Sridev Suman University

Details of PG courses & Syllabus (Physics)
(M. Sc. Two year course, Semester system)

Marks Distribution

Theory : External =80, Internal assessment =20 (80+20= 100) each paper
Practical: (80+ 20=100) each semester, 80 marks Practical + 20 Internal

M Sc I Year

Semester I:

Paper I: Classical Mechanics
Paper II: Mathematical Physics
Paper III: Astrophysics
Paper IV: Electrodynamics
Lab Course: Practical

Semester II:

Paper I: Atomic and Molecular Physics
Paper II: Solid State Physics
Paper III: Statistical Mechanics
Paper IV: Quantum Mechanics
Lab Course: Practical

M Sc II Year

Semester III:

Paper I: Advanced Quantum mechanics
Paper II: Nuclear Physics
Paper III: Particle Physics
Paper IV: Elective: (any one of the followings)
i. Condensed Matter Physics -A
ii. Electronics - A
Lab Course: Practical

Semester IV:

Paper I: Computational Physics
Paper II: Environmental Physics
Paper III: Laser and Fiber Optics
Paper IV: Elective: (any one of the following)
i. Condensed Matter Physics –B
ii. Electronics –B

Lab Course: Practical/ Dissertation (or Project)

M. Sc. I Semester

CLASSICAL MECHANICS

Lagrangian formulation and Variational Principle: Mechanics of particles and system of particles, conversion law, constraints, degree of freedom, generalized coordinates, D'Alembert's Principle, Lagrange's equations of motion from D'Alembert's principle, application of Lagrange's equation of motion to a particle and system of particles, conservation theorem, Hamilton's Variational principle, Euler- Lagrange's differential equation.

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

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 Poission's Bracket form, Jacobian's form.

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

Reference Books :

1. N C Rama and P S Joag: Classical Mechanics (Tata McGrawHil, 1991)
2. H Goldstein: Classical Mechanics (Addition Wesley, 1980)
3. A Sommerfield: Mechanics (Academic Press, 1952)
4. I Peiceivel and D Richards: Introduction to Dynamics (Cambridge University Press)

MATHEMATICAL PHYSICS

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

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, Schur's Lemmas and orthogonality theorem, Characters of representaions.

Complex Variable: Function of complex variable, Analytic functions, Cauchy's integral theorem and Cauchy's integral formula , Taylor and Laurent's expressions, theorem of residues, Contour intergration.

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)
5. Mathematical Physics: Satya Prakash, Pragati Prakashan, Meerut
6. Mathematical Physics: Dass and Verma, S Chand & company
7. Mathematical physics: B S Rajput

ASTROPHYSICS

The universe and Solar System: Basic idea of universe and galaxies, Astronomical telescopes. The solar system. Classification of the Planets, Orbits, Laws of planetary motion. Physical features, surface features, Internal Structure, Atmosphere. Satellites and Rings. Asteroids, Meteors and Meteorites their types. Orbits: physical nature and composition. Origin of the minor planets, Observation of meteor showers and sporadic meteors. Meteorite craters. Origin of Comets, Periodic comets, Physical nature, Spectra, Brightness variation, Gas production rates, dust and ion tails.

Stellar System: Sun As a Star. History of Sun, Sun's interior, the photosphere, the solar atmosphere (chromosphere & corona). Salient features of sunspots, sun's 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 magnitudes 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.

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. Bottlinger's 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.

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.

Reference Books:

1. Principles of Stellar Dynamics, S.Chandrasekhar
2. The Great Universe, G K Sudarshan. S chand Publications.
3. Our Solar System, Joshi and Rana, New Age Publicatiopns
4. Galaxies and Universe , K.C.Freeman:
5 The Origin and Evolution of Galaxies , S.D.M.White:
6. Lecture notes on "Dynamics of Stellar Systems", S.M.Alladin:
7. Stars and Galaxies: K.D.Abhyankar (Tata McGraw Hill Publication)
8. Exploration of the Universe: G.Abell
9. The Structure of Universe:Jayant Naralikar
10.Physics of Comets: K.S. Krishnaswamy
11. Our solar system: A.W. Joshi & N. Rana
12.Introduction to Astrophysics: Baidyanath Basu
13.Astrophysics of the Sun:Harold Zirin
14. The Quiet Sun: Gibson
15. Stellar Evolution: M. Schwarzschild
16. S.Chandrasekhar:Stellar Structure: S. Chandrasekhar
17.Principles of Stellar Interiors - Vol.I and II: Cox and Guili
18. White Dwarfs, Neutron Stars and Black Holes:Shapiro and Tevkolsky

ELECTRODYNAMICS

Maxwell's equations and Electromagnetic Wave: Equation of Continuity, Displacement current, Maxwell's equations, Poynting theorem, Electromagnetic Wave equation, Propagation of Plane Electromagnetic Wave in free space, conducting and non-conducting medium and ionised gases.

Interaction of Electromagnetic Waves with Matter: Boundary Conditions for the Electromagnetic field vectors, Reflection and Refraction at the boundary of two conducting and non-conducting media, Propagation of Electromagnetic wave between parallel con2ucting plates, Basic concept of Wave Guides, Scattering by a free and bound electron

Electromagnetic Radiation: Electromagnetic vector and scalar potential, Lorentz and Coulomb Gauge, Lienard-Wichert potential, Electric and magnetic fields of a charge in uniform motion and concept of virtual photon, Radiation from an Accelerated Charge, Larmor's formula and its relativistic Generalization, Bremstrahlung, Cerenkov radiation.

Relativistic Electrodynamics: Minkowski space, Four vectors, Lorentz transformation of space and time in four-vector form, Transformation of electromagnetic potential, Invariance of Maxwell's field equations in terms of four-vectors, Electromagnetic field tensor, Maxwell's equations in covariance four tensor form, Lorentz force, Invariants of the electromagnetic field.

Reference Books :

1. Electrodynamics –D.J. Griffiths
2. Classical Electrodynamics – J.D.Jackson, Wiley Eastern, New Delhi
3. Classical theory of fields – Landau and Lifshitz, Pergameon Press
4. Elecrodynamic wave and fields, R N Singh
5. Classical Electricity and Magnetism- Panofsky and Phillips
6. Electrodynamics of Continuous Media - Landau &Lifshitz
7. Electromagnetic Theory and Electrodynamics – SatyaPrakash

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's Oscillator
14. Study of Wien Bridge oscillator
15. Design and study of different Network theorems
16. Study of Hubble's law (from given data)
17. Study of constant density neutron star
18. Study of the static parameters of a Neutron Star model with inverse square density distribution
19. Study of star cluster from a given data
20. Study of Extinction coefficients
21. Study of variability of stars

M.Sc. II Semester
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, Hunde's rule Spectra of two valence electron atoms, (Helium, Magnesium), selection rules for atomic transitions, multielectron spectra, Central field approximation Hartreeself consistent field theory, Thomas Fermi statistical model, Pauli's 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.

Lasers: Einstein's quantum theory of radiation, Life time, Theory of some simple optical processes, Kinetics of optical absorption, Stimulated emission, laser pumping, three and four level scheme, Threshold condition, different types of lasers, gas lasers: He-Ne, N_2 and CO_2 , dye lasers, solid state lasers, semiconductor lasers, Holography and its applications.

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 – Arul Das.
6. Elements opf spectroscopy, Gupta, Kumar & Sharma, Pragati Prakasan, Meerut
7. Laser and applications : Thyagrajan & Ghatak

SOLID STATE PHYSICS

Crystal Binding and Elastic Constants: Ionic Crystal, Covalent Crystal, Metals, Hydrogen bonds, analysis of elastic springs, elastic stress and strain, work done by elastic forces, elastic energy density, stress –strain relations, elastic compliance and stiffness constants, Reduction in number of elastic constants in cubic systems, Elastic waves and velocity in cubic crystals, Experimental determination of elastic constants,

Diffraction and Reciprocal lattice: Diffraction waves by crystals, Braggs diffraction of X-rays, , Different experimental methods, diffraction of electron and neutron, Inelastic neutron scattering, The atomic scattering factor, Atomic form factor, Structure factor for sc, fcc and bcc lattice, Scattered wave amplitude, Laue equations, Brillouin Zones, Bragg's diffraction condition in reciprocal space.

Phonons and Lattice Vibrations : Quantization of elastic waves, Normal modes of vibration, Concept of phonon, Phonon momentum, Inelastic scattering of photons by phonons, Vibrations of one dimensional monatomic lattice, First Brillouin Zone, Group Velocity, Long wavelength limit, Vibrations of one dimensional diatomic lattice, Infrared absorption and optical properties.

Thermal Properties of Solids: Specific heat of solids, Einstein Model of lattice specific heat, Debye theory of lattice specific heat, Debye approximation, Thermal expansion, lattice thermal conductivity, Electronic heat conduction.

Reference Books:

1. Introduction of Solid State Physics, C Kittel
2. Solid State Physics, Ashcroft & Mermin
3. Solid State Physics- Ajay Kumar Saxena
4. Solid State Physics, A J Dekker;
5. Solid State Physics, S O Pillai
6. Introduction to Solid State Physics, Peterson
7. Solid State Physics, Singhal
8. Solid State Physics, R Asokamani

STATISTICAL PHYSICS

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.

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.

Quantum Statistics: Drawbacks of M B distribution, Bose-Einstein's 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.

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

QUANTUM MECHANICS

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.Schroedinger equation in spherically polar coordinates. Free particle in spherical coordinates. Applications: three dimensional squares well potential. three dimensional harmonic oscillator

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.

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.

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

Recommended Books:

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).

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

1. Multivibrator Bistable/Monostable/Astable
2. Study of different types of Oscillators
3. Ionisatin potential of Mercury using gas filled diodes
4. Michelson Interfermeter
5. Fabry Pert Interferometer
6. Fresnals law
7. Determination of absorption coeficient of iodine vapour
8. B-H curve
9. Lecher wire experiment
10. Determination of magnetic susceptibility
11. Study of CRO.
12. Velocity of Ultrasonic waves
13. Linear Air track
14. Determination of Planks constant
15. Wein's and Stefan's law

M.Sc. III Semester

ADVANCED QUANTUM MECHANICS

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. Born approximation

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.

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 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.

Quantization of wave fields: The quantization of wave fields, Classical and quantum field equations quantization of non-relativistic Schrodinger equation. Second quantization of Schroedinger field. K-G field and Dirac fields, quantization of electromagnetic fields, creation and annihilation operators.

Reference Books:

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).

NUCLEAR PHYSICS

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

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.

Radioactive decay: Radioactive decay equation equilibrium units,Gamow's theory of alpha decay and Geiger Nuttal law, Fermi's theory of beta decay, parity violation in beta decay, electromagnetic decays.

Nuclear Reactions- Q-value of nuclear reaction, Bohr's 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- E. Segre : Nuclei & Particles.
6- B.R. Martin : Nuclear & Particle Physics.
7- B.L. Cohen : Concepts of Nuclear Physics.
8- S.S.M. Wong : Introductory Nuclear Physics
9- S.B. Patel : Nuclear Physics
10- S.N. Ghoshal : Nuclear Physics.

PARTICLE PHYSICS

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.

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.

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.

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.

Reference Books:

1. Introduction to High Energy Physics-D.H.Perkins. (Addision – Wesley-1986)
2. Introduction to Nuclear & Particle Physics.Mittal, Verma &.Gupta (Prentice Hall of India, Pvt.Ltd., New Delhi.
3. Concepts of Modern Physics- Arthur Beiser (Tata McGraw Hill Edu.Pvt Ltd., New Delhi, Sixth Ed. 2009
4. Quarks and Leptons- An Introductory course in Modern Particle Physics-Francis Halzen & A D.Martin ,John Wiley & Cons.Inc.
5. Nuclear and Particle Physics, W.E..Burcham& M. Jobes (Essex,England ISE Reprint
6. Introduction to Particle Physics-M.P. Khanna, (Prentice Hall India)
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. Shawi 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

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

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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- E. Segre : Nuclei & Particles.
6- B.R. Martin : Nuclear & Particle Physics.
7- B.L. Cohen : Concepts of Nuclear Physics.
8- S.S.M. Wong : Introductory Nuclear Physics
9- S.B. Patel : Nuclear Physics
10- S.N. Ghoshal : Nuclear Physics.

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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.

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Reference Books:

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2. Introduction to Nuclear & Particle Physics.Mittal, Verma &.Gupta (Prentice Hall of India, Pvt.Ltd., New Delhi.
3. Concepts of Modern Physics- Arthur Beiser (Tata McGraw Hill Edu.Pvt Ltd., New Delhi, Sixth Ed. 2009
4. Quarks and Leptons- An Introductory course in Modern Particle Physics-Francis Halzen & A D.Martin ,John Wiley & Cons.Inc.
5. Nuclear and Particle Physics, W.E..Burcham& M. Jobes (Essex,England ISE Reprint
6. Introduction to Particle Physics-M.P. Khanna, (Prentice Hall India)
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. Shawi 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)
13. Modern Elementary Particle Physics G. L. Kane (Addison- Wesley 1987)
14. Grand Unified theories, Graham Ross.
15. Gauge Theories of Strong, Weak and Electromagnetic Interactions, C. Quigg (Addison – Wesley)
16. Gauge Theory of Elementary Particle Physics , T.D. Cheng and Ling Fong Li (Clarendon Oxford)

Elective I :-CONDENSED MATTER PHYSICS- A

Defects in crystals: Point defects, 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.

Magnetism: Magnetic materials and their importance in solid state physics, Dia, Para and ferromagnetism, Langvin"s theory of paramagnetism, Ferromagnitiam, Weiss molecular theory, quantum theory of ferromagnetism, Bloch wall, Temperature dependence of spontaneous magnetism, Ferromagnetic domains, Antiferromagnitism, Neel"s theory, Two sublattice model, ferrites.

Energy Bands: Origin of energy gap, Magnitude of the energy gap, Brillouin Zone, Bloch function, Bloch theorem, velocity of electrons, Kronig penny model, Number of possible wave function in a band, crystal momentum, the concept of effective mass, concept of holes, hole band construction, distinction between metal, insulator and semiconductor, experimental evidence of band theory.

Dielectric and electrical properties of insulators: Polar and non polar dielectrics, Polarization, Internal Lorentz field static dielectric constant, measurement of dielectric constant, Macroscopic description of dielectric constants, electronic ionic and orientational polarizability of molecules, Complex dielectric constant, Dielectric loss and relaxation time, Optical absorption, Piezoelectric effect,.and its applications, piezoelectric crystals and uses, ferroelectricity, antiferroelectricity, uses of ferroelectric materials

Reference Books:

1. Introduction to solid state Physics: Kittel
2. Principles of theory of solids: Ziman
3. Quantum theory of solids: J. Callaway
4. Solid State Physics: A.J. Dekker
5. Intermediate Quantum theory of crystalline solids:Animalu
6. Solid State Physics: N W Ashcroft and N David Mermin
7. Solid State Physics: Ajay Kumar Saxena
8. Solid State Physics: Aschroft and Mermin
9. Solid State Physics: Saxena Gupta Saxena
10. Solid State Physics: R.L. Singhal
11. Solid state physics: S O Pillai

Elective-II: Eletronics A

Transistor Oscillators and Multivibrators: Tuned collector oscillator, tuned emmiter oscillator, tuned based oscillator, Hartly, phase shift, Colpit's, Clapp, Wein bridge, RC and crystal oscillator, frequency stability, Switcing charactristics of transistor, Astable, Mono and Bistable multivibrators, Schmitt trigger-bootstrap-sweep circuits.

Combinational digital circuits: Implementations of Logic Functions using gates, RTL, DTL, TTL, ECL MOS 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

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

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 – PROM, EPROM, EEPROM, EAPROM ,Programmable Logic Devices, Programmable Logic Array (PLA), Programmable Array Logic (PAL).Basic Ideas of IC-Technology, Monolithic IC's, IC Components- Resistors (Integrated, Diffused, Thin Film), MOS Capacitors, Inductors, Bipolar Transistors, Thin Film Technology, LSI, MSI.

Reference Books:

1. Integrated Electronics ,Millman & Halkias , (McGraw Hill)
2. Electronic devices and circuit theory, Bolested
3. Electronics-fundamentals and applications, Ryder, (PHI)
4. Optical fibre communications Keiser, (McGraw Hill)
5. Nonlinear fibre optics, Agarwal ,(AP)
6. Digital Principles and Applications , Malvino& Leach:
7. Digital Design , Morris Mano
8. Digital Fundamentals, Thomas L. Floyd;
9. Hand Book of Electronics, Gupta Kumar, Pragati prakashan
10. Digital electronics: Principle and Practice, Avinashi Kapoor and Maheshwari, Macmillon Publications

List of experiments: At least 10 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 Comparator
7. Study of different flip- flop circuits (RS, JK, D 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. Shift Registers

13. e/m by Zeeman effect
14. G.M. Counter
15. Study of IC - Based Power supply
16. Absorption spectroscopy by spectrophotometer
17. Study of optoelectronic devices
18. Measurement of thickness of thin wire using laser
19. Logicom AND/OR/NAND/NOR/NOT gates
20. Study of pin connection and biasing of various linear IC's and timers 555

M.Sc. IV Semester

COMPUTATIONAL PHYSICS

Interpolation: Roots of functions, Finite differnces, Interpolation with equal and intervals, Central difference Interpolation. Inverse interpolation, Numerical differentiation , Numerical integration, integration by trapezoidal and Simpson's rules. Least square fitting method: Straight line, fitting, fitting of parabola, exponential function

Solution of ordinary differential equations and linear equations: Tylor's series, Eulers method, Runge-Kutta Method. Eigenvalues and eigenvectors of matrices, power and Jacobi method, solution of simultaneous linear equations Gaussian elimination, Pivoting, Iterative method, matrix inversion.

Fortran Programming : Flowchart and algorithm, Problem analysis, flowchart of some basic problems. Fundamentals of Fortran 90/95, constant and variables , input/output statements, conditional statements, loops and control, constructs, arithmetic and logical operators and expressions, Format statements, Strings, arrays, pointers, control constructs, Functions, sub programs and modules.

Solutions of physics problems using Fortran Programming : Sum of finite Sin, Cos, Log and exponential series, Integration by Simpson 1/3, 3/8th and Trapezoidal rules, Matrix product and transpose, Roots of Quadratic equation, Projectile motion, Equation of motion, Motion in central field, Solutions of linear equations, Least square fitting of straight line and parabola.

Reference Books:

1.B.D.Hahn: Fortran 90 for Scientists and engineers.
2.VRajaraman: Computer Programming in c.
3. Computer Oriented numerical methods V Rajaraman:
4.Wong: Computational methods in Physics and engineering.
5.S.BalachandraRao: Numerical Methods.
6. Computer programming in Fortran 90/95, V Rajaraman, PHI
7.Numerical Analysis by G Shankar Rao, New Age International

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: Elementary 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. Energy sources and combustion processes.

Environmental Changes, Remote Sensing Global and regional Climate: Renewable Sources of energy. Solar energy, wind energy, bioenergy, hydropower, fuel cells. Nuclear energy.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.

Reference 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 (Ellis, 1988)
4. Sol Wieder : An Introduction to Solar Energy for Scientists and Engineers (John Wiley,1982
5. R.N. Keshavsamurthy and M.ShankarRao : The Physics of Monsoons(Allied Publuishers,1992)
6. J. Haltiner and R.T. Williams : Numerical Weather Prediction (John Wiley, 1980)

LASER PHYSICS

Basic principles: Basic principles and theory of absorption and emission of radiation. Einstein's 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.

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.

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

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

Elective-I: CONDENSED MATTWER PHYSICS- B

Free electron and Nearly free electron Theory: Nearly free electron model, One dimensional free electron case, Sommerfiel model., Fermi-Dirac distribution, Quantum theory of free electron in a box, Fermi gas, 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.

Transport Properties of Solids and ordered phase: Boltzmann transport equation, Mean free path, Hall effect, Hall voltage and coefficient, experimental determination of hall coefficient, resistivity of metals and semiconductors, thermoelectric phenomena, Onsager coefficients. Ordered phases of matter, translational and orientational order, kinds of liquid crystalline order, Quasi crystals.

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.

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)

Reference books

1. Principle of condensed matter Physics : Chaikimand Lubensky
2. Solid State Physics : Kubo and Ngumia
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
9. Introduction to Nano Technology: Poole and Owners
10. Quantum Dots: Jacak, Hawrylak and Wojs
11. Handbook of Nano Structureed Materials and Nano Technology: Nalva(Editor)
12. Nano Technology/ Principles and Practices: S K Kulkarni
13. Carbon Nano Tubes: SilvanaFiorito
14. Nano Technology: Richard Booker and Earl Boysen

Elective-II: ELECTRONICS - B

Modulation and Demodulation: AM and FM (Transmission and reception): Modulation, AM generation, Power consideration, Balanced modulator, SSB transmission AM detection, AGC, Signal to noise ratio, FM analysis, noise considerations, generation, direct method and reactance tube method, FM transmitter, AFC, FM Propagation, phase discriminator. Envelope diode detector, super regenerative detection, Ratio Detector

Propagation of radio waves and Radar system: Ground wave, sky wave and space wave propagation, Ionosphere (Eccle- larmer theory, magneto ionic theory), Appleton-Hartee theory of skywave propagation. 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.

Transmission Lines: TL Equations and their solutions, transmission line as a two conductor system, transit time effect, calculation of line parameters, voltage and current relation on radio frequency transmission line, propagation constant and its physical significance, line distortion and attenuation, characteristic impedance, 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: 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, dish antenna, Parabolic reflectors, Lens Antenna. Satellite communication.

Reference Books :

1. F.E. Terman – Radio Engineering
2. G. Kennedy & B. Davis – Electronic Communication Systems
3. G.K. Mithal – Radio Engineering Vol. II
4. G. Keiser - Optical Fiber Communication
5. C.K. Sirkar& S.K. Sirkar, Fiber optical Communication Systems.
6. Gupta & Kumar – Handbook of Electronics
7. Frenzel - Communication Electronics
8. Rody&Coolen - Communication Electronics.
9. L.E. Frenzel – Communication Electronics

List of experiments/Dissertation:

1. Study of computational software's.
2. Study of numerical techniques.
3. Computer programming.
4. Study of Modulation and Demodulation (Amplitude & Frequency).
5. Study of operational amplifier
6. Dielectric constant
7. Measurement of wavelength of He-Ne laser using interference and diffraction pattern
8. Fiber Optics communication.

Note: Either student should perform the experiments or complete the dissertation.