oscillations: Coordinates of rigid body motion, Eulerôs angle, angular momentum of a rigid body moments and products of inertia, principle axis transformation, Eulerôs equation of motion of a rigid body, stable and unstable equilibriums. Lagrangeôs equation of motion for small oscillators, normal coordinates and normal mode frequency of vibrations, free vibration of linear triatomic molecules

Reference Books :N C Rama and P S Joag: Classical Mechanics (Tata Mc Graw Hil, 1991)

1. H Goldstein: Classical Mechanics (Addition Wesley, 1980)
2. A Sommerfield: Mechanics (Academic Press, 1952)
3. I Peiceivel and D Richards: Introduction to Dynamics (Cambridge University Press)

SOP/FOS/PHY/C002: MATHEMATICAL PHYSICS

Unit I

Differential Equations: Special equations of Mathematical Physics, Legendre and Associated Legendre equations.Hermite equation, Lagueree equation, Besselôs equation, Beta and Gamma functions. Fourier and Laplace Transforms, Laplace equation and its solution, Poission, Diffusion and Wave equations, Vibrating membrane.

Unit II

Group Theory: Definition, Classification of groups, subgroup, cyclic group, isomorphism and homomorphism, classes, vector spaces, representation theory of finite groups, Reducible and Ir-reducible representations, Schurôs Lemmas and orthogonality theorem, Characters of representaions .

Unit III

Complex Variable: Function of complex variable, Analytic functions, Cauchyôs integral theorem and Cauchyôs integral formula , Taylor and Laurentôs expressions, theorem of residues, Contour intergration.

Unit IV

Matrix and Tensors: Inverse and Trace of Matrix, Unitary Matrices, Orthogonality, Eigen values-Eigen vectors and Diagonalistaion of matrices, Coordinate transformation, Covarient and contravarient Tensors, addition, multiplication and contration of tensors, Associated tensors.

Reference Books :

1. G Arfken: Mathematical Methods for Physicist (Academic Press)
2. Pipes and Harvil: Mathematical Methods for Engineers and Physicist
3. C Harper: Introduction to Mathematical Physics (Prentice Hall of India)
4. A W Joshi: Element of Group Theory for Physicists (Wiley Eastern)

SOP/FOS/PHY/C003 : ELECTRODYNAMICS AND ASTROPHYSICS

Unit I

Maxwell's equations and Electromagnetic waves: Maxwell's equations and their physical significance. Equation of continuity and relaxation time, Vector and scalar potentials, Lorentz and Coulomb gauge,electromagnetic energy and Poynting's theorem, electromagnetic wave equations in free space, their plane wave solutions . Concept of Retarded potentials, Lienard Wiechert potentials, Multipole expansion of EM fields, Electric dipole radiations, field due to oscillating electric dipole, magnetic dipole radiations, electric quadrupole radiation

Unit II

Radiations from moving charges: Fields produced by moving charges, radiations from an accelerated charged particle at low velocities, radiations from a charged particles with co-linear velocity and acceleration, Radiations from an accelerated charged particle at low velocities in circular orbits-Larmor formula,Radiations from an accelerated charged particle at relativistic velocities in circular orbitsrelativistic generalization of Larmor Formula.

Unit III

The Solar System: Aspects of the sky: Concept of Celestial Coordinates and spherical astronomy. Astronomical telescopes. The early years of solar system, the solar system today. Study of Planets:Classification of the Planets, Orbits, Laws of planetary motion, Physical features, surface features, Internal Structure, Atmosphere, Satellites and Rings. Minor Bodies in Solar System: Asteroids, Meteors and Meteorites**:** Discovery of minor planets (Asteroids), their orbits and physical nature. Origin of the minor planets. Meteors and Meteorites. Observation of meteor showers and sporadic meteors. Orbits of sporadic meteoroids and meteor showers. Meteorites, its types and composition. Meteorite craters. Comets- Discovery and designation. Periodic comets. Physical nature. Spectra. Brightness variation. Gas production rates, dust and ion tails. Nature of dust particles and origin of comets.

Unit IV

Stellar System: Sun As A Star: History of Sun, Sunôs interior, the photosphere, the solar atmosphere (chromosphere & corona). Salient features of sunspots, sunôs rotation & solar magnetic field, explanation for observed features of sunspots. Distances of stars from the trigonometric. secular. and moving cluster parallaxes. Stellar motions. Magnitude scale and magnitude systems. Atmospheric extinction. Absolute magitudes and distance modulus. color index. The Hertzberg- Russell Diagram:The colour, Brightness or luminosity, the population of star. Elementary idea of Binary & Variable Stars. Nuclear fission, Nuclear fusion, condition for nuclear reaction in stars.Types of galaxies, Structure and features of the Milky Way Galaxy.

Reference Books:

1. D.J. Griffiths: Introduction to Electrodyanamics (Prentices Hall, 2002)
2. J.R. Reitz, F.J. Milford & R.W. Christy: Foundation of E.M. Theory
3. J.D.Jackson: Classical Electrodynamics (Wiley Eastern)
4. S.P. Puri: Classical Electrodynamics (Tata McGraw Hill, 1990)
5. J.B. Marion: Classical Electromagnetic Radiation
6. Landau and Lifshitz: The Classical theory of Fields (*Pergman Press*)
7. Panofsky and Philips: Electricity and Magnetism
8. R.N. Singh: Electromagnetic waves and fields (*Tata McGraw Hill*)
9. Jordan and Balman: Electromagnetic Waves and Radiation system

10. Marc L. Kutner: Astronomy: A Physical Perspecttive (Cambridge University Press)
11. Shu, F.H.: The Physical Universe An Introduction to Astronomy
12. Robert H. Baker : Astronomy
13. L Motz. & A.Duveen: The Essentials of Astronomy (Colombia University Press)
14. Willian K. Hartmann: Moons & Planets
15. I Morison: Introduction to Astronomy and Cosmology
16. A.W.Joshi & N.Rana: Our solar system
17. Jayant Naralikar: The Structure of Universe
18. K.D. Abhyankar : Astrophysics (Stars & Galaxies)
19. K.S.Krishnaswamy: Physics of Comets
20. McCusky: Introduction to Celestial Mechanics

SOP/FOS/PHY/C004 : ELECTRONICS

Unit I

Power amplifiers : Types of power amplifiers-series fed class A amplifier-series fed transformer coupled class B: push pull circuits-harmonic distortion in amplifiers-class C and D amplifiers-design considerations.

Unit II

Feedback in amplifiers: Feedback principle-effect of feedback on stability-nonlinear distortion input and output impedance-bandwidth-different types of feedback. Criteria for oscillation-phase shift,Wein bridge, crystal oscillator-frequency stability, astable, mono stable and bistable multivibrators, Schmitt trigger-bootstrap-sweep circuits.

Unit III

Operational amplifiers: Differential amplifier-ideal and real opð amp-input and out put impedance-frequency response-applications : amplifiers, mathematical operations, active filters, waveform generators-analog computations-comparators-S and H circuit-voltage regulator.

Unit IV

Optoelectronics: Optical fibres: graded index step index fibres-refractive index profiles-propagation of optical beams in fibres-mode characteristics and cut off conditions-losses in fibrwes-signal distortion group delay-material and wave guide dispersion.

Optical sources: Light emitting diodes-LED structure-internal quantum efficiency-injection laser diode-comparison of LED and ILD.

Optical detectors: PN junction photo diodes-PN photo detectors-avalanche photo diode-performance comparison.

Reference Books:

1. Millman & Halkias : Integrated Electronics (McGraw Hill)
2. Bolested: Electronic devices and circuit theory
3. Ryder : Electronics-fundamentals and applications(PHI)
4. Keiser : Optical fibre communications (McGraw Hill)
5. Agarwal : Nonlinear fibre optics(AP)

SOP/FOS/PHY/C005 : Laboratory Course –I

SOP/FOS/PHY/C006 : Laboratory Course -I

List of experiments : At least 10 experiments are to be performed

1. Study of LCR circuit
2. Transistorized LCR bridge
3. Study of UJT
4. Study of MOSFET
5. Study of NPN and PNP transistor characteristics
6. Study of DIAC
7. Study of TRIAC
8. Study of FET
9. R.C.coupled amplifier
10. T.C. coupled amplifier
11. Study of feedback amplifier
12. Study of Hartley oscillator
13. Study of Colpit oscillator
14. Study of Wien bridgev oscillator
15. Design and study of different network theorems

Seminar: Two seminars for each student are compulsory

Laboratry Course: Internal assessment through a written test

M.Sc. Semester II

SOP/FOS/PHC007: ATOMIC AND MOLECULAR PHYSICS

Atomic Spectroscopy: Fine structure of Hydrogen lines, alkali atom Spectra, penetrating and non penetrating orbits, electron spin orbit interaction, L-S and J-J coupling schemes, Hundeös rule Spectra of two valence electron atoms, (Helium, Magnesium), selection rules for atomic transitions, multielectron spectra, Central field approximation Hartrees self consistent field theory, Thomas Fermi statistical model, Pauliös exclusion principle and determination of ground state.

Zeeman Effect, Paschen Back Effect, Hyper fine structure, Stark effect, width of spectral lines, lamb shift.

Molecular Spectroscopy: Rotational spectra of diatomic molecules, non rigid rotator, vibrational spectra enharmonic oscillator explanation of rotational vibrational spectra in infrared, molecular dissociation and calculation of dissociation energy, Raman effect and intensity alternation of the rotational bands, Applications of infrared and Raman spectroscopy.

Born Openheimer approximation, Molecular orbital theory, Heitler-Loudon treatment of Hydrogen molecule ion and Hydrogen molecule, Electronic spectra of molecules, Fortrait Parabola, Deslandres table, vibrational structure of electronic bands, Intensities of electronic transitions, Franek Condon principle, Condon parabola.

Reference Books:

1. Atomic Spectra- H.E white Cambridge University Press, Newyork, 1935)
2. Principle of Atomic Spectra - Shore and Menzel
3. Spectra of Diatomic Molecules - G. Herzberg
4. C.B.Banewell: fundamentals of Molecular Spectroscopy
5. Molecular Spectroscopy ï Arul Das.

SOP/FOS/PHY/C008 : SOLID STATE PHYSICS

Unit-I:

Crystal Structure: Periodic arrays of atoms, Primitive lattice cell, fundamental types of lattices, index system for lattice planes, Simple crystal structure, Atomic radii, coordination number, Cesium chloride structure, Hexagonal Close Packed Structure, Diamond Structure, cubic Zinc Sulphide structure, point group

Unit-2

Reciprocal lattice: diffraction waves by crystals,Braggs law,Scattered wave amplitude, Laue equations, Brillouin zones,reciprocal lattice to SC lattice, B C C lattice, F C C lattice, structure factor of B C C structure, F C C lattice, Atomic form factor

Unit -3

Crystal Binding and Elastic Constants: Ionic Crystal, Covalent Crystal, Metals, Hydrogen bonds, analysis of elastic springs, elastic compliance and stiffness constants, Elastic waves in cubic crystals, Experimental determination of elastic constants,

Unit-4:

Lattice Vibrations: Vibrations of crystals with monoatomic basis, First Brillouin zone, Group Velocity, Long wavelength limit, Two atoms per primitive basis, quantization of elastic waves, Phonons, Phonon momentum, Inelastic scattering of photons by phonons.\

Reference Books:

1. Introduction of Solid State Physics_ C Kittel
2. Solid State Physics_ N W Ashcroft & N David Mermin
3. Solid State Physics- Ajay Kumar Saxena
4. A J Dekker: Solid State Physics
5. Azaroff: Introduction to solids
6. Aschroft and Mermin: Solid State Physics
7. Peterson: Introduction to Solid State Physics
8. Verma and Srivastava: Crystallography for Solid State Physics

SOP/FOS/PHY/C009: STATISTICAL PHYSICS

Unit I

Basic Postulates- Phase space, relation between eigen states and phase space volume, Liouville's theorem, ensembles, microcanonical, canonical and grand canonical ensembles, Maxwell's Boltzmnn's distribution and Gibb's formulation for canonical and grand canonical ensembles, partition function, their thermodynamic properties, laws of thermodynamics.

Unit II

Application of classical distribution to the ideal gases: Degrees of freedom, translational motion, Helmholtz free energy, Gibb's free energy, entropy and thermodynamic properties, Gibb's paradox, Sakur-tetrode equation.

Imperfect gases: Difference between ideal and real gas, imperfect gases, Vander Waal's equation, virial coefficients, condensation of gases, general properties of liquids, Fermi theory, liquid Helium, phase rule.

Unit III

Quantum Statistics: Drawbacks of M B distribution, Bose-Einsteinǿs and Fermi-Dirac distribution, symmetric and antisymmetric particles, partition functions, non degenerate, weakly degenerate and strongly degenerate cases, B.E. condensation, application to He, pressure-energy relationship, electronic specific heat of solids and paramagnetism.

Unit IV

Black Body Radiation: Planck's distribution, pressure and energy relationship of photons, black body radiation, Rayleigh Jean's formula, Wein's law, Wein's displacement formula, absorption and emission of radiation, Stefan's law, high temperature measurements.

Reference Books:

1. Glasstone: Theoretical Chemistry
2. E.S. Raj Gopal: Statistical Mechanics and Properties of Matter
3. Mayer And Mayer: Statistical Mechanics
4. Landau and Lifshitz: Statistical Physics
5. Pointon: Introduction to Statistical Physics
6. Huang: Statistical Mechanics
7. Wanier: Statistical Physics

SOP/FOS/PHY/C0010: QUANTUM MECHANICS

Section A

Introduction:

A brief review of foundations of quantum mechanics, basic postulates of quantum mechanics, uncertainty relations, Schrodinger wave equation, expectation value and Ehrenfest theorem. Relationship between space and momentum representation. **Applications:** One dimensional potential step, tunneling, Hydrogen atom, particle in a three dimensional box.

Section B.

Matrix Formulation of Quantum Mechanics:

Vector representation of states, transformation of Hamiltonian with unitary matrix, representation of an operator, Hilbert space. Dirac bra and ket notation, projection operators, Schrodinger, Heisenberg and interaction pictures. Relationship between Poisson brackets and commutation relations. Matrix theory of Harmonic oscillator.

Section C

Symmetry in Quantum Mechanics:

Unitary operators for space and time translations. Symmetry and degeneracy. Rotation and angular momentum; Commutation relations, eigenvalue spectrum, angular momentum matrices of J_+, J_-, J_z, J^2. Concept of spin, Pauli spin matrices. Addition of angular momenta, Clebsch-Gordon coefficients and their properties, recurssion relations. Matrix elements for rotated state, irreducible tensor operator, Wigner-Eckart theorem. Rotation matrices and group aspects. Space inversion and time reversal: parity operator and anti-linear operator. Dynamical symmetry of harmonic oscillator.

Applications: non-relativistic Hamiltonian for an electron with spin included. C. G. coefficients of addition for j =1/2, 1/2; 1/2, 1; 1, 1.

Section D

Approximation Methods for Bound State:

Time independent perturbation theory for non-degenerate and degenerate systems upto second order perturbation. Application to a harmonic oscillator, first order Stark effect in hydrogen atom, Zeeman effect with electron spin. Variation principle, application to ground state of helium atom, electron interaction energy and extension of variational principle to excited states. WKB approximation: energy levels of a potential well, quantization rules. Time-dependent perturbation theory; transition probability (Fermi Golden Rule), application to constant perturbation and harmonic perturbation. Semi-classical treatment of radiation. Einstein coefficients; radiative transitions.

Books Recommended

1. L. I. Schiff, Quantum Mechanics (McGraw Hill).
2. V. K. Thankappan, Quantum Mechanics (Wiley Eastern).
3. P. M. Mathews and K. Venkatesan, A Text-Book of Quantum Mechanics (TMH)
4. C. Cohen-Tannoudji, Bernard Diu, Franck Loloe, Quantum Mechanics Vols-I&II (John Wiley).
5. J. J. Sakurai, Modern Quantum Mechanics (Addison-Wesley).
6. A. K. Ghatakh and S. Lokanathan, Quantum Mechanics 3rd ed. (MacMillan).

SOP/FOS/PHY/C011: Laboratory Course-I

SOP/FOS/PHY/C012: Laboratory Course-II

List of experiments: At least 10 experiments are to be performed

1. Multivibrator bistable/monostable/Astable
2. Ionisatin potential of Mercury using gas filled diodes
3. Michelson interfermeter
4. Fabry Pert interferometer
5. Fresnals law
6. Determination of absorption coeficient of iodine vapour
7. B-H curve
8. Study of amplitude modulation and demodulation
9. Study of frequency modulation and demodulation
10. Lecher wire experiment
11. Determination of magnetic susceptibility
12. Study of CRO.
13. Velocity of Ultrasonic waves
14. Linear Air track
15. Determination of Planks constant

Seminar: Two seminars for each student are compulsory

Laboratry Course: Internal assessment through a written test

M.Sc. Semester III

SOP/FOS/PHY/C013: ADVANCED QUANTUM MECHANICS

Section A

Scattering Theory:
General considerations; kinematics, wave mechanical picture, scattering amplitude, differential and total cross-section. Green's function for scattering. Partial wave analysis: asymptotic behaviour of partial waves, phase shifts, scattering amplitude in terms of phase shifts, cross-sections, Optical theorem. Phase shifts and its relation to potential, effective range theory. Application to low energy scattering; resonant scattering, Breit-Wigner formula for one level and two levels, non-resonant scattering. s-wave and p-wave resonances. Exactly soluble problems; Square-well, Hard sphere, coulomb potential. Born approximation; its validity, Born series.

Section B

Identical Particles:
The Schrodinger equation for a system consisting of identical particles, symmetric and anti-symmetric wave functions, elementary theory of the ground state of two electron atoms; ortho- and Para-helium. Spin and statistics connection, permutation symmetry and Young tableaux. Scattering of identical particles.

Section C

Relativistic Wave Equations:
Generalization of the Schrodinger equation; Klein-Gordon equation, plane wave solutions, charge and current densities, interaction with electromagnetic fields, Hydrogen-like atom (to show it does not yield physical spectrum), non-relativistic limit. Extension of Klein-Gordon equation to spin 1 particles.

Dirac Equation; relativistic Hamiltonian, probability density, expectation values, Dirac gamma matrices, and their properties, non-relativistic limit of Dirac equation. Covariance of Dirac equation and bilinear covariance, plane wave solution, energy spectrum of hydrogen atom, electron spin and magnetic moment, negative energy sea, hole interpretation and the concept of positron. Spin-orbit coupling, hyperfine structure of hydrogen atom.

Section D

Quantization of wave fields: The quantization of wave fields, Classical and quantum field equations quantization of non-relativistic Schrodinger equation, second quantization, N-representation, creation and annihilation operators.

Books Recommended

1. P. M. Mathews and K. Venkatesan, A Text book of Quantum Mechanics (TMH)
2. A. S. Davydov, Quantum Mechanics (Pergamon).
3. L. I. Schiff, Quantum Mechanics (McGraw Hill).
4. J. D. Bjorken and S. D. Drell, Relativistic Quantum Mechanics (McGraw Hill).
5. J. J. Sakurai, Advanced Quantum Mechanics (Addison Wesley).
6. V. K. Thankappan, Quantum Mechanics (Wiley Eastern).
7. R.P Feynman and A.R.Hibbs; Quantum Mechanics and Path Integrals.
8. L.H. Ryder, Quantum field Theory (Academic Press).

SOP/FOS/PHY/C014 : NUCLEAR PHYSICS

Unit I

General Properties & Models-: Nuclear size, nuclear angular momentum (Spin), Nuclear magnetic moments, statistics, Binding energy, Liquid drop model, Shell model, Collective model.

Unit II

Nuclear Forces and Detectros – Ground state of deuteron, Low energy neutron-proton scattering and proton-proton scattering, Exchange and tensor forces, G.M. Counter, Electron & Proton Synchrotron.

Unit III

Radioactive decay: Radioactive decay equation equilibrium units, Gamowês theory of alpha decay and Geiger Nuttal law, Fermiôs theory of beta decay, parity violation in beta decay, electromagnetic decays.

Unit IV

Nuclear Reactions- Q-value of nuclear reaction, Bohrôs Theory of compound nucleus, Scattering cross section of nuclear reaction (phase shift method), Breit Wigner single level resonance formula for scattering cross section.

References Books:

1- I. Kaplan: Nuclear Physics
2- H.A. Enge : Nuclear Physics
3- R.Roy & B.P. Nigam : Nuclear Physics
4- R.D. Evans: Nuclear Physics
5- W.E. Bucham & M. Jobes : Nuclear & Particle Physics (AWL)
6- D. Halliday : Nuclear Physics
7- E. Segre : Nuclei & Particles.
8- B.R. Martin : Nuclear & Particle Physics.
9- B.L. Cohen : Concepts of Nuclear Physics.
10- S.S.M. Wong : Introductory Nuclear Physics
11- S.B. Patel : Nuclear Physics
12- M.K. Pal : Theory of Nuclear Structure
13- S.N. Ghoshal : Nuclear Physics.

SOP/FOS/PHY/C015: Laboratory Course- I (General)

List of experiments: At least10 experiments are to be performed

1. e/m by Zeeman effect
2. G.M.counter
3. Study of IC- Based Power supply
4. Absorption spectroscopy by spectrophotometer
5. Study of optoelectronic devices
6. Design and study of FET amplifier
7. Design and study of Mosfet amplifier
8. Study of SCR
9. Measurement of wavelength of He-Ne laser using interference and diffraction pattern
10. Measurement of thickness of thin wire using laser.
11. Logicom AND/or/NAND/NOR/NOT gates
12. Design and study of UJT relaxation oscillator
13. Study of pin connection and biasing of various linear ICôs and timers 555
14. Design and study of phase shift oscillator
15. Study of operational amplifier

Seminar: Two seminars for each student are compulsory

Laboratory Course: Internal assessment through a written test

SOP/FOS/PHY/E001 : CONDENSED MATTER PHYSICS- A

Unit-1

Defects in crystals:Point defect, Impurities, Vacancies, Frenkel defects, Schottky defects, Intrinsic vacancies, Concentration of Schottky defects, Concentration of frankel defects, extrinsic vacancies, Diffusion, Colour centres, F-Centre, V-Centre, dislocation, Line defects, edge dislocation, screw dislocation, Burger vector.

Unit-2

Magnetism: Dia, Para and ferromagnetism, Langvinòs theory of paramagnetism, Ferromagnitiam, Weiss molecular theory, Ferromagnetic domains, Antiferromagnitism, Neelòs theory, Two sublattice model, ferrites.

Unit-3

Energy Bands: Origin of energy gap, Magnitude of the energy gap, Bloch function, Bloch theorem, Kronig penny model, Number of possible wave fuction in a band, crystal momentum, the concept of effective mass, concept of holes, hole band construction, metal, insulator and semiconductor.

Unit-4

Dielectric and electrical properties of insulators: Macroscopic description of dielectric constants, static, electronic and ionic polarizability of molecules, orientational polarization, Internal Lorentz field static dielectric constant, Complex dielectric constant, Dielectric loss and relaxation time, Optical absorption.

Reference Books:

1. Kittel: Introduction to solid state Physics
2. Ziman: Principles of theory of solids
3. J. Callaway: Quantum theory of solids
4. A.J. Dekker: Solid State Physics
5. Animalu: Intermediate Quantum theory of crystalline solids
6. Solid State Physics: N W Ashcroft and N David Mermin
7. Solid State Physics: Ajay Kumar Saxena

SOP/FOS/PHY/E002 : ELECTRONICS- A

Unit I

Number Systems, Boolean Algebra & Basic Logic Gates: Binary, Octal, Decimal & Hexadecimal Numbers, Base conversions and arithmetic, Complements, Signed Binary numbers, Binary codes (Weighted,BCD,2421,Gray code, Excess 3 code, Error detecting code, Error correcting codes, ASCII,EBCDIC), Conversion among codes.

Boolean postulates and laws, Dual & Complement, De-Morganôs Theorem, Boolean expressions and functions , Minimization of Boolean expressions, Sum of Products (SOP), Product of Sums (POS), Minterms & Maxterms, Karnaugh maps and minimization.

Unit II

Logic Gates & Combinational Circuits: Logic Gates: AND, OR, NOT, NAND, NOR, XOR, XNOR, Universal Gates, Positive and Negative Logic, Implementations of Logic Functions using gates, TTL and CMOS Logic and their characteristics, 7400 Series. Adders, Subtractors, Serial adder/ Subtractor, Parallel adder/ Subtractor, Carry look ahead adder, BCD adder, Magnitude Comparator, Multiplexer, Demultiplexer, Encoder, Decoder, Parity-checker, Code converters

Unit III

Sequential Circuits: Flip flops: Latches, RS, JK, T, D and Master-Slave, Characteristic table and equation, Edge triggering, Level Triggering. Registers & Counters: Asynchronous/ Ripple counters, Synchronous counters, Moduloï n Counters, Shift registers, Universal shift register, Shift counters, Ring counters.

Unit IV

Memory Devices & IC-Technology: Classification of memories, RAM organization, Write/Read operations, Memory cycle, Timing wave forms, Memory decoding, Memory expansion , Static RAM Cell-Bipolar RAM cell, MOSFET RAM cell, Dynamic RAM cell, ROM organization ï PROM, EPROM, EEPROM, EAPROM ,Programmable Logic Devices, Programmable Logic Array (PLA), Programmable Array Logic (PAL)

Basic Ideas of IC-Technology, Monolithic ICôs, IC Components- Resistors (Integrated, Diffused, Thin Film), MOS Capacitors, Inductors, Bipolar Transistors, Thin Film Technology, LSI, MSI.

Reference Books:

1. Malvino & Leach: Digital Principles and Applications
2. Morris Mano: Digital Design
3. Thomas L. Floyd: Digital Fundamentals
4. Millman & Halkias: Integrated Electronics

SOP/FOS/PHY/E003: LASER PHYSICS- A

Unit I

Basic principles: Basic principles and theory of absorption and emission of radiation, Einsteinös coefficients, line-broadening mechanisms, rate equations for three and four level laser systems, population inversion, theory of optical resonators, laser modes, spatial and temporal coherence,

Unit II

Types of lasers: Gas lasers, He-Ne, argon ion, N_2, CO_2 lasers; dye lasers, solid state, Semiconductor lasers: Ruby, Nd:YAG and Nd:glass lasers, Fabrication technology of lasers, diode lasers, colour centre and spin flip lasers, laser spikes, mode locking Q-switching, CW and pulsed lasers.

Unit III

Non linear optics: Theory of non linear phenomenon, second and third harmonic generation, phase matching, parametric generation, self focussing,

Unit IV

Laser spectroscopy: Laser fluorescence spectroscopy using CW and pulsed lasers, Single photon counting, Laser Raman apectroscopy, multiphoton processes, photo accoustic and photon electron spectroscopy, stimulated Raman spectroscopy, Coherent antistokes Raman spectroscopy.

Reference Books:

1. Ghatak and Thyagrajan: Lasers
2. O. Svelto: Principles of Lasers
3. Silvfast: Lasers
4. B.B.Loyd: Lasers

SOP/FOS/PHY/E004: HIGH ENERGY PHYSICS A

Section A

Classical and Quantum Field Equations, Coordinates of the field, Classical Lagrangian Equation, Classical Hamiltonian Equations, Quantum Equations for the Field, Fields with more than one component, Complex Field, Quantization of the Non-relativistic Schrodinger Equation, Classical Lagrangian and Hamiltonian Equations, Quantum Equations, The N-representation, Creation and Destruction Operators, Number Operators, Anticommutation Relations, Equations of Motion, Physical Implications of Anticommutation, Representation of Anticommuting operators

Section B

Quantization of fields: Quantization of neutral and complex scalar fields, U (1) Gauge Invariance, Quantization of Dirac field covariant anticommutation relations, Quantization of electromagnetic field. Interaction Lagrangian for the fields, QED Lagrangian.

Section C

Scattering Matrix and Feynman Rules: The S-Matrix reduction of S- Matrix chronological product, Wicks theorem Furryǿs theorem Covariant perturbation theory interaction lagrangian for QED, Feynman Diagrams and Feynman rules for QED in configuration and momentum space, Electron- Positron scattering, Coulomb scattering of Electrons, electron ï positron annihilation , Compton scattering.

Section D

Renormalization of QED: Self energy correction, vacuum polarization and vertex correction, classification of Divergences, Renormalization of mass and charge, wave function renormalization .

Reference:

1. Theory of photons and electrons, J.M. Jauch and E. Rohrlich
2. Relativistic Quantum field, J.D. Bjorken and S. D. Drell.
3. Quantum electrodynamics , A.I. Akhiezer and Berestetski
4. Quantum Electrodynamics, Walter Greiner

SOP/FOS/PHY/E005 : ASTROPHYSICS- A

Unit I

Physics of the Stars : Apparent and Mean Position of stars. Effects of atmospheric refraction, aberration, parallax, precession, nutation and proper motion on the coordinates of stars. Reduction from apparent to mean places and vice versa. Spectra of Stars. Distribution of stars in space. Statistical parallaxes. Local standard of rest. Solar motion and its determination. Peculiar velocities. Single and Two star stream hypothesis. Velocity ellipsoid. Comparison with solar neighbourhood. Bottlingerὂs diagram. HR diagram, HD and MK spectral classification of stellar spectra. Radiation laws and basic ideas on spectral line formation. Explanation of stellar spectra in terms of Boltzmann and Saha equations. Spectroscopic parallax.

Unit II

Fundamental Equations: Equation of mass distribution. Equation of hydrostatic equilibrium. Equation of energy transport by radiative and convective processes. Equation of thermal equilibrium. Equation of state. Stellar opacity. Stellar energy sources.Stellar models:The overall problem and boundary conditions. Russell-Voigt theorem. Dimensional discussions of mass-luminosity law. Polytropic configurations. Homology transformations.

Unit III

Stellar Evolution : Abundance of elements in the sun by the method of fine analysis-Stromgren's method, use of weight functions, abundances of elements in normal stars. Composition of differences in population I and II stars. Anomalous abundances in cool stars. Peculiar A stars and metallic line stars. Magnetic field in stars. Jean's criterion for gravitational contraction and its difficulties. Pre-main-sequence contraction under radiative and convective equilibrium. Evolution in the main sequence. Growth of isothermal core and subsequent development. Ages of galactic and globular clusters.

Unit IV

Superdense Objects : Mechanism of Mass transfer in Binary Stars. Use of polytropic models for completely degenerate stars. Mass-radius relation. Non-degenerate upper layers and abundance of Hydrogen. Stability of white dwarfs. Final cooling of white dwarfs. Accretion by white dwarfs and its consequences. Pressure ionisation and mass-radius relation for cold bodies. Formation , features and properties of Neutron stars, Pulsars and black holes.

Reference Books:

1. D.Mihalas: Galactic Astronomy
2. S.Chandrasekhar: Principles of Stellar Dynamics
3. James Binney and Scoth Tremaine: Galactic Dynamics (Princeton University Press)
4. K.C.Freeman: Galaxies and Universe
5. D.Mihalas and J.Binney: Galactic Astronomy
6. S.D.M.White: The Origin and Evolution of Galaxies
7. S.M.Alladin: Lecture notes on "Dynamics of Stellar Systems".
8. W.M.Smart: Text book of Spherical Astronomy
9. K.D.Abhyankar: Astrophysics:Stars and Galaxies (Tata McGraw Hill Publication)
10. G.Abell: Exploration of the Universe.

SOP/FOS/PHY/E006: Laboratory Course (Circuit Design)

Electronics:

List of experiments : At least 5 experiments are to be performed

1. Study of regulated power supply (723).
2. Study of Timer (555).
3. A to D and D to A convertor
4. 1 of 16 Decoder/Encoder
5. Study of Multiplexer/Demultiplexer
6. Study of Comprator and Decoder
7. Study of different flip- flop circuits (RS, JK, Dk type, T-type, Master slave).
8. Study of Digital combinational and sequential circuits
9. Study of Microprocessor (8085)
10. Study of SCR, DIAC, TRIAC
11. Study of IC- Based Power supply
12. Microwave experiment.
13. Shift Registers
14. Fiber Optics communication

High Energy Physics:

List of experiments : At least 5 experiments are to be performed

1. Characteristic curve of a GM Detector and Absorption coefficient of a using aluminum GM Detector.
2. Energy spectrum of gamma rays using gamma ray spectrometer.
3. Absorption coefficient of aluminum using gama-ray spectrometer.
4. Characteristics of Scintillation Detector.
5. Study of gama-gama unperturbed angular correlations.
6. Study of particle tracks using a Nuclear Emulsion Detector.
7. Classification of tracks in interaction with Nuclear Emulsion and determination of excitation energy.
8. Mossbauer spectrometer

Condensed Matter Physics:

List of experiments : At least 5 experiments are to be performed

1. Determination of elastic constant of crystals by optical methods
2. Study of fluorescence spectra of a given compound
3. Study of colour centers
4. Determination of lattice parameters using powder method.
5. Determination of hall coefficient using Hall effect
6. Determination of Energy gay of a semiconductor by four probe method
7. ESR
8. Dielectric constant

Astrophysics:

List of experiments : At least 5experiments are to be performed

1. Study of Hubbleĝs law (from given data)
2. Study of constant density neutron star
3. Study of the static parameters of a Neutron Star model with inverse square density distribution
4. Study of star cluster from a given data
5. Study of Extinction coefficients
6. Study of variability of stars

Laser Physics:

List of experiments : At least 5 experiments are to be performed

1. Study of the vibrational levels of Iodine.
2. Measurement of the fluorescence spectra of Uranyl Nitrate Hexahydrate.
3. Determination of the intrinsic life time for a dye molecule.
4. Determination of change in dipole moment in excited state using Solvatochromic shift method.
5. Measurement of non radiative decay rate for a known sample.
6. Determination of the quantum yield of known samples using steady state spectroscopy.
7. Study of electro optic effect
8. Study of Acousto-optic effect

M.Sc. Semester IV

SOP/FOS/PHY/C016 : COMPUTATIONAL PHYSICS

Unit I

Roots of functions, interpolation, extrapolation, integration by trapezoidal and Simpsonôs rule, Runge-Kutta Method, Least square fitting method.

Unit II

Eigenvalues and eigenvectors of matrices, power and Jacobi method, solution of simultaneous linear equations Gaussian elimination, Pivoting, Iterative method, matrix inversion.

Unit III

Flowchart and algorithons-Problem analysics flowchart of some basic problems. The concept and properties of algorithmic languages, elementary algorithm development algorithm involving decision and loops.

Unit IV

C-Programming : selection of C and Fortran 90/95 programming loops and control, constructs, arithmetic and logic operators, Strings, arrays, pointers, floats and other types, input, output, control constructs, recursion structures, sub programmes and modules.

Reference Books:

1.B.D.Hahn: Fortran 90 for Scientists and engineers.
2.V Rajaraman: Computer Programming in c.
3.Rajaraman: Computer Oriented numerical methods.
4.Wong: Computational methods in Physics and engineering.
5.S.Balachandra Rao: Numerical Methods.
6.Stephen j Chapman: Fortran 90/95 for Scientists and Engineers.

SOP/FOS/PHY/C017: PARTICLE PHYSICS

Unit I : Classification and Properties of Elementary Particles

Elementary Particles,their classification on the basis of their mass and spins

(Leptons, Mesons, Baryons) and field quanta. Their general properties (mass, spins, life time and their production and decay modes), Antiparticles.

Unit II: Conservation Laws and Gauge Invariances

Conservation of Energy, Linear and Angular momentum, Spin, Charge, Lepton No., Baryon No. Isospin, Hypercharge, Parity, Strangeness, Charge conjugation, Time Reversal,CP, CPT theorem, Global and Local gauge invariances.

Unit III: Fundamental Interaction

Qualitative ideas (Relative strengths, Ranges, Characteristic times and Mediators) of Gravitational, Electromagnetic, Strong and Weak Nuclear interactions. General idea of Electro-week and Grand unifications.

Unit IV: Quark Model

Eight fold way, Quarks as building blocks of hadrons, six quarks (u,d,s,c,t and b), Antiquarks, General properties of quarks (Charge, Mass, Colour - A new degree of freedom, quark confinement, Asymptotic freedom) Evidences for Quarks (Lepton scattering, Hadron Spectroscopy, Jet production), Quark compositions of Mesons and Baryons. General idea of Standard Model. Idea of Higgs Boson.

Books and References:

1- Introduction to High Energy Physics-D.H.Perkins. (Addision ï Wesley-1986)
2- Introduction to Nuclear & Particle Physics-VK Mittal, R.c. Verma & S.C.Gupta (Prentice Hall of India, Pvt.Ltd., New Delhi, 2009) (All units approx.)
3- Concepts of Modern Physics- Arthur Beiser (Tata Mc Graw Hill Edu.Pvt Ltd., New Delhi, Sixth Ed. 2009) Chapter 13 page 529.
4- Quarks and Leptons- An Introductory course in Modern Particle Physics-Francis Halzen & A D.Martin(John Wiley & Cons,Inc. Canada,1984),Gauge invariance page-314,315,316, Unit III and Unit IV
5- Nuclear and Particle Physics-W.E. Burcham & M. Jobes(Essex,England ISE Reprint 1998) Unit-II, III, & IV Gauge Invariances pages 484, 485, 486, 487
6- Introduction to Particle Physics-M.P. Khanna (Prentice Hall of India, 1999) Unit II,III,IV
7- Introduction to Elementary Particle Physics-D.Griffiths (John Wiley 4 sons,1987)
8- Elementary Particle Physics-Gasiorowicz (John Wiley & sons, 1966).
9- Nuclear & Particle Physics-B.R. Martin & G. Shaw(John wiley & sons, 1997)
10- A Modern Introduction to Particle Physics- Riyazuddin and Fayazuddin
11- Particle Physics- M.Leon
12- Principles of Physics- Resnick, Halliday & Walker (John wiley & sons,England) 9th Extended edition, 2013, chapter 44)

SOP/FOS/PHY/C018 : Laboratory Course

List of experiments:

1. Study of computational softwares
2. Study of numerical techniques.
3. Computer programming.

SOP/FOS/PHY/E007: CONDENSED MATTWER PHYSICS- B

Unit-1:

Nearly free electron model, One dimensional free electron case, Nearly free electron case, energy bands in one dimension, tight binding approximation, energy surfaces, Wigner Seitz cellular method, Orthogonalized plane wave (OPW) method, Pseudo potential method, Limitations of band theory (Mott Transition)

Unit-2

Dielectrics and ferroelectrics: Polarization, Macroscopic electric field, depolarization fiels, local electric field at an atom, fields of dipoles inside cavity, dielectric constant and polarizability, electronic polarizability, structural phase transition, ferroelectric crystals, classification of ferroelectric crystals, displacive transition, soft optical phonons, landau theory of phase transition, Second and first order transition, antiferroelectricity, ferroelectric domains, piezoelectricity, ferroelasticity, optical ceramics.

Unit-3

Superconductivity: Experimental Survey, Occirance of super conductivity, destruction of superconductivity by magnetic field and temperature, Meissner effects, Type-I and Type-II superconductors, Isotope effect, Thermodynamics of Superconducting transition, London Equations, Coherence length, BCS Theory, Cooper pairs, Josephson superconductor tunneling, AC & DC Josephson effect, High temperature superconductors, critical fields and critical currents.

Unit-4

Nano Material Science and Technology: History, Origin, Quantum dots, Synthesis, Applications and advantages, Quantum wires, Quantum well & application, Fullerenes, Carbon nanobuds, carbon nanotubes as quantum wires, Areas of Nanotechnology, nanomaterials, nanoelectronics, nanobiotechnology, nanofabrication, microelectromechanical systems (MEMS)

Text and Reference books

1. Principle of condensed matter Physics : Chaikimand Lubensky
2. Solid State Physics : Kubo and Ngamia
3. Elements of Solid State Physics : Srivastava
4. Introduction to Solid State Physics : Madelung
5. Introduction to Solid State Physics : Paterson
6. Introduction to Solid State Physics : Kittel
7. Solid State Physics-N W Ashcroft & N David Mermin
8. Solid State Physics-Ajay Kumar Saxena

SOP/FOS/PHY/E008 : ELECTRONICS- B

Unit I

Modulation – Amplitude Modulation-Theory, Plate Modulated class C amplifier, Balanced Modulator, Single Side Band modulation (phase shift method), Frequency modulation ï Theory, Reactance tube modulator, transistor reactance modulator, FET reactance modulator.

Demodulation- Envelope diode detector, super regenerative detection, Foster Seely phase discriminator, Ratio Detector.

Transmitters & Receivers- A.M Transmitter, F.M. transmitter, TRF Receiver, Super heterodyne receiver, amplitude limiting.

Unit II

Transmission Lines– TL Equations and their solutions, characteristic impedance, lossless open and short circuited lines, standing wave ratio and refection coefficient, stub matching, quarter wave length and half wave length lines.

Antenna ï Radioactive field strength, power and radiation patterns of an elementary electric doublet and linear antenna, effects of ground reflection. Hertz antenna, Marconi antenaa, Yagi antenna, loop antenna, direction finding, Resonant & Non resonant Antenna, Antenna array (Broad side & End fire arrays), T.V. aerials. Horn Antenna, Parabolic reflectors, Lens Antenna.

Unit III

Propagation of Radio Waves-

Electes-Larmor theory, Applecton ï Hartree theory of sky wave propagation, skip distance and maximum usable frequency, Chapmannȏs theory of layer formation.

Pulse method for measuring the height of ionospheric region.

Unit IV

Television Systems-

General Principle of Image transmission and reception of signals, pick up instruments (Iconoscope, Image orthian and Videocon) Image scanning sequence, scanning synchronization, composite video signal, colour television.

Radar Systems-

Principle of Radar, Basic arrangement of Radar system, Azimuth and Range measurement, operating characteristics of systems, Radar transmitters and Receivers, Duplexers, Indicator unit, maximum range of a Radar set.

References Books :

1. F.E. Terman ï Radio Engineering
2. G. Kennedy & B. Davis ï Electronic Communication Systems
3. G.K. Mithal ï Radio Engineering Vol. II
4. G. Keiser ï Optical Fiber Communication
5. C.K. Sirkar & S.K. Sirkar, Fiber optical Communication Systems.
6. Gupta & Kumar ï Handbook of Electronics
7. S.D. Parsonick ï Fiber Opitics
8. Introduction to Fiber optics ï Ghatak & Thyagarajan.
9. Frenzel ï Communication Electronics
10. Rody & Coolen - Communication Electronics.
11. L.E. Frenzel ï Communication Electronics
12. A. Ghatak & K. Tyagrajan ï Fiber optics & Lasers.
13. M. Satish Kumar ï Optical Fiber Communication

SOP/FOS/PHY/E009: LASER PHYSICS- B

Unit I

Electro optic effect, longitudinal and transverse phase modulation, consideration of modulator designs and circuit aspects, acousto optic effect, Raman Nath and Bragg regimes, acousto optic modulators, magneto-optic effect, integrated optics, optical directional couplers and optical switches, phase modulators.

Unit II

Optical sources and detectors: Laser devices, radiation pattern and modulation, LED structures, light source materials, liquid crystal diodes, photoelectric, photovoltaic and photconductive methods of detection of light, photodiodes: structure, materials and working, PIN photodiodes, avalanche photodiodes, microchannel plates, photodetector noise responsivity and efficiency, photomultipliers, image intensifier tubes, Videocon and CCD.

Unit III

Fibre optics: Basic characterstics of optical fibres, fibre structure and fundamentals of waveguides, step and graded index fibres, signal degradation in optical fibres, absorption scattering, radiation and core cladding losses, Design considerations of a fibre optical communication system, analogue and digital modulation, optical fibre amplifiers.

Unit IV

Holography: Basic principles, construction and reconstruction of holograms, applications of holography, laser interferometry, laser applications in industry and medicines

Reference Books:

1. Ghatak and Thyagrajan :Optical Electronics
2. Hawks : Optoelectronics
3. Keiser : Optical fibre communications
4. Ghatak and Thyagrajan:Introduction to fibre optics
5. I.P. Csorba: Image tubes
6. Ed.L.M.Bibermman and S.Hudelman : Photoelectronics

SOP/FOS/PHY/E010: HIGH ENERGY PHYSICS- B

Section-A

Symmetries and conservation laws, Noetherôs Theorem, U (1) Gauge Invariance, Baryon and Lepton number conservation, The concept of gauge invariance; Global and Local gauge invariance, spontaneous Breaking of Global gauge invariance, Goldstone Bosons, the Higgs mechanism, Generalized local gauge invariance-Abelian and non Abelian gauge invariance.

Section-B

Weinberg- Salam theory of electroweak unification, The matter fields, the gauge fields, the gauging of SU (2) XU (1), The vector bosons, The fermion sector, Helicity states, parity, charge conjugation Fermion masses, Fermion assignments in the electroweak model, spontaneous symmetry break down, Fermion Mass generation, The color gauge theory of strong interactions.

Section C

Color gauge invariance and QCD, The standard model of fundamental interaction, general mass terms, Cabibbo Angle, Kobayashi- Maskawa matrix and CP violation, The SU (5) Grand unified theory, The generators of SU (5), The choice of Fermion representations spontaneous breaking of SU (5) symmetry Fermion masses and mixing angles.

Section D

The classic predictions of SU (5) Grand Unified, Theory, quark and Lepton masses, The SO(N), The SO (10) Grand Unified Theory, Fermion Masses in SO (10), Neutrino Mass in SO (10).

References:

1. A Modern Introduction to Particle Physics, Riazuddin and Fayyazudin.
2. Modern Elementary Particle Physics G. L. Kane (Addison- Wesley 1987).
3. Grand Unified theories, Graham Ross.
4. Gauge Theories of Strong, Weak and Electromagnetic Interactions, C. Quigg (Addison ï Wesley)
5. Gauge Theory of Elementary Particle Physics , T.D. Cheng and Ling Fong Li (Clarendon Oxford)

SOP/FOS/PHY/E011 : ASTROPHYSICS- B

Unit-1

Detectors ,Photometry and Spectroscopy: Detectors for optical and infrared regions. Application of CCD's to stellar imaging, photometry and spectroscopy. Techniques of observations of astronomical sources from space in infrared. EUV, X-ray and gamma-ray regions of the electromagnetic spectrum.

Astronomical photometry. Simple design of an astronomical photometer. Observing technique with a photometer Correction for atmospheric extinction. Tansformation to a standard photometric system. Astronomical spectroscopy. Spectral classification. Simple design of astronomical spectrograph. Radial velocity measurements.Radio Astronomy Techniques. Electro-magnetic spectrum. Radio window. Design and construction of a simple radio telescope. Receiver systems and their calibration. Design and construction of a simple radio interferometer.

Unit-2

Galactic System: Interstellar Matter:Composition and properties. of interstellar matter. Oort limit. Interstellar extinction. Estimate of colour excess. Visual absorption. Interstellar reddening law and Polarisation. Spin temperature. Interstellar magnetic fields. Stromgren's theory of H II regions. Physical processes in planetary nebulae. Gallastic Structure: General galactic rotational law. Oortôs theory of galactic rotation. Determination of Oortôs constants. Spiral structure of our Galaxy from optical and radio Observations. Size and mass of our galaxy.

.Unit -3

Extragalactic Systems:Classification of galaxies and clusters of galaxies. Hubble sequence. Galaxy interactions. Determination of the masses. Determination of extragalactic distances. Active Galaxies: Active galaxies and galactic nuclei. Properties of Radio galaxies and Quasars. Their energy problem and accretion discs. Dark matter in galaxies and clusters of galaxies.

Unit-4

Gravitation & Cosmology: Conceptual foundations of GR and curved spacetime: Principle of equivalence, Connection between gravity and geometry,Form of metric in Newtonian, limit Metric tensor and its properties, Einstein's field equations, observational tests of general relativity. Models of the universe : Steady State Models. Standard Model: The expanding universe, Hubble's law . Microwave background radiation Friedmann-Robertson-Walker models, The early universe, Thermodynamics of the early universe Primordial neutrinos. Elementary ideas on structure formation . Implications of the dark matter in modern cosmology.

References Books :

1. A.Unsold: New Cosmos.
2. Baidyanath Basu: Introduction to Astrophysics.
3. Harold Zirin: Astrophysics of the Sun.
4. Gibson: The Quiet Sun.
5. G.Abell: Exploration of the Universe.
6. K.D. Abhayankar: Astrophysics of the solar system.
7. M.Schwarzschild:Stellar Evolution
8. S.Chandrasekhar:Stellar Structure
9. K.D.Abhyankar:Astrophysics: Stars and Galaxies
10. Menzel,Bhatnagar and Sen:Stellar Interiors.
11. Cox and Guili:Principles of Stellar Interiors - Vol.I and II.
12. Shapiro and Tevkolsky: White Dwarfs, Neutron Stars and Black Holes.
13. R.Bowers and T.Deeming:Astrophysics(John and Barlett.Boston).

SOP/FOS/PHY/E012 : Project work for all specializations

This course will be based on preliminary research oriented topics both in theory and experiment. The teachers who will act as supervisors for the projects will float projects and any one of them will be allocated to the students. At the completion of the project by the semester end, the student will submit Project Report in the form of dissertation which will be examined by the examiners. The examinations shall consist of presentation and comprehensive viva-voce. Marks allotment- **Project and viva of Project-Evaluation by internal + External- -Project =60, Viva=20, (Separately sealed), Internal assessment=20(Separate sealed envelope for internal evaluation)**

SN	Name of student	Roll number	External & Internal Term End Evaluation	
			Project- Max Marks- 60	Viva- Max Marks-20
1.				
2.				

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M.Sc. (Physics) Semester I

Paper Code	Paper	Credits	Total Credits
SOP/FOS/PHY/C001	Classical Mechanics	3	18
SOP/FOS/PHY/C002	Mathematical Physics	3	
SOP/FOS/PHY/C003	Electrodynamics & Astrophysics	3	
SOP/FOS/PHY/C004	Electronics	3	
SOP/FOS/PHY/C005	Laboratory Course I (Practical ï I)	3	
SOP/FOS/PHH/C006	Laboratory Course II (Practical ï II)	3	

M.Sc. (Physics) Semester II

Paper Code	Paper	Credits	Total Credits
SOP/FOS/PHY/C007	Atomic &, Molecular Physics	3	18
SOP/FOS/PHY/C008	Solid State Physics	3	
SOP/FOS/PHY/C009	Statistical Physics	3	
SOP/FOS/PHY/C010	Quantum Mechanics	3	
SOP/FOS/PHY/C011 SOP/FOS/PHY/C012	Laboratory Course I (Practical ï I) Laboratory Course II (Practical ï II)	3 3	

M.Sc. (Physics) Semester III

Paper Code	Paper	Credits	Total Credits
SOP/FOS/PHY/C013	Advanced Quantum Mechanics	3	18
SOP/FOS/PHY/C014	Nuclear Physics	3	
SOP/FOS/PHY/C015	Laboratory Course I (General)	3	
SOP/FOS/PHY/E001	Condensed Matter Physics A	3	
SOP/FOS/PHY/E002	Electronics A	3	
SOP/FOS/PHY/E003	Laser Physics A	3	
SOP/FOS/PHY/E004	High Energy Physics A	3	
SOP/FOS/PHY/E005	Astrophysics A	3	
SOP/FOS/PHY/E006	Laboratory Course II (Circuit Design)	3	

M.Sc. (Physics) Semester IV

Paper Code	Paper	Credits	Total Credits
SOP/FOS/PHY/C016	Computational Physics	3	18
SOP/FOS/PHY/C017	Particle Physics	3	
SOP/FOS/PHY/C018	Lab Course	3	
SOP/FOS/PHY/E007	Condensed Matter Physics B	3	
SOP/FOS/PHY/E008	Electronics B	3	
SOP/FOS/PHY/E009	Laser Physics B	3	
SOP/FOS/PHY/E010	High Energy Physics B	3	
SOP/FOS/PHY/E011	Astrophysics B	3	
SOP/FOS/PHY/E012	Project	3	

SELF STUDY COURSE/PAPERS

Any one of the following, in third or fourth semester, will be conducted and evaluated at Department level

SOP/FOS/PHSS001: QUANTUM ELECTRODYNAMICS

Dirac equations, Properties of Dirac Matrices, Projection Operators, Traces< Feynman's theory of Position.

Second quantization of Klein Gordon field,Creation and annihilation operators, commutation relations, Quantisation of electromagnetic field, Creation and annihilation operators, commutation relation, Fock space representation, interaction fields. Dirac (interaction) picture, S-matrix and ita expansion. Ordering theorems, Feynman graph and Feynman rules. Application to some problems, like Rutherford Scattering and Compton scattering, calculations of cross sections using Feynman graphs.

Reference Books:

1.Bjorken and Drell: Relativistic Quantum Fields

2. Muirhead: The Physics of Elementary Particles

3. Schweber, Bethe and Hoffman: Mesons and Fields

4.Sakurai: Advanced Quantum Mechanics

5.Mandal: Introduction to Field Theory

6. Lee: Particle Physics and Introduction to Field Theory

SOP/FOS/PHSS002: PHYSICS OF LIQUID CRYSTALS

Introduction: States of Matter, Liquid crystals, Symmetry, Structure and order, Mesogenic Molecules, Liquid Crystals of Chiral and Chiral Molecules, Calamitic, disc Shape and Polymer liquid Crystals.

Physical Properties: Order parameters, measurement by magnetic resonance spectroscopy, Optical anisotropy, refractive index, Dielectric anisotropy, Dielectric Permittivity, diamagnetic anisotropy, magnetic susceptibility, Transport Properties, Eleastic Constants, Continum Description.

Statistical Theories of Nematic Order: Landau- de- Gennes, Theory, hard particle, Maier Saupe and Van der Walls type theories.

Nematic-Smectic A Transition: Phenomenological description, McMillan Theory, polymorphism in smectic A Phase.

Ciral Liquid Crystals: Chirality in liquid crystals, Chiral nematic Phase, Optical Properties, field induced nematic Cholesteric Phase Change, Distortion of Structure by magnetic field, Blue Phase, Chiral smectic phases,

origin of ferroelectricity: Structure, symmetry and ferroelectric ordering in Chiral Smectic C Phase, Antiferroelectric and ferroelectric Chiral smectic C Phase.

Application of Liquid Crystals.

Reference Books:

1. Liquid Crystals: S Chandrashekhar
2. 2.The Physics of Liquid Crystals: P G de Gennes and J Prost
3. Liquid Crystals, Fundamentals: S Singh

SOP/FOS/PHSS003: ATMOSPHERIC PHYSICS

Introduction to Atmosphere:

Atmosphere and its composition; Physical and Dynamical processes on layer formation Troposphere, Stratosphere and ionosphere; Vertical variation of temperature, ozone and its spatial and temporal variation; Measurement of ionization density, Ozone Density; Temperature, pressure and wind distribution in the atmosphere and general circulation.

Mathematical and Statistical Methods:

First and second order differential coefficients and their applications to atmosphere variabilities. Autocorrelation theory, Standard statistical distributions (Normal, binomial, gamma, students, t, x2). Application of Auto correlation and auto regressive processes applied to atmospheric variabilities. Error Analysis, Sampling and Test of Hypothesis, Analysis of variance. Interpolation and de extrapolation techniques, Grid point interpolation. Harmonic analysis and Spectral analysis and their use in atmosphere science.

Observational Techniques leading to understanding of the atmosphere:

Working principle, application and circuit description in blocks of the system: Ionospnde, Radiosonde,, Ozone sonde, LIDARS, DIAL, SODARS, AWS, Weather satellites, Doppler Radar, ST Radar and MST Radar

Atmosphere and their role in the wave propagation:

Super and refraction conditions and mm/cm propagation. Rain attenuation of waves in atmosphere, Ionopshere and its role in brief on radio propagation.

Atmospheric Thermodynamics and radiation budget:

Radiative Transfer in the Atmosphere, aerosol scattering (Rayleigh, Mie), Role of aerosol and atmospheric dust in radiation balance; Calculation of radiative heating and Cooling and energy balance. Energy exchange processes through waves and instabilies

Reference Books:

1.H G Houghton: Physical Meteorology

2.J M Vallance and P V Hobbs: Atmospheric Sciences: An Introductory Survey

3.R R Rogers: A Short Course on Cloud Physics

4.J R Holton:An Introduction to Dynamic Meterology

5. S L Hess: Introduction to Theoretical Meterology

6. T Beer: Atmospheric Waves

7.Chapman and Lindzen Riedel: Atmospheric Tides

<u>SOP/FOS/PHSS004: BIO PHYSICS</u>

Introduction to Bio Physics: Molecular Organisation, Different levels, Organization of Proteins- Primary, Secondary, teriary and quaternary structures, Osmosis, Diffusion and Donnan Equilibrium.

Conformational Analysis: Nucleic acids and their organization in living cells; interactions of Nucleic acids.

Methods in BioPhysical Analysis: CD, ORD & Fluorescence Spectroscopy, Raman Spectroscopy,

Separation and Characterization of bio molecules using centrifugal, electrophoretic and chromatographic techniques.

Absorption and Emission Spectroscopy- Principles and applications of visible, UV, IR, AAS, NMR, ESR and MS Spectroscopy.

Characterization of macromolecules using X-ray diffraction analysis.

Use of analytical microscopy in elucidating the structure function relationship in-

Prokaryotes: Electron Microscopy, Phase Contrast and Fluorescence microscopy and scanning tunneling microscopy.

Radio Isotope Techniques: Detection and measurement of radioactivity, Geiser Muller Counters, Scintillation counting, Autoradiography and RIA; Applications of isotopes in biological studies.

Reference Books-

1.David Freifelder: Physical Biochemistry

2.Willard Merrit, Dean and Settle: Instrumental methods of analysis

3.D R Browning: Spectroscopy

4. Wilson and Walker: Principles and Techniques of Practical Biochemistry

5. D A Skoog: Instrumental methods of analysis

SOP/FOS/PHSS005: PHYSICS OF NANO MATERIALS

Nanoparticles: Synthesis and Properties:

Method of Synthesis: R F Plasma Chemical Methods, Thermolysis, Pulsed laser Methods, Biological Methods, Synthesis using micro-organisms, Synthesis using Plant extract, Metal Nanoclusters, Magic Numbers, modeling of Nano Particles, Bulk of Nano Transitions.

Carbon Nano Structures:

Nature of Carbon Clusters, Discovery of C60, Structure of C60 and its crystal, Superconductivity in C60, **Carbon Nano Tubes:** Synthesis, structure, Electrical and Mechanical Properties. **Graphene**: Discovery, Synthesis and Structural Characterization through TEM, Elementary concept of its applications.

Quantum Wells, Wires and Dots:

Preparation of Quantum Nano Structures, Size Effects, Conduction Electrons and Dimensionality, Properties Dependent on Density of States.

Analysis Techniques for Nano Structures/Particles:

Scanning Probe Microscopes(SPM), Diffraction Techniques, Spectroscopic Techniques, Magnetic Measurements.

Bulk Nano Structure Materials:

Methods of Synthesis, Solid Disorders Nano Structures, Mechanical Properties, Nano Structure Multilayers, Metal Nano Cluster, Composite Glases, Porous Silicon.

Reference Books:

1. Introduction to Nano Technology: Poole and Owners
2. Quantum Dots: Jacak, Hawrylak and Wojs
3. Handbook of Nano Structureed Materials and Nano Technology: Nalva(Editor)
4. Nano Technology/ Principles and Practices: S K Kulkarni
5. Carbon Nano Tubes: Silvana Fiorito
6. Nano Technology: Richard Booker and Earl Boysen

SOP/FOS/PHSS006: ENVIRONMENTAL PHYSICS

Essentials of Environmental Physics: Structure and thermodynamics of the atmosphere. Composition of air, Green House Effect, Tramnsport of Matter, Energy and momentum in Nature. Stratification and stability of atmosphere.Laws of motion, hydrostatic equilibrium.

Solar and Terrestrial: Physics of Radiation, Interaction of light with matter,Rayleigh and Mie scattering, laws of radiation(Kirchoff’s law, Plank’s law, Wein’s displacement law etc.) , solar and terrestrial spectra, UV radiation. Ozone depletion problem, I R absorption.

Environmental Pollution and Degradation: Elementry fluid dynamics, Diffusion, Turbulence and turbulent diffusion, Factors Governing air, water and noise Pollution, Air and water quality standards. Waste Disposal. Gaseous and particulate matters, wet and dry deposition.

Environmental Changes and Remote Sensing: Energy sources and combustion processes. Renewable Sources of energy: Solar energy, wind energy, bioenergy, hydropower, fuel cells, Nuclear energy.

Global and regional Climate: Elements of whether and climate. Stability and vertical motion of air, Horizontal motion of air and water, Pressure gradient forces, viscous forces.

Inertia forces, Reynolds number, enhanced Greenhouse effect, Global Climate Models.

Referene Books:

1. Egbert Boeker & Rienk Van Groundelle : Enviromental Physics (john wiley)
2. J.T. Hougtion : The Physics of Atmosphere (Cambridge Univ.Press. 1977)
3. J. Twidell and J.Weir : Renewable Energy Resources (Elbs, 1988)
4. Sol Wieder : An Introduction to Solar Energy for Scientists and Engineers (John Wiley,1982
5. R.N. Keshavsamurthy and M.Shankar Rao : The Physics of Monsoons(Allied Publuishers,1992)
6. J. Haltiner and R.T. Williams : Numerical Weather Prediction (John Wiley, 1980)

SOP/FOS/PHSS007: PLASMA PHYSICS

Plasma Physics : Elementary concepts, plasma oscillations, Debye shielding, Plasma Parameters, Magneto Plasma, Plasma Confinement, First , Second and Third Adiabatic Invariants(Pinch effect, Magnetic Mirrors), Formation of Van Allen Belt.

HydrDynamical Description of Plasma:

Fundamental Equations, Hydromagnetic Waves, Magnetosonic and Alfven Waves, Magnetoconvection and sun spots, Bipolar magnetic regions and magnetic Buoyancy, Magnetised winds (Solar Wind).

Wave Phenomena in Magnetoplasma:

Polarisation, Phase velocity, Group velocity, cut offs, resonance for Electromagnetic Wave Propagating Parallel and Perpendicular to the Magnetic Field, Propagation at Finite angle.

Reference Books:

1- W.K.H. Panofsky and M. Phillips : Classical Electricity and Magnetism.
2- A Bittencourt : Plasma Physics
3- F.F. chen : Palsma Physics and Controlled fusion
4- J.D.Jackson : Classical Electrodynamics