Akkamahadevi Women's University
Vijayapura

Department of Physics

M.Sc. Physics

Choice Based Credit System (CBCS)
Syllabus

With effect from
2018-2019

Akkamahadevi Women's University, Vijayapur
M.Sc. Physics Choice Based Credit System (CBCS) Syllabus

Course code	Course name	Credits L:T:P	Instruction Hrs./week	Duration of Exam Hrs	Marks		
					IA	Exam	Total
Semester I							
PHT-1.1	Classical Mechanics	4:0:0	4	3	30	70	100
PHT-1.2	Mathematical and Computational Methods of Physics-I	4:0:0	4	3	30	70	100
PHT-1.3	Atomic, Molecular and Optical Physics (General)	4:0:0	4	3	30	70	100
PHT-1.4	Basic Electronics	4:0:0	4	3	30	70	100
PST-1.5	(Any one to be selected) a) Instrumentation b) Astrophysics	4:0:0	4	3	30	70	100
PHP- 1.6	Practical I- General Physics and Basic Electronics Lab	0:0:4	4	4	30	70	100
O.E -1.7	Offered by Dept. of Women's Studies	4:0:0	4	3	30	70	100
	Total	**28**					**700**
Semester II							
PHT-2.1	Quantum Mechanics - I	4:0:0	4	3	30	70	100
PHT-2.2	Mathematical and Computational Methods of Physics-II	4:0:0	4	3	30	70	100
PHT-2.3	Nuclear Physics (General)	4:0:0	4	3	30	70	100
PHT-2.4	Condensed Matter Physics (General)	4:0:0	4	3	30	70	100
PST-2.5	(Any one to be selected) a) Physics of Nanomaterials b) Physics of Laser and Laser Applications	4:0:0	4	3	30	70	100
PHP-2.6	Practical II- General Physics and Numerical Methods using C Programming Lab	0:0:4	4	4	30	70	100
OE-2.7	Offered by dept. of Women's Studies	4:0:0	4	3	30	70	100
	Total	**28**					**700**
Semester III							
PHT-3.1	Quantum Mechanics -II	4:0:0	4	3	30	70	100
PHT-3.2	Statistical Mechanics	4:0:0	4	3	30	70	100
PHT-3.3	Electrodynamics	4:0:0	4	3	30	70	100

PST-3.4	(Any one to be selected) a) Nuclear Physics – I (Special) b) Condensed Matter Physics – I (Special)	4:0:0	4	4	30		
PSP-3.5	Practical III- a) General Physics Lab (Any one of the following to be selected based on PST- 3.4 a / b) b) Nuclear Physics Lab (Special) c) Condensed Matter Physics Lab (Special)	0:0:4	4	3	30	70	100
POE-3.6	Biophysics	4:0:0	4	3	30	70	100
	Total	**24**					**600**
Semester IV							
PHT-4.1	(Any one to be selected based on PST- 3.4 a / b) a) Nuclear Physics – II (Special) b) Condensed Matter Physics – II (Special)	4:0:0	04	3	30	70	100
PHT-4.2	(Any one to be selected based on PHT- 4.1 a / b) a) Nuclear Physics – III (Special) b) Condensed Matter Physics – III (Special)	4:0:0	04	3	30	70	100
PST-4.3	(Any one to be selected) a) Material Science b) Advanced Statistical Mechanics and Phase Transition	4:0:0			30	70	100
PHP-4.4	Project Work	0:0:4	04	3	30	70	100
POE-4.5	Atmospheric Science	4:0:0	04	3	30	70	100
	Total	**20**					**500**
	Programme Total						**2500**

L- Lecture, T- Tutorial, P- Practical.
PHT- Physics Hard Core Theory, PST- Physics Soft Core Theory, OE- Open Elective, PHP- Physics Hard Core Practical, POE- Physics Open Elective course offered to students of other department.
*The project evaluation marks 100 are a total of 50 marks for dissertation, 20 marks for presentation and viva voce and 30 marks for internal assessment.

PHT-1.1: Classical Mechanics

UNIT I **13 Hours**

Review of Newtonian mechanics: Laws of Motion, Conservation of linear momentum, energy and angular momentum, Mechanics of single particle and system of particles.

Lagrangian Formulation :

Constraints in motion. Generalized co-ordinates, Virtual work and D' Alembert's principle, Lagrangian equation of motion, Symmetry and conservation laws and cyclic co-ordinates. Hamilton variational principle, Lagrangian equations of motion from variational principle, Simple applications.

UNIT II **13 Hours**

Motion in Central Force Field:

General Properties of Central Force Motion, Motion in central force field, Equation of motion for the orbits, Keplers laws (inverse equations of force field) scattering in a central force field. Scattering cross section, the Rutherford scattering problem.

UNIT III **13 Hours**

Motion of Rigid bodies:

Fixed and moving coordinate systems, Euler theorem and angle, Angular momentum and kinetic energy of rigid body. Inertia tensor Eulers equation of motion, Torque free motion, Equation of motion of symmetric top, Heavy Symmetric top with one point fixed.

UNIT IV **13 Hours**

Hamiltonian Formalism:

Hamilton's equations of motion- from Legendre transformations and the variational principle, Simple applications, Canonical transformations, Poisson brackets- canonical equations of motion in possion bracket notation, Hamilton- Jacobi Equations.

References:

1. Classical mechanics: H Goldstein, 3rd edition, Pearson Education Inc. 2002.
2. Introduction to classical mechanics : RG Takawale and PS Puranik, Tata McGraw Hill 1979.
3. Classical mechanics: NC Ran and PS Joag, Tata McGraw 1991.
4. Mechanics: Landai LD and lifshitz EM, Addition Wesley, 1960.
5. Classical mechanics KN Srinivasa Rao, University Press, 2003.
6. Classical Mechanics :J.C.Upadhyaya, Himalaya Publishing House

PHT-1.2: Mathematical and Computational Methods of Physics-I

Unit-I **13 Hours**

Matrices: Orthogonal, Hermitian and unitary matrices, Eigen vectors and Eigen values, diagonalisation of matrices.

Vector Analysis: Review of vector algebra, gradient of scalar field, line integral, surface integral and volume integral, divergence of a vector function, curl of vector field, Gauss divergence theorem, Stoke's theorem.

Tensors: Coordinate transformation in linear spaces, definition and types of tensors, covariant and contravariant tensors, symmetric and antisymmetric tensors. Tensor algebra, equality, addition and subtraction, tensor multiplication, outer product contraction of indices and inner product quotient theorem kronecker delta tensor, christoffeld symbols. Tensors in physics.

Unit-II **13 Hours**

Differential Equations: Linear Ordinary Differential Equations of first and second order, Green's function, Partial differential equations (Laplace, Wave and heat equations in two and three dimensions),Boundary value problems.

Unit-III **13 Hours**

Special functions:

Legendre functions: Legendre polynomials, rodrigue's formula generating function and recurssion relations, orthogonality and normalization, associated legendre function spherical harmonics.

Bessel functions: Bessel functions of the first kind representation relations orthogonality.

Hermite functions: Hermite polynomials, generating five recursion relations, orthogonality

Laguerre functions: Laguerre and associated laguerre polynomials, recursion relations, orthogonality

Applications of special functions to problems in physics.

Unit-IV **13 Hours**

Integral transforms: Review of Fourier series, generalized Fourier series, explanation of functions in Fourier series, Fourier integrals, sine and cosine transformations, convolution theorem, Parsevel's theorem & applications, Laplace transforms and their properties, inverse Laplace transforms, solution of differential equation using Laplace transformations.

References:

1. Matrices and tensors in physics, AW Joshi, 3rd edition, New Age international (P) ltd, 2000.
2. Introduction to mathematical physics, Charlie Harper, Prentice Hall of India, New Delhi 1995
3. Mathematical Physics, DK Chatopadhyay, Wiley Eastern Ltd, 1990
4. Mathematical Methods for Physicist, George Arfken and Hans J Weber, Academic press San Diego, 1995.

PHT-1.3: Atomic, Molecular and Optical Physics (General)

Unit – I

One Electron System: **4 Hours**

Quantum states of one electron atoms, atomic orbitals hydrogen spectrum. Spectra of alkali elements, spin-orbit interaction. (Ref 1,6,7)

Two electron system: **9 Hours**

LS- coupling equivalent and non-equivalent electrons, spectral terms, Pauli exclusive principle, coupling schemes for two electrons, interaction energies for LS coupling, fine structures splitting for s p electron configuration. lande interval rule. jj-coupling spectral terms, interaction energies for jj coupling fine structure splitting for sp electron configuration. Qualitative consideration of selection and intensity rules for LS and jj coupling hyperfine structure for one and two electrons and Lande interval rule. (Ref 1,6,7)

Unit – II

Weak magnetic field effects: **6 Hours**

Normal and anamolous zeeman effect- magnetic moment of bound electron and lande g-factor, magnetic interaction energy, selection rules, zeeman pattern for principlal series doublet, intensity rules. Zeeman effect for two electrons magnetic moment of the atom and g-factors. Expression for magnetic interaction energy, selection rules, zeeman pattern transistions for diffuse series singlet, intensity rules. (Ref 1,6,7)

Strong magnetic field and electric field effects: **7 Hours**

Paschen back effect- express for total energy shift, transistions for principal series doublet qualitative treatment of paschen – back effect and complete paschen back effect for two electrons. Isotope structure. Stark effect- first and second order Stark effects in hydrogen width of spectral lines qualitative.

Unit – III

Microwave and infra red spectra: **13 Hours**

Types of molecules- linear symmetric top, asymmetric top and spherical top molecules. Theory rotational spectra for rigid and non rigid rotator diatomic molecules, energy levels, intensity of rotational lines. Microwave spectrometer and applications.

Vibrational energy of diatomic molecule as simple harmonic and anharmonic oscillators, morse potential energy curve, energy levels and vibrational spectra. Diatomic molecule as a vibrating-rotator, vibration rotation spectra- PQR branches. IR spectrometer and applications. (Ref 2-7)

Unit – IV

UV- visible spectra: **13 Hours**

Electronic spectra of diatomic molecules, Born Oppenheimer approximation, vibrational coarse structure- band progressions and sequences, Frank Condon principle-intensity of vibrational electronic spectra, dissociation energy and dissociation products. Rotational fine structure of electronic vibration transitions, determination of vibrational and rotational constants.

Molecular orbital. Classification of electronic states and multiplet structure selection rules for electronic transitions and simple electronic transitions. UV visible absorption and flurescence spectrophotometers and applications. (Ref 2-7)

References:

1. Introduction to atmic spectra : HE White, MCGraw hill.

2. Fundamentals of molecular spectroscope: CN Banwell and EM Mc Cash ,Tata McGraw Hill 1999, 4th Edn.
3. Molecular spectra and molecular structure Vol I Spectra of Diatomic Molecules G Herberg Von Nostand.
4. Spectroscopy Vols 1, 2 and 3 BP Straughan and S Walkar, Chapman and Hall.
5. Introduction to Molecular Spectroscopy GM Barrow, Mc Graw Hill.
6. Physics of atoms and molecules BH Brandson and CJ Joachain, Longman 1983.
7. Spectra of atoms and molecules, PF Bernath, Oxford University Press 1995.

PHT-1.4: Basic Electronics

Unit – I **13 Hours**

Semiconductor Diode: construction, operation, characteristics, application of p-n diode and Zener diode, **Bipolar Junction Transistors**- construction, operation, common-emitter configuration, common-base configuration, common-collector configuration, derivation of β, α and various parameters, loadline analysis, Operating point, voltage-divider bias, transistor switching networks, bias stabilization, working of CE amplifier.
Construction, working and characteristics of JFET and MOSFET.

Unit – II **15 Hours**

Operational Amplifier- Introduction, ideal characteristics, voltage follower circuit, inverting amplifier, non-inverting amplifier, Op-Amp parameters- input and output voltage, common mode and supply rejection, offset voltages and currents, input and output impedances, slew rate. Op-Amps as summing amplifier, difference amplifier, differentiator and integrator.
Active filters: Types, specifications, filter transfer function, first order and second order low pass and high pass filters, band pass and band reject filters.
Signal generator: Basic principles, phase shift oscillator, Wien bridge oscillator, triangular/ rectangular wave generators. A/D and D/A conversion circuits.

Unit – III **10 Hours**

Number systems-binary, octal, decimal and hexadecimal, number base conversions, binary arithmetic, 1's and 2's complement, Binary codes-BCD, 8421, Excess-3, reflected code, alpha-numeric codes, logic gates analysis-AND, OR, NOT, NAND, NOR, Boolean Algebra- theorems and properties, Boolean functions- Canonical and Standard forms , AND-OR and NAND-NOR implementation and simplification of Boolean expressions, Karnaugh map (upto four variables).

Unit – IV **13 Hours**

Combinational logic circuits- Adder, Parallel binary adder, subtractor, comparator, decoders, BCD to seven segment decoder, encoders, code converter, multiplexers and demultiplexers.
Sequential logic circuits: Flip flops-SR, JK, D, T and master-slave JK flip flops, Edge triggered flip flops, Registers, shift register, ripple counters, synchronous counters.

References:

1) Semiconductor Devices Physics and Technology, S.M.Sze, John Wiley and sons Inc Asia, 2nd edition, 2002
2) Solid State Electronics Devices. Ben G Streetman, Sanjay Banerjee, Pearson Ed Asia, 5th edition, 2000.
3) Electronic Devices and Circuit Theory: Robert L. Boylestad and Louis Nashelsky, PHI/Pearson Education, 9th Edition
4) Textbook of Applied Electronics: R. S Sedha, S. Chand & Co Ltd, Multicolor Edition
5) Operational Amplifiers and Linear IC's: David A. Bell, PHI/Pearson, 2nd edition, 2004
6) Op - Amps and Linear Integrated Circuits: Ramakant A. Gayakwad, PHI, 4th edition
7) Digital Logic and Computer design, M Morris Mano, PHI.
8) Digital Principles and Applications, Donald P.Leach and Albert Paul Malvino, Tata Mc Graw Hill, 5th edition, 2002.
9) Digital Systems, Principles and Applications, Ronald J Tocci and Neal S Widner, pearson education 8th edition 2001.

PST-1.5 (a): Instrumentation

Unit – I: Generalized Characteristics of Instruments **13 Hours**

Static characteristics: accuracy, precision, repeatability, reproducibility, resolution, sensitivity, linearity, drift, span, range.

Dynamic characteristics: transfer function , zero order instruments, first order instruments – step, ramp, frequency responses – second order instruments – step-ramp response – dead time elements.

Types of Errors: gross, systematic, random, linear and nonlinear curve fitting, chi-square test

Unit – II: Vacuum Systems **13 Hours**

Principle and operation of various pumps: rotary, diffiusion, sorption, turbomolecular, ionisation and cryopumping.

Gauges: McLeod, diaphragm, thermocouple, pirani, penning, ionisation and hot and cold cathodes – design of high vacuum systems – high pressure cells – measurements at high pressures.

Unit – III: Thermal Systems **13 Hours**

Temperature scales – liquefaction of gases, achieving low temperature – design of cryostats.

High temperature furnaces: resistance, induction and arc furnaces – high temperature measurements – pyrometers – total and selective radiation pyrometers – optical pyrometer.

Unit – IV: Detectors and Spectroscopy **13 Hours**

Detectors: pyroelectric, thermoelectric, photoconducting, photoelectric, photomultiplier, scintillation types of detectors, photon counters.

Spectroscopy: principles of atomic absorption spectroscopy – instrumentation – single and double beam spectrometers –theory and components of nuclear quadrupole resonance technique – applications.

References:

1) A.K. Sawhney and Puneet Sawhney, A Course in Mechanical Measurement and Instrumentation, DhanpatRai&Sons, New Delhi 2000.
2) Dennis Roddy and John Coolen, Electonic communication, 4th edition, PHI private Ltd., (1999). (Unit – II)
3) C.S. Rangan, G.R. Sharma and V.S.V. Mani, Instrumentation Devices and Systems, Tata McGraw-Hill (1983).
4) H.H. Willard, L.L. Merrit and John A. Dean, Instrumental Methods of Analysis, 6th edition, CBS Publishers & Distributors (1986).
5) D.V.S. Murty, Transducers and Instrumentation, Prentice – Hall of India (P) Ltd., New Delhi (1995).
6) Ernest O. Doebelin, Measurement System Applications and Design, McGraw Hill International Book Company, Singapore (1983)

PST-1.5(b): Astrophysics

Unit – I **13 Hours**

Basic concepts, Michelson's stellar interferometer, binary stars and their masses, radial and transverse velocities types of optical telescopes and their characteristics, modern telescopes like Gemini Keck etc.

Unit – II **13 Hours**

Properties of stars: Spectra of stars, spectral sequence –temperature and luminosity classifications, H-R diagram, Saha's ionization formula and application to stellar spectra, virial theorem, stellar structure equations, star formation and main sequence evolution, mass luminosity relation, White dwarf's, Pulsars, magnetars, Neutron stars and Black holes, variable stars.

Unit – III **13 Hours**

The solar system: The surface of the sun, solar interior structure, solar rotation, sun spots, the active sun, properties of interior planets and exterior planets, satellites of planets, comets, asteroids, meteorites, Kuiper Belt Objects and Oort Cloud, Theories of formation of the solar system.

Unit – IV **13 Hours**

Star clusters, Galaxies and the Universe: open and global clusters, the structure and contents of milky way galaxy, Hubble's classification of galaxies, galactic structure and dark matter, galactic motions, hubble's law, Olber's paradox. Big bang theory and the origin of the early universe, nucleosynthesis, cosmic microwave background radiation and evolution of the universe.

References

1) The new cosmos A unsold, Springer Verlag 1977
2) Introduction to stellar astrophysics E Bohm Vitense 3rd volume ,CUP 1989
3) Astrophysics and stellar astronomy T L Swihart: Wiley 1968
4) The stars ; their structure and evolution R J Taylor , Cambridge University Press 1993
5) Introduction to Cosmo Log J V Narlikar Y, Cambridge University Press 1993
6) Principles of physical cosmology Peebles P J E, Princeton U P 1993
7) Galaxies their structure and evolution R J Taylor, Cambridge University Press 1993
8) Solar system astrophysics Brandt J C and Hodge, Mc graw Hill 1964
9) The physical universe, F Shu So press 1987
10) Introduction to modern astrophysics Ostlie and Caroll, Addn Wesley 1997
11) Astrophysics concepts M Herwit, John wiley 1990
12) An introduction to astophysics Baidyanath Basu, PHI
13) A textbook of astrophysics and cosmology V B Bhatia, New Age International
14) Our solar system, Rana
15) Stars and galaxies K D Abyankar, Cambridge University Press
16) Astrophysics, Krishanswamy
17) Pulsar Astronomy A G Lyne and G Smith, Cambridge University Press

PHP-1.6: Practical I – General Physics and Basic Electronics Lab

General Physics lab

1) Thermal conductivity of a material of a rod by Forbes's method.
2) Determination of the size of the lycopodium particles by diffraction method using
   a) Spectrometer b) Young's method
3) Verification of Stefan's Law by electrical method.
4) Determination of wavelength of iron arc spectral lines using constant deviation spectrometer.
5) Verification of Fresnel's law of reflection.
6) Determination of elastic constant of glass plates by Cornu's interference method.
7) Experiment with Babinet compensator.
8) Determination of Hartmann's constants and hence to verify the Hartmann's formula and study of electronic absorption band $KMnO_4$.
9) Febry perot etalon
10) Thermionic emission and verification of Richardson's law.

New experiments may be added.

References

1) R.A. Dunlap, Experimental Physics: Modern Methods, Oxford University Press, New Delhi (1988).
2) E.V. Smith, Manual for Experiments in Applied Physics, Butterworths (1970).
3) D. Malacara (ed.), Methods of Experimental Physics, Series of Volumes, Academic Press Inc. (1988).

Basic Electronics lab

1) Op-amp 741 as an adder, subtractor, differentiator and integrator.
2) Low –pass, high-pass and band reject filters using op-amp 741.
3) Lead-lag network and wein bridge oscillator using op-amp 741.
4) RC Phase shift oscillator using op-amp 741.
5) Half adder, half subtractor, full adder and full subtractor.
6) Boolean expressions implementation.
7) Sinewave and square wave generators.
8) Study of triggered SR, JK and D flip-flop
9) Ripple counter and shift register using JK flip flop.
10) R-2R ladder network D/A converter.
11) Regulated power supply using 78XX integrated circuits.

New experiments may be added.

References

1) B.K. Jones, Electronics for Experimentation and Research, Prentice-Hall (1986).
2) P.B. Zbar, A.P. Malvino and M.A. Miller, Basic Electronics: A Text-Lab Manual, Tata Mc-Graw Hill, New Delhi (1994).

PHT-2.1: Quantum Mechanics- I

UNIT-I **13 Hours**

Physical basis of Quantum mechanics:

Experimental background, inadequency of classical physics, summary of principal experiments and inferences(Compton effect,Black body radiation,Photo electric effect),wave particle duality, uncertainity and complementarity. Wave packets in space and time and their physical significance.

Schrodinger wave equation:

Development of wave equation: One dimensional and extension to three dimensions inclusive of forces, Interpretation of wave function: Statistical interpretation, normalization, expectation value and Ehrenfest's theorem. Energy eigen functions: separation of wave equation, boundary and continuity conditions.

UNIT -II **13 Hours**

Some exactly soluble eigen value problems:

One dimensional: Square well and rectangular step potentials, rectangular barrier, harmonic oscillator. Three dimensional: Particle in a box. Particle in spherically symmetric potential, rigid rotator. Hydrogen atom.

UNIT -III **13 Hours**

General formalism of quantum mechanics:

Hilbert space. Operators-definition and properties, eigen values and eigen vectors of an operator. Hermitatian, unitary and projection operators, commuting operators, complete set of commuting operators. Bra and Ket notations for vectors. Representation of an operator, change of basis. Co-ordinate and momentum representations. The basic formalism: The fundamental postulates, expectation values and probabilities: quantum mechanical operators, explicit representation of operators, uncertainty principle. Operator method solution of linear harmonic oscillator.

Quantum dynamics: Equations of motion, Schrodinger, Heisenberg and interaction pictures. Poisson brackets and commutator brackets.

UNIT -IV **13 Hours**

Approximation methods for stationary states:

Time independent perturbation theory; non-degenerate and degenerate cases (upto second order), perturbed harmonic oscillator. Variational method: Application to ground state of helium.

WKB approximation: application to barrier penetration Bohr Sommerfield quantum condition

Theory of scattering: Scattering cross-section, wave mechanical picture of scattering, scattering amplitude. Born approximation, Partial wave analysis: phase shifts, scattering amplitude in terms of phase shifts, optical theorem; exactly solution problem scattering by square well potential.

References:

1. Quantum mechanics: LI Schiff, Mc Graw-Hill, 1968
2. Quantum Mechanics: F Schwabl, Narosa, 1995.
3. A Text book of quantum mechanics PM Mathews and K Ventateshan, Mc Graw-Hill 1994
4. Quantum Mechanics: VK Thankappan, Wiley Eastern, 1980

   Quantum Mechanics BK Agarwal and Hari Prakash ,Prentice Hall 1997

PHT-2.2: Mathematical and Computational Methods of Physics- II

Unit I **13 Hours**

Group theory:

Groups, subgroups and classes; homomorphism and isomorphism, group representation, reducible and irreducible representation, schur's Lemmas, orthogonality theorem, character of representation, character tables, decomposing a reducible representation into irreducible representations, construction of representations, lie groups, rotation groups, SU(2) and SO(3).

Unit–II **13 Hours**

Functions of Complex Variables:

Cauchy-Riemann conditions, analytical functions, integration in complex plane, Singularities, Taylor series representation, Poles and Residues, Laurent Expansion, Cauchy residue theorem, Applications of the residue theorem. Evaluation of Integrals

Unit III **12 Hours**

Numerical methods:

Solutions of algebraic and transcendental equations-Bisection, iterative and Newton- Raphson methods, Eigen values and eigen vectors of a matrix, solutions of ordinary differential equations- Euler's method, modified Euler's method, Taylor series method, Picard's method and Runge Kutta method. Interpolation-Newtons and Lagrange's methods, Curve fitting-Method of least squares, Differentation-Newton's formula, Integration- Trapezoidal rule, Simpsons 1/3 ad 3/8 rules

Unit IV **14 Hours**

C- programming: Tokens, keywords, identifier and constants, basic data types, user defined data types, derived data types, arithmetic operators, relational operators, logical operators, assignment operators, increment and decrement operators, conditional operators, bit wise operators, special operators, expressions and evaluation of expressions. Decision making, branching and looping: if, if-else, else-if, switch statement, break, continue and go to statement, for, while and do-while. Arrays, strings, Functions-Defining function, function arguments and passing, returning values from functions.

Numerical methods using C-programming.

References:

1. Elements of group theory for physicists, 3rd edition AW Joshi, wiley Eastern (1982).
2. Mathematical methods for physicists, George Arfken 4th edition, academic press, San Diego (1995).
3. Introductory methods of numerical analysis SS Sastry 3rd edition, prentice Hall of India New Delhi (2000).
4. Programming in ANSI-C E Balaguruswamy Tata McGraw Hill New Delhi (1992).
5. Mathematical physics, P K Chatopadhaya Wiley Eastern Ltd New Delhi (1990).

PHT-2.3: Nuclear Physics (General)

Unit – I

Basic properties of Nucleus: **6 Hours**

Nuclear constitution, The notion of nuclear radius and its estimation from Rutherford's scattering experiment; the coulomb potential inside the nucleus and the mirror nuclei. The nomenclature of nuclei and nucleon quantum numbers. Nuclear spin and magnetic dipole moment. Nuclear electric moments and shape of the nucleus.

Nuclear forces: **7 Hours**

General features of nuclear forces. Bound state of the deuteron with square well potential. Binding energy and size of deuteron. Deuteron electric and magnetic moments –evidence for no-central nature of nuclear forces. Yukawa's meson theory of nuclear forces.

Unit- II

Nuclear reactions: **7 Hours**

Reaction scheme, types of reactions and conservation laws, reaction kinematics, threshold energy and Q-value of nuclear reaction. Energetics of exoergic and endoergic reactions. Reaction probability and cross section. Bohr's compound nucleus theory of nuclear reactions.

Nuclear models: **6 Hours**

The shell model; evidence for magic numbers, energy level, scheme for nuclei with infinite square well potential and ground state spins. The extreme single particle prediction of nuclear spin and magnetic dipole moments Schmidt limits. The liquid drop model nuclear binding energy, Bethe Wizsacker's semi empirical mass formula; stability limits against spontaneous fission and nuclear decay.

Unit – III

Nuclear decays: **8 Hours**

Alpha decay: Quantum mechanical barrier penetration, Gammow's theory of alpha decay and alpha half-life systematic. Beta decay: continuous beta spectrum, neutrino hypothesis, and Fermi's theory of beta decay, beta comparative half-life systematics. Gamma decay: Qualitative consideration of multipole character of gamma radiation and systematics of mean lives for gamma multipole transitions.

Interaction of radiation with matter. **5 Hours**

Interactions of charged particles with matter, ionization energy loss, stopping power and range energy relations for charged particles. Interactions of gamma rays; photoelectric, Compton and pair production processes. Nuclear radiation detectors- GM counter and scintillation detector.

Unit – IV

Nuclear energy **5 Hours**

Fission process, fission chain reaction, four factor formula and controlled fission chain reactions, energetics of fission reactions, fission reactor, fusion process, energetics of fusion reactions; controlled thermonuclear reactions; fusion reactor. Stellar nucleo synthesis.

Fundamental interactions and elementary particles: **5 Hours**

Basic interactions and their characteristic features. Elementary particles, classification conservation laws in elementary particle decays. Quark model of elementary particles.

Nuclear techniques: **3 Hours**

Radioisostope tracer method, Neutron activation analyses.

References:

1) The atomic nucleus :RD Evans, Mc Graw Hill
2) Nuclear and particle physics : WE Burcham and M Jobes ,Adison Wesley, 1998, ISE
3) Nuclear physics: R R Roy and V P Nigam ,Wiley Eastern
4) Physics of nuclei and particles : P Mermier and E Sheldon ,Academic Press
5) Subatomic physics: nuclei and particles: L Valentin
6) Nuclei and particles: E Segre, Benjamin
7) Nuclear physics : D C Tayal ,Himalay Publishers
8) Nuclear physics : R C Sharma, Khanna Publishers
9) Introduction to nuclear physics: S B Patel ,Wiley Eastern

PHT-2.4: Condensed Matter Physics (General)

Unit – I

Crystal structures: **7 Hours**

Crystal systems, crystal classes, Bravias lattice. Unit cell: Wigner Seitz cell, equivalent positions in a unit cell. Notations of planes and directions. Atomic packing: packing fraction. Co-ordination number. Examples of simple crystal structures. NaCl, ZnS and diamond. Symmetry operations, point groups and space groups. (Ref 1,5,6)

X-ray diffraction: **6 Hours**

X-ray diffraction, Bragg law, Laue equations, atomic form factor and structure factor. Concept of reciprocal lattice and Ewald's construction. Experimental diffraction methods: Laue rotating crystal method and powder method. (Ref 1,5,6)

Unit – II

Crystal binding: **7 Hours**

Types of binding, Van der Waals-London reactions, Repulsive interaction. Modelung constant. Born's theory for lattice energy in ionic crystals and comparison with experimental results. Ideas of metallic binding. Hydrogen bonded crystals.

Lattice vibrations **6 Hours**

Vibrations of monoatomic lattices. First brillouin zone. Quantization of lattice vibrations, concept of phonon, phonon momentum. Specific heat of lattice (qualitative) (Ref 1—3)

Unit – III

Energy bands in solids. **7 Hours**

Formation of energy bands, free electron model: free electrons in one and three dimensional potential wells, electrical conductivity, heat capacity, paramagnetism, Fermi-dirac distribution, density of states, concept of Fermi energy. Kronig - penny model. Nearly free electron model (qualitative) tight binding model (qualitative) (Ref 1—3)

Defects in solids: **6 Hours**

Point defects: Schottky and Frenkel defects and their equilibrium concentrations. Line defects: dislocations, multiplication of dislocations (Frank – Read mechanism). Plane defects grain boundary and stacking faults. (Ref 1—3)

Unit – IV

Semiconductors: **13 Hours**

Intrinsic and extrinsic semiconductors. Concept of majority and minority carriers. Statistics of electons and holes. Electrical conductivity. Hall effect. Experimental determinations of resistivity of semiconductor by four probe method. **Superconductors:** Superconductivity, Zero resistance, Meissner effect, critical field, classification into type I and type II, Thermodynamics and superconducting transition, electrodynamics of superconductors. (Ref 1—2)

Reference books:

1) Elementary Solid State Physics: Principles and Application, M A Omar, Addision Wesley.
2) Introduction to Solid State Physics C Kittel, Wiley Eastern
3) Solid State Physics A J Dekkar, Prentice Hall Inc
4) Semiconductor Physics P S Kireev, MIR Publishers
5) Solid State Physics K.Ilangovan,MJP Publishers
6) Solid State Ohysics S.O.Pillai,New age International Publishers

PST-2.5(a): Physics of Nanomaterials

Unit – I **13 Hours**

Topics in condensed matter:

Density of states – variation with energy. Variation of density of states and band structure with size of crystal. Density of states for different dimensions.

Introduction to nano materials: (Definitions, reason for interest in nanomaterials, classification of nanostructures, 1D, 2D and 3D confinement, effect of nanostructure on structural and mechanical properties, chemical reactivity and stability thermal magnetic optical and electronic properties, nanoprocess in biosystems) – overview. Mechanical behaviour of nanostructured systems: Effect of gain size on elasticity and hardness – empirical Hall-Petch equation models to explain it modification for small grain sizes. **Gas reactive applications of nanostructrured materials:** Catalysts electrocatalysis processes, impact of nanostructure, Gas sensors; physical principles of semiconductor sensors and nanostructure design. Hydrogen storage: properties of hydrogen storage compounds and nanostructure design. **Nano magnetic materials and applications:** Domain and domain walls- Bulk and nano structures, magnetization processes in particulate nano magnets and layered nano magnets, applications, magnetoresistance, giant magnetoresistance, spin values and tunneling magnetoresistance.

Unit – II **13 Hours**

Overview of semiconductors: Electronic band structure, concept of the effective mass, optical processes, direct and indirect band gap semiconductors, exciton formation superlattice heterostructure. **Quantum size effect:** Quantum confinement in one dimensions quantum wells-Electron confinement in infinitely deep square well square, square well of finite depth, optical absorption in quantum well in the case of heterostructure consisting of thin layer of GaAs sandwiched between thick layers of AlGaAs. Quantum confinement in 2 dimensions**-** quantum wires, Quantum confinement in 3 dimensions- quantum dots, Applications of wires and dots. **Tunneling transport:** T matrices for potential step and square barrier, current and conductance. Resonant tunneling, charging effects, coulomb blockade and coulomb blockade devices.

Unit – III **13 Hours**

Methods for preparing nanomaterials Bottom up : Nano particles

Nano structures: Quantum dots, quantum well structures, thin film deposition techniques molecular beam of epitaxy MOVPE-MOCVE. Cluster beam evaporation cluster nucleation theory of condensation from super saturated vapor clusters formation. **Top down :** ball milling – details shaker mills, lithography electron beam/ion beam. **Self assembled molecular materials** – principles of self assembly micelar and vesicular polymerization colloidal nano particle crystals self organizing inorganic nanoparticles. **Thin organic films** spin coating of polymers multilayers layer by layer deposition Langmuir Blodgett techniques.

Unit – IV **13 Hours**

Characterization of nanomaterials

Diffraction techniques: X-ray diffraction (XRD) crystallinity, particle/crystallite size determination and structural analysis. **Microscope techniques**: Scanning Electron Microscopy (SEM) – morphology grain size EDX; Transmission Electron Microscopy (TEM)- morphology particle size and electron diffraction. **Scanning probe techniques**: Scanning Tunneling Microscopy (STM) surface imaging and roughness; Atomic Force Microscopy (AFM) – surface imaging and roughness; other scanning probe techniques

Reference:

1) Introduction to solid state physics, Charles Kittel ,VII edn 1996
2) Nanostructured materials –processing , properties and applications, edited by Carl C Koch William, Andrew Publishing – Norwirch New york USA 2004
3) Nanoscale science and technology edited by Robert W Keasalla , Ian W Hamley and Mark Geoghegan, John wiley and sons UK 2005
4) Physics of semiconductor nanostructures K P Jain ,Narosa 1997
5) Nanotechnology: molecular speculations on global abundance , BC Crandall, MIT Press 1997.
6) Physics of low dimensional semiconductor nanostructures Jahn H Davies ,Cambridge University Press 1997
7) Nano materials; synthesis, properties and applications edited by A S Edelsteins, R C Cammarata, Institute of physics publishing Bristol and Philadelphia 1996
8) Nano particles and nano structured films: preparation, characterization and applications Ed J H Fendler, John Wiley and sons 1998
9) Quantum dot heterostructures D Bimerg M Grundmann and N N Ledentsar, John Wiley and Sons.

PST-2.5(b): Physics of Laser and Laser Applications

Unit – I **13 Hours**

Laser characteristics:

Review of fundamentals of lasers – population inversion, pumping techniques and types. Characteristics of laser beams – Gaussian and its properties. Stable two minor optical resonators. Modes of laser oscillations of a laser cavity – longitudinal and transverse. An expression for the number of modes of oscillation in terms of frequency and the cavity length. Mode selection, mode locking, gain in a regenerative laser cavity. Threshold for 3 and 4 level laser systems – mode locking, pulse shortening. Line broadening mechanism. Spectral narrowing and stabilization. Continuous lasers and pulsed lasers.

Unit – II **13 Hours**

Laser systems: High powered lasers and low powered lasers pumping techniques for population inversion. Mechanism and energy levels of the following lasers – Ruby laser Nd YAG laser. Semiconductor lasers, diode pumped solid state lasers – homogenous and hetergenous double heterogenous lasers. Carbon dioxide lasers, excimer lasers, dye laser, argon ion laser. Qualitative treatment of engineering and medical applications of lasers.

Unit – III **13 Hours**

Laser spectroscopic techniques: Spectral characteristics of laser emission – active resonators, gain saturation, spatial hole burning. Laser fluoresescence and Raman scattering and their application in pollution studies. Non-linear spectroscopy – non linear interaction of light with matter. Laser induced multiphoton processes and their application. Ultrahigh resolution spectroscopy with lasers and its applications.

Unit – IV **13 Hours**

Lasers in fiber optics: Review of optical fibers. Propagation of light in a medium with variable reflective index. Optical fiber as a waveguide. Types of optical fibers and their applications – optical switches, optical couplers, transmission characteristics of optical fibers. Types of losses-attenuation loss, dispersion loss, splice loss etc. intermodal dispersion and material dispersion EDOF as an amplifier – optical fiber communications using lasers. WDM optical fibers. Modal analysis for step index and parabolic index medium. Attenuation of lasers in optical fibers.

References:

1) Lasers: theory and applications K Thyagarjan, AK Ghatak, Mc Milan India 1981
2) Principles of lasers O Swelto, Springer 1998
3) Lasers A E Sigman, University Press 1986
4) Solid state laser engineering W Koechener, Springer verlag 1992
5) Laser spectroscopy W Demtroder, Springer international 2002
6) Laser and nonlinear optics B B Laud, Wiley Eastern ltd 1991
7) Optical electronics Amn Yariv on, holt Rinchart and Winston 1991
8) Fiber-optic communication, D Jafar K Myubaev and Lowell L scheiner
9) Introduction to fiber optics A K Ghatak K Thaygarajan, Cambridge university press 1997
10) Optical electronics A K Ghatak K Thyagarajan, Cambridge University Press 1997.

PHP-2.6: Practical II - General Physics and Numerical Methods using C Programming Lab

General Physics

1. Interference and diffraction using He Ne Laser.
2. Ultrasonic interferometer.
3. Edser Butter fringes.
4. Study of elliptically polarized light.
5. Rydberg consant.
6. Rotatory dispersion.
7. Absorption coefficient of solution.
8. Study of dispersion of grating spectrograph.
9. Determination of e/m by Zeeman effect.

New experiments may be added.

Numerical Methods using C Programming

1. Bisection method
2. Euler method.
3. Gauss elimination method.
4. Least square method (linear regression)
5. Newton- Raphson method.
6. Simpson's 1/3rd rule method.
7. Simpson's 3/8th rule method.
8. Runge Kutta 2nd order method.
9. Runge kutta 4th order method.
10. Trapezoidal rule method.

New Analysis for numerical techniques may be added.

References

1) R.A. Dunlap, Experimental Physics: Modern Methods, Oxford University Press, New Delhi (1988).
2) E.V. Smith, Manual for Experiments in Applied Physics, Butterworths (1970).
3) D. Malacara (ed.), Methods of Experimental Physics, Series of Volumes, Academic Press Inc. (1988).

PHT-3.1: Quantum Mechanics - II

Unit – I

Time – dependant phenomena **13 Hours**

Perturbation theory for time evolution, first and second order transition amplitudes and their physical significance. Application of first order theory : constant perturbation, wide and closely spaced levels – Fermi's golden rule, scattering by a potential. Harmonic perturbation: interactions of an item with electromagnetic radiation, dipole transitions and selection rules; spontaneous and induced emission, Einstein A and B coefficients. Sudden approximation

Unit – II

Identical particles and spin **13 Hours**

Indistinguishability of identical particles. Symmetry of wave function and spin. Bosons and Fermions. Pauli exclusion principle. Single and triplet states of He atom and exchange integral, spin angular momentum, Pauli matrices

Angular momentum: Definitions, eigen values and eigen vectors, matrix representation, orbital angular momentum. Addition of angular momenta, Cebsch-Gordon coefficients for simple cases.- j_1=1/2, j_2=1/2 and j_1=1, j_2=1/2.

Symmetry principles Symmetry and conservation laws, symmetry and degeneracy. Space-time symmetries, displacement in space - conservation of linear momentum, displacement in time-conservation of energy, rotation in space – conservation of angular momentum, space inversion-parity. Time reversal invariance.

Unit III

Relativistic wave equations: **13 Hours**

Schrodinger's relativistic equation: free particle, electromagnetic potentials, separation of equations energy level in a coulomb field.

Dirac's relativistic equation: free particle equation, dirac matrices, free particle solutions, charge and current densities. Electromagnetic potentials. Diracs equation for central field: spin angular momentum, approximate reduction, spin orbit energy. Separation of the equation. The hydrogen atom, classification of energy levels and negative energy states.

Unit IV

Quantization of wave fields: **13 Hours**

Classical and quantum field equations; co-ordinates of the field, classical Lagrangian equation, functional derivative; Hamilton's equations quantum equations for the field; quantization of non-relativistic Schrodinger wave equation: classical Lagrangian and Hamiltonian equation. Second quantization.

References:

1. Quantum Mechanics : LI Schiff (McGraw Hill 1968).
2. Quantum Mechanics F. Schwabl (Narosa, 1992).
3. A text book of quantum mechanics PM Mathews and K Venkateshan (TMH, 1994)
4. Quantum mechanics : VK Thankappan (Wiley Eastern, 1980)
5. Quantum mechanics BK Agarwal and Hariprakash (Prentice Hall, 1997).

PHT-3.2: Statistical Mechanics

Unit – I

Basic thermodynamics and statistical concepts: 13 Hours

The laws of the thermodynamics and their implications. Thermodynamic potential, Maxwell's relations and their applications. Phase space, ensembles, Ergodic hypothesis and Liouville's theorem, probability, probability distribution and the most probable distribution. The probability distribution and partition function. Micro canonical, canonical and grand canonical ensembles. Thermodynamic potentials and the partition function. (Ref - 1)

Unit- II

Classical statistics: 13 Hours

Partition function of a systems of particles. The translation partition function. Gibbs paradox and Boltzmann equipartition theorem. Rotational and vibration partition function. Einstein relation and electronic partition function. The various partition functions and the corresponding thermodynamic potentials. Maxwell-Boltzmann distribution and its physical applications. (Ref - 2,4 & 5)

Unit – III

Quantum statistics: 13 Hours

The symmetry and anti symmetry of the wave functions. Bosson's and Femino's, Bose Einstein and Fermi Dirac distributions. Ideal Bose and Fermi gases – their properties at high temperatures and densities. Bose-Einstein condensation. Blackbody radiation and photons. The phonons and specific heat of solids. (Ref-2,3,5 and 7)

Unit – IV

Fluctuations 13 Hours

Fluctuations in canonical, grand canonical and microcanonical ensembles. The Brownian motion and Langevin equation. Random walk, diffusion and Einstein relation for mobility. Fokker-plank equation. Johnson noise and shot noise. (Ref-2)

Irreversible thermodynamics: Onsager reprocity relations. Thermoelectric phenomena, non-equilibrium phenomenon in liquid helium-fountain effect. Gibbs entropy for non-equilibrium states. The entropy and information. (Refer-2,6 and 7)

References:

1) Statistical mechanics : K Huang ,Wiley Eastern
2) Statistical mechanics and properties of matter: E S R Gopal, Macmilan
3) Elementary statistical physics: C Kittel ,John Wiley
4) Fundamentals of statistical and thermal physics: F Reif ,Mc Graw Hill
5) An introduction to statistical physics: W G V Roser ,John Wiley
6) Thermodynamics of irreversible processes: S R de Groot
7) Statistical physics: L D Landau and EM Lifshitz,Pergamon

PHT-3.3: Electrodynamics

Unit – I

Electrostatics **13 Hours**

The static electric charge, Coulomb's law, the electrostatic field and Gauss law. The static field laws in integral and differential forms. The electrostatic scalar potential, Poisson and Laplace equations. The potential energy of charges and field energy density. The electric potential and fields due to monopole, dipole and quadropole. The dipole in an external field and the dipole interaction energy. The multi polar expansion of potential and for the energy of localized charge distribution in an external field, the physical significance of various multipoles. The electrostatic fields of matter, polarization, macroscopic filed equations. The electrostatic energy in dielectric media. The electrostatic boundary conditions.

Unit – II

Magnetostatics **13 Hours**

The steady electric current, Biot-Savart law, magnetic filed and Ampere's law. The magneto static field laws in integral and differential forms. The magnetic scalar and vector potentials. Potential and field of circular current element –magnetic dipole. The dipole in an external field and the dipole interaction energy. The multipolar expansion for the potential of localized current distribution, the physical significance of multipoles. Magnetic fields in matter, magetisation of the microscopic equations. The energy in the magnetic field. The magnetostatic boundary conditions.

Unit – III

Electromagnetics **13 Hours**

The nonsteady currents and charges, Lorentz force law and Faraday's law of induction. The displacement current. Maxwell's electromagnetic filed laws in integral and differential forms. The macroscopic equations and boundary conditions. The electromagnetic potential, Coulomb and Lorentz gauges. Energy in the the electromagnetic field. Poynting's theorem and energy momentum conservation.

Unit – IV

Electromagnetic waves **13 Hours**

The wave equation, light and its electromagnetic character. Plane waves in free space, waves in non conducting media and polarization. Electromagnetic waves in conducting media, skin depth. Electromagnetic waves in bounded media; Refection and refraction of waves. Energy flux in a plane wave. The retarded potentials, Lienard – Wiechart potentials and fields for a moving point charge. **Relativistic electrodynamics-**The principle of invariance Lorentz transformations. Four vectors in electrodynamics and the covariant formulation of the laws of electrodynamics. The electromagnetic field tensor.

References:

1) Introduction to electrodynamics: D J Grififth ,Prentice Hall 1981
2) Classical electromagnetic radition: J B Marion ,Academic 1968
3) Classical electrodynamics: C D Jackson ,Wiley Eastern 1978
4) Electromagnetics: BB Laud ,Wiley Eastern 1987
5) The Feyman lectures on physics: vol-II R P Feynmann ,Addison Wesley 1964
6) Classical electricity and magnetism: W Panofsky & M Philips ,Addison Wesley 1962

PST-3.4(a): Nuclear Physics – I (Special)

Unit – I

Nuclear forces: **13 Hours**

Deuteron problem: inadequacies of the central force, experimental evidence for the tensor force, magnetic moment and quadrupole moment of the deuteron, deuteron ground state as an admixture of s and d states. Rarita Schwinger equation, magnetic moment of the deuteron for s and d states, quadrupole moment of the deuteron.

Meson theory of nuclear forces, charged and neutral piones. Pion-nucleon scattering, isopin analysis, ratio of cross sections, pion nucleon and N-N resonances.

Unit – II **13 Hours**

Low energy nucleon – Nucleon interaction: n-p scattering:

Partial wave analysis expression for total scattering cross sections, n-p infoherent scattering using square well potential, singlet and triplet potentials, scattering length and its significance, coherent scattering by ortho and para hydrogen, spin dependence of nuclear forces, effective range theory for n-p scattering.

p-p scattering: qualitative features, effect of Coulomb and nuclear scattering, charge symmetry and charge independence of nuclear forces, isopin formalism generalized pauli principle.

Unit – III **13 Hours**

Nucleon interactions at high energy:

Experimental results of p-p and n-p scattering at high energies, repulsion at very small distances, exchange forces, role of saturation, polarization due to scattering, spin orbit dependence of nuclear forces, structure of nucleons, nucleon form factors, deep inelastic electron proton scattering.

Ion optics: Electric and magnetic fields in paraxial approximation, focusing properties of linear fields, electrostatic aperture lens, magnetic quadruple lens, transfer matrices for common optical elements.

Unit – IV **13 Hours**

Nuclear Electronics:

Preamplifiers, charge sensitive, current and voltage sensitive preamplifiers, linear pulse amplifier, linearity, stability pulse shaping and pulse stretching operational amplifiers integral and differential discriminators, Schimitt trigger as a discriminators, analog to digital converters (ADC) time to amplitude converters, scalars, timers, memories single channel analyzer (SCA) multichannel analyzer (MCA) functional block diagram: its use in data processing.

References:

1) Nucleon –Nucleon interaction, GE Brown and AD Jackson, North Holland Amsterdam 1976
2) Nuclear interactions S de Bendett, John Wiley New York 1964.
3) Physics of nuclei and particles P Marmier and E Sheldon Vol I and II, Academic press 1969.
4) Introduction to nuclear physics H A Enge, Addison Wesley 1975
5) Structure to the nucleus MA Preston and RK Bhaduri ,Addn Wesley 1975
6) Theoretical nuclear physics M Blatt and V F Weisskopf, John Wiley 1967
7) Nuclear physics – Theory and experiments R R Roy and B P Nigam, John wiley 1967
8) Atomic and nuclear physics S N Ghoshal vol II 2000
9) Introduction to high energy physics L D H Perkins, Addison Wesley London 4th edition 2000.

10) Principles of Charged particle acceleration S Humphris Jr ,John Wiley 1986
11) Practical gamma ray spectrometry G Gilimore and J D Hemingway, John Wiley and sons 1995.
12) Radiation detection and measurements G F Knoll 3rd edition, John Wiley and sons 2000
13) Nuclear radiation detectors, S S Kapoor and V S Rammurthy ,Wiley Eastern New Delhi 1986.
14) Radiation detection W H Tait, Butter Worths London 1980.
15) Nuclear radiation detection W J Price, Mc Graw Hill New York 1964.

PST-3.4(b): Condensed Matter Physics – I (Special)

Unit – I **13 Hours**

Periodic structures:

Reciprocal lattice and its properties, periodic potential and bloch theorem, reduction to brillourin zone, Born-von Karman boundary conditions, Counting of states.

Electron states: nearly free electron model, discontinuity at zone boundary, energy gap and Bragg reflection. Tight binding method, bandwidth and effective mass. APW and KP methods of band structures calculations.

Unit – II **13 Hours**

Fermi Surface studies:

Extended, reduced and periodic zone schemes, Construction of Fermi surface in square lattice, Harrison construction, electron orbits. Hole orbits and open orbits. Experimental methods: electron dynamics in a magnetic field, cyclotron frequency and mass, cyclotron resonance. Quatization of orbits in a magnetic field. Landau quantization, degeneracy of Landau levels, quantization of area of orbits in K space de ass van Alphen effect, extremal orbits.

Unit – III **13 Hours**

Quantization of lattice vibrations and phonons:

Potential and kinetic energies in terms of generalized coordinates and momenta, Hamiltons equations of motion, quantization of normal modes.

Elastic properties of solids:

Stress and strain tensors, elastic constants and Hooke's law, strain energy, reduction of elastic constants from symmetry, isotropy for cubic crystals, technical moduli and elastic constants. Propogation of long wavelength vibrations. Experimental determinations of elastic constants by ultrasonic interference method.

Unit – IV **13 Hours**

Electrical transport in metals and semiconductors:

Boltzman equation, relaxation time, approximation, electrical conductivity, thermal conductivity, thermoelectric effects calculation of relaxation time, scattering by impurities and lattice vibrations. Mattheisen's rule, temperature dependence of resistivity, residual resistance.

References:

1) Solid state physics: N W Aschroft and AD Mermin ,Saunder college publishing New York 1976.
2) Principles of theory solids: J M Ziman, Cambridge University, Press 1972.
3) Introduction to solid state physics: C Kittel, Wiley Eastern Ltd, Bangalore 1976.
4) Lattice dynamics: AK Ghatak and L S Kothari ,Addison Wesley Reading 1971.
5) Physics of solids: F C Brown Benjamin Inc Amsterdam 1967.
6) Introduction to theory of solid state physics J D Peterson ,Addision Wesley publishing co. Reading 1971.

PSP-3.5 (a): General Physics lab

1) Solar cell
2) Miller sweep circuit
3) Analysis of X-ray diffraction pattern
4) Study of β absorption
5) Analysis of single crystal rotation photographs
6) Solar rotation period
7) Experiments with Geiger Counting Systems (GCS) (2 experiments)
8) Energy gap and semiconductor by 4-probe (resisitivity) method
9) Hall effect
10) Beer's law

PSP-3.5(b): Nuclear Physics Lab (Special)

1) Statistics of counting
2) Dead time of a GM counter by single source method
3) Z-dependence of Beta absorption co-efficient
4) Half life of In-116m state by beta measurement
5) Gamma ray spectrometer (SCA)
6) Gamma ray spectrometer (MCA)
7) Absorption of gamma rays
8) Two stage amplifier
9) Schmitt trigger as discriminator
10) Transistor coincidence circuit
11) Calibration of detector (NaTl) proportional counter
12) Back scattering of beta particles
13) Randomcity of GM counter
14) End point energy of beta particles by feather analysis
15) Dead time of GM counter by the method of two sources.
16) Resolving time of a coincide module
17) Energy loss of alpha particles
18) Determination of half life of In -116ms state by gamma measurement
19) Z- dependence of external bremstrahlung radiation
20) Pulse shaping
21) Pre amplifier

PSP-3.5(c): Condensed Matter Physics Lab (Special)

1) Analysis of X-ray powder photograph- Cu, Au, Ag
2) Analysis of X-ray powder photograph- W, Mo.
3) Calibration of electromagnet and magnetic susceptibility determination of magnetic salts- MnSo4, MnCl2 by Quinke's method
4) Fermi energy of copper and related parameter using calendar and grififth's bridge.
5) Experiments with p-n junction a) determination of n, Eg and dV/dt of p-n junction material b) determination of junction capacitance (Cd)
6) Ionic conductivity of NaCl : study of the temperature variation of σ and estimation of activation energy.
7) Indexing of rotation photograph using Bernal chart.

8) Analysis of X-ray diffraction of Si and estimation of R factor.
9) Determination of curie temperature for ferromagnetic material (Ni-Fe alloy)
10) Thermal expansion determination of co-efficients of thermal expansion of some materials at room temperature. (Al, Cu,Brass,NaCl,KCl)
11) Indexing of cubic crystals.
12) Analysis of X-ray diffractogram and estimation of R- facor (Sample NaCl)
13) Analysis of X-ray diffractogram and estimation of R- facor (Sample KCl)
14) Analysis of X-ray powder photograph (Cu backward reflection)
15) Analysis of X-ray powder photograph (KBr)
16) Analysis of X-ray powder photograph (NaCl)
17) Electrical resistivity of thin films by four probe method and its temperature dependence (Cu, Al, Si)
18) Determination of a) optical constants and k b) energy gap using transmission data of $ZnO-B_2O_3-V_2O_5$ thin film
19) Determination of a) optical constants and k b) energy gap using transmission data of Zno-$P_2O_5-V_2O_5$ thin film
20) Temperature variation of dielectric constant and determination of curie point of a ferro electric and solid-lead Ziconate Titanate.
21) Magnetic susceptibility of ferrous ammonium sulphate by Gouy's balance method.
22) Indexing of tetragonal crystals.

POE-3.6: Biophysics

Unit – I **13 Hours**

Cell biophysics: Cell doctrine: general organization and composition of the cells.

Bioenergetics: The biological energy cycle and energy currency. Thermodynamic concepts; free energy of a system – Gibb's free energy function, chemical potential and redox potentials. Energy conversion pathways - Kerb's cycle, respiratory chain, oxidative phosphorylation. Photosynthesis apparatus; mechanisms of energy trapping and transfer photophosphorylation.

Unit – II

Membrane biophysics: **7 Hours**

Cell membranes – structure, function and models; transport across membranes – passive and active processes; chemiosmotic energy and transduction – van't Hoff equation ; ionic equilibrium electrochemical potential; Nernst's equation; flow across membranes-membrane permeability.

Neuro physics: **6 Hours**

The nervous system. Synaptic transmission information processing in neuronal systems. Physical basis of biopotentials; action potential; Nernst Planck equation. Nerve excitation and conduction; Hodgkin – Huxley model.

Unit – III

Physiological biophysics **13 Hours**

Physics of sensory organs – the transmission of information generator potentials. Visual receptor – mechanism of image formation, auditory receptor, mechanism of sound perception; mechanisms of chemical somatic and visceral receptors. Mechanism of muscle contractility and motility. Temporal organization basis of biorhythms.

Unit – IV

Biophysics of the immune system: **13 Hours**

The immune system; cellular basis of immunal responses antibodies and antigens immunological memory. **Genetic Engineering:** Gene, structure, expression and regulation; genetic code genome organization; recombinant technology. Transgenic systems. Cybernetics – genetic information and the brain; neural nets.

References:

1) An introduction to biophysics C Sybesma, Academic 1977
2) Biophysics, V Pattabhi and N Gautham, Narosa 2002
3) Essential of biophysics P Narayan, New Age 2001.
4) Molecular biophysics R B Setlow and E C Polland ,Addn Wesley 1962
5) Biophysics W Hope, W Lohmann H Markl H Ziegler ,Springer Verlag 1983
6) Biophysics and human approach I W Sherman and V G Sherman ,Oxford 1979
7) Molecular biology of the cell B Alerts D Bray, J Lewis M Raft, K Roberts and J D Watson ,Garland 1984
8) Molecular cell biology H Lodish A Berk S L Zipursky P Matsudaira, D Baltomore and J Darnel ,Freeman 2000
9) Biophysical principles of structure and function F M Snell S Shulman R P Spensor and C Moos ,Addn Wesley 1965
10) Principles of neural science E R Kendel J G Schwar ,Elsevier 1982.

PHT-4.1(a): Nuclear Physics – II (Special)

Unit: I **13 Hours**

Nuclear Fission:

Fission cross section, spontaneous fission, mass energy distribution of fission fragments. Liquid drop model applied to fission, Bohr Wheeler theory saddle point barrier penetration, comparison with experiment. Shell correction to the liquid drop model, strutinky's smoothing procedure, induced fission below the fission barrier, evidence for the existence of second well in fission isomers, photo fission.

Unit II: **13 Hours**

Nuclear reactors:

Slowing down of neutrons by elastic collisions, logarithmic decrement in energy, number of collisions for thermalisation, elementary theory of diffusion of neutron flux (i) in an infinite slab with a plan source at one end (ii) in an infinite medium point source at the center, reflections of neutrons albedo.

Slowing down density, Fermi age equation, correction for absorption, resonance escape probability the pile equation, bulking critical size for spherical and rectangular piles, condition for chain reaction, the four factor formula, classification of reactors, thermal neutron and fast breeder reactors.

Unit III **13 Hours**

Gamma decay :

Selection Rules of gamma decay, multipole expansion of electromagnetic radiation in the source free region, sources of multiple radiation, quantum mechanical derivation of the single particle transition probabilities, multipole moments, parity selection rule, weisskopf estimates.

Angular distribution of multiple radiation, angular distribution function for dipole and quadrupole radiation, gama-gama angular correlation for dipole transitions, angulrar correlation studies in cobalt-60, life time measurements.

Internal conversion: Elementary theory of internal conversion, derivation of the K- conversion coefficient 0->0 transitions in nuclei.

Unit IV **13 Hours**

Elementary particle physics:

SU(3) symmetry and eight fold way, Gell-Mann Okubo mass formula, mass formula for baryon octet; equal spacing rule for baryon decuplet, fundamental representation of SU(3) and quarks

Week interaction: weak decays, lifetimes and cross sections, Feynman diagrams, leptonic, semi leptonic and non-leptonic processes, quark flavor changing interactions with examples, muon decay. Fermi's four particle coupling and modern perspective with a mediating vector boson, W and Z bosons; their masses and range of weak interactions.

Charged weak interactions of Quarks:

Cabibbo factor, GIM-mechanism (Glashowllipoulos- Miani mechanism)

Neutral kaons: CP as a symmetry, CP violation in neutral kaon decay (Fitch cronin experiment) CPT theorem (qualitative) evolution of a neutral kaon beam with time regeneration experiments. Standard and us predictions(qualitative) Grand theories (quadrative)

References:

1. Introduction to nuclear reactor theory JR Lamarsh, Addison Wesley 1966.
2. The elements of nuclear reator theory S Gasstoene and MC Edund ,Van Noutrand Co 1953.
3. Physics of nuclei and partiecles P Marmier and E Sheldon: Vol I and II ,Academic Press 1969.
4. Elementary pile theory H Soodak and BC Campbell, John Wiley 1950.
5. Structure of the nucleus MA Preston and RK Bhaduri ,Addn Wesley 1975.
6. Theoretical Nuclear Physics M Blatt and VF Weisskopf, John Wiley, 1952.
7. Nuclear Physics – Theory and Experiments RR Roy and BP Nigam ,John Wiley, 1967
8. Classical Electrodynamics JD Jackson, John wiley 1975.
9. Atomic and nuclear physics SN Ghoshal Vol II 2000.
10. Alpha bet and gama spectroscopy K Seighbahn Vol I and II, John Wiley 1967.
11. Introduction to High Energy physics DH Perkins ,Addision Wesley London, 4th edition 2000.
12. Introduction to elementary particles D Griffiths: John Wiley 1987.
13. Quarks and Leptons F Halzen and AD Martin, John wiley and sons, New York 1984.
14. Modern Elementary particle Physics G Kane, Addison Wesley 1987.
15. Unitary symmetry ad elementary particles, DB Liehtenberg 2nd edition ,Academic Press 1978.
16. Elementary particles JM Longo II Edition, McGraw Hill New York 1973.

PHT-4.1(b) :Condensed Matter Physics – II (Special)

Unit I **13 Hours**

Ferromagnetism:

Review of Weiss theory of ferromagnetism, its success and failures, Heisenberg exchange interaction, exchange integral, exchange energy, Ising model, spin waves (one dimensional case only), quantization of spin waves and magnons, density of modes, thermal excitation of magnons and Bloch $T^{3/2}$ law, specific heat using spin wave theory. Band theory of ferromagnetism. Ferromagnetic domains, hysteresis curve, magnetocrystalline anisotropy energy, bloch wall.

Antiferromagnetis:

Characterstic property of antiferromagnetic substance, neutron diffraction experiment. Two sub-lattice model molecular field theory of antiferromagnetism, Neel temperature susceptibility below and above neel temperature.

Ferrimagnetism:

Ferrimagnetic order, ferrites, curie temperature and susceptibility of ferrimagnets.

Unit II **13 Hours**

Magnetic Resonance:

Basic principles of paramagnetic resonance, spin-spin and spin-attice relaxation, susceptibility in the a.c magnetic field power absorption, equation of Bloch, steady state solutions, determination of g-factor line width and spin lattice relaxation time, paramagnetic resonance and nuclear magnetic resonance.

Effect of crystal field on energy levels of magnetic ions (qualitative). Spin Hamiltonian, zero field splitting.

Unit: III **13 Hours**

Dielectrics:

Review of basic formulae, dielectric constant and polarizability, local field, Clausius-Mossotti relation, polarization catastrophe. Sources of polarazibility, Dipolar polarizability: dipolar dispersion, Debyes' equations, dielectric loss, dipolar polarization in solids, dielectric relaxation. Ionic polarizability. Electronic polarizability: classical treatment, quantum theory, interband transitions in solids.

Unit IV **13 Hours**

Ferroelectrics:

General properties of ferroelectrics, classficaion and properties of representative ferroelectronic crystals, dipole theory of ferroelectricity, dielectric constant near curie temperature, microscopic source of ferroelectricity, Lyddane-Sachs-Teller relation and its implication, thermodynamics of ferroelectric phase transition ferroelectric domains, piezoelectricity and its applications.

References:

1. The physical principles of magnetism: A H Morrish ,John Wiley and Sons, New York (1965)
2. Solid state physics : A J Dekker, Macmillian India Ltd Bangalore (1981).
3. Introduction to solid state Physics: 5th edition C Kttel, Wiley Eastern Ltd Bangalore (1976).
4. Elementary solid state pysics: M A Omar, Addision Wesley Pvt Ltd New Delhi (2000).
5. Introduction to magnetic Resonance : A Carrington and AD Mclachlan, Harper and Row, New York (1967).

PHT-4.2(a): Nuclear Physics – III (Special)

Unit- I **13 Hours**

Partial wave approach:

Partial wave analysis of nuclear reactions, expression for scattering and reaction cross sections and their interpretation, shadow scattering, resonance theory of scattering and absorption, overlapping and isolated resonances, Briet wiger formula for scattering and reactions, shape of cross section curve near resonance.

Heavy ion reaction:

characteristics of heavy ion reactions, classical elastic scattering of particles, deflection function, rainbows and glories, diffraction model strong absorption scattering effects of coulomb field.

Unit – II **13 Hours**

Perturbation approach:

Nuclear reaction cross section, its behaviour threshold, inverse reactions, principle of detailed balance, optical model, mean free path, optical potential and its parameters for elastic scattering, transfer reactions, stripping and pickup semi classical description, plane wave born approximation (PWBA) its predictions of angular distribution, modifications introduced in the distorted wave born approximation (DWBA) spectroscopic factors transfer reactions and shell model.

Unit – III

Nuclear models: **13 Hours**

Independent nuclear models: Empirical evidence for magic numbers and shell structure in nuclei, energy levels according to the 3-d isotropic oscillator potential effectct of spin orbit interaction, prediction of ground state spin-parity of odd-A nuclei, magnetic moments of nuclei (quantum treatment) Schmidt lines, Nordheim's rules for odd—odd nuclei: strong and weak rules.

Shell model for one nucleon outside the core, configuration for excited states, model for two nucleons outside the core, Oxygen -18 spectrum (qualitative only) for two particles in d-5/2 orbit and in the s-1/2, d3/2 orbits, configuration mixing.

Unit – IV **13 Hours**

Collective model:

inadequacies of shell model, nuclear deformation; properties of deformation parameters, spheroidal and ellipsoidal deformations.

Vibration model: Hamiltonian for charged liquid drop, Phonons, vibrational energy levels of even-even nuclei.

Rotational model:

Principal axes co-ordinate system, Rotational model Hamiltonian, Rotation levels in even-even nuclei, semi-empirical formula for rotational levels, rotational spectrum of odd-A nuclei, rotational particle coupling.

Nilsson model:

Nilsson Hamiltonian, calculation of energy levels prediction of ground state spins.

References:

1) Introduction to nuclear reactions G R Satchler, Macmilan Press 1980
2) Quantum collision theory, Jochain, North Holland 1975
3) Semi classical methods for nucleus-nucleus scattering D M Brink: Cambridge university Press 1985.

4) Classical mechanics II Goldsten, 2nd edition, Narosa publishing House 1990
5) Concepts of nuclear physics B I Cohen, Tata Mc Graw Hill New Delhi 1978
6) Physics of nuclei and particles P Marmier and E Sheldon Vol I and II, Academic press 1969.
7) Theory of nuclear structure M K Pal ,Affiliated East West Madras 1982
8) Structure of nucleus M A Preston and R K Bhaduri, Addn Wesley 1975
9) Theoretical nuclear physics M Bhatt and V F Weisskopf ,John Wiley 1952
10) Nuclear physics – Theory and experiments R R Roy and B P Nigam, John Wiley 1967
11) Nuclear structure A Bohr and B R Mattelson Vol I and II Benjamine reading 1969
12) Nuclear models J M Eissenebrg and W Greiner, North Holland 1970
13) Theoretical nuclear physics A de Shalit and II Feshbach Vol. I ,John Wiley 1974
14) Atomic and nuclear physics S N Ghoshal vol II 2000.

PHT-4.2(b): Condensed Matter Physics – III (Special)

Unit – I **13 Hours**

Semiconductors:

Elemental and compound semiconductor, band structure of real semiconductors.

Intrinsic semiconductors: Carrier concentrations, Fermi energy, extrinsic semiconductors; binding energy of impurity, impurity levels, population of impurity levels, carrier concentration Fermi energy and its dependence on impurity concentration and temperature.

Unit – II **13 Hours**

Transport in semiconductors:

Electrical conductivity and mobility, their dependence on temperature and scattering mechanisms, energy gap determination, diffusion, Einstein relation, diffusion equation and diffusion length.

Magenetic field effects:

Hall effects hall resistance , magnetoresistance (qualitative), cyclotron and effective mass determination.

Optical properties:

Interband and intraband absorption, fundamental absorption, absorption edge excitaton absorption free carrier absorption, impurity involved absorption. Photoconductivity, luminescence.

Unit – III **13 Hours**

Semiconductor devices:

p-n junction in equilibrium space charge region, barrier potential, barrier thickness, contact field, junction capacitance its determination, potential diagram of p-n junction.

p-n junction in non-equilibrium generation and recombination current, continuity equations current voltage relation saturation current, tunnel diode, gunn diode, semicondcuctor lasers, LED and photocell.

Unit- IV **13 Hours**

Low dimensional semiconductor structures:

Inversion layer, quantum well. modulation doping, quantum well wire, quantum dot and superlattice. Two – dimensional electron gas, energy levels and density states. Quantum hall effect (qualitative). Thin film physics: preparation: chemical vapor deposition MOCVD, MBE and thermal evaporation methods. Thickness measurements: electrical methods, (resistivity and capacitance measurements), optical methods (optical absorption and interference) and vibrating quartz method.

Reference:

1. Elementary solid state pysics: M A Omar, Addision Wesley Pvt Ltd New Delhi (2000).
2. Solid state physics:N W Aschroft and A S Mermin
3. Solid state and semiconductor physics : J P Mckelvey, Harper and Row, New york (1966)
4. The physics of low dimensional semiconductors : J H Davies, Cambridge university press 1966.
5. Physics of thin films, L Eckertova, Cambridge university press ,Cambridge 1998
6. Thin film phemomena: K L Chopra, Mc Graw Hill Book Company New York 1969.

PST-4.3(a): Material Science

Unit – I

Engineering materials: **07 Hours**

Materials Science and Engineering, Classification levels of structure, structure- property relationship in materials. (Ref 1, 2 and 3)

Structure of solids: **06 Hours**

The crystalline and non crystalline states, covalent solids, metals and alloys, ionic solids, the structure of silica and silicates. (Ref 1, 2 and 3)

Unit – II

Crystal growth: **07 Hours**

Crystal growth from melt: Bridgemann technique, crystal pulling by czocharalski's method, growth from solutions, hydrothermal method, gel method, zone refining method of purification. (Ref: 2 and 5)

Crystal imperfections: **06 Hours**

Point imperfections, dislocation –edge and screw dislocation, concept of burger vector and burger circuit, surface imperfections, colour centres in ionic solids. (Ref 1, 2 and 3)

Unit – III

Solid phases and phase diagrams: **13 Hours**

Single and multiphase solids, solid solutions and hume-rothery rules, intermediate phase, the intermediate and interstitial compounds, properties of alloys; solid solutions and two component alloy systems; phase diagram, gibbs phase rule, lever rule, first, second and third order phase transitions with examples; some typical phase diagrams: Pb-Sn and Fe-Fe_2O_3 , Eutectic, eutectoid peritectic and peritectoid systems. (Ref 1, 2 and 3)

Unit – IV

The phase transformation: **07 Hours**

Time scale for phase changes; nucleation and growth, nucleation kinetics, the growth and overall transformation kinetics, applications; transformation in steel; precipitation processes, solidification and crystallization, glass transition recovery re-crystallization and grain growths. (Ref 1, 2 and 3)

Diffusion in solids: **06 Hours**

Theory of diffusion, self diffusion, Fick's law of diffusion, Kirkindal effect activation energy of diffusion, applications of diffusion. (Ref 1, 2 and 3)

References:

1) Elements of material science and engineering L H Vanvleck, Addison Wesley 1989, 6th edn
2) Material science and engineering V Raghvan, Prentice Hall of India 3rd edn
3) Material science and processes S K Hazra Choudhary, Indian Distr Co 1977
4) Introduction to solids L V Azaroff ,Tata McGraw Hill
5) Crystal growth B R Pamplin, Pergamon press

PST-4.3(b): Advanced Statistical Mechanics and Phase Transition

Unit – I: **13 Hours**

Probability and Random Process: Fluctuations and random processes – Brownian motion – diffusion – random walks – Langevin equation – fluctuation-dissipation theorem – irreversibility – Markov processes – master equation – Fokker -Planck equation.

Unit – II: **13 Hours**

Phase Transition Theories: Examples of first order and continuous phase transitions – mean field (van der Waals and Weiss molecular field) theories – fluid-magnet analogy – correlations – classical (Ornstein -Zernicke) theory.

Statistical Mechanical Models: Ising, lattice gas, Heisenberg, XV and Potts models – transfer matrix method –illustration using one-dimensionallising model – duality in the two-dimensionallsing model – high and low temperature series expansions.

Unit – III: **13 Hours**

Critical Phenomena: Long-range order, order parameter, scaling, universality, critical exponents – Peierls argument for phase transitions – spontaneous breakdown of symmetry – Landau theory of phase transitions – role of fluctuations, lower and upper critical dimensions – GinzburgLandau model – Higgs mechanism – examples – Mermin-wagner theorem – topological (Berezinski-Kosterlitz-Thouless) phase transition.

Unit –IV: **13 Hours**

Renormalization Group Theory: Elements of re-normalization group approach to continuous phase transitions –flows in parameter space, fixed points, epsilon expansion, real-space re-normalization – connection with Euclidean field theories – elementary ideas on percolation.

References:

1) N.G. Van Kampen, Stochastic Processes in Physics and Chemistry, North-Holland (1985).
2) H.E. Stanley, Introduction to Phase Transitions and Critical Phenomena, Clarendon Press, Oxford (1971).
3) J.M. Yeoman, Statistical Mechanics of Phase Transitions, Clarendon Press, Oxford (1992).
4) C.W. Gardiner, Handbook of Stochastic Methods, Springer-Verlag (1983).
5) C.J. Thompson, Classical Equilibrium Statistical Methods Springer-Verlag (1988).
6) D. Stauffer, Introduction to Percolation Theory, Taylor and Francis (1985).

PHP-4.4: PROJECT WORK – 100 MARKS

Project work can be carried out in industries/R&D Organization/IITs/IISc/Any Universities. Project shall be conceptualized soon after the completion of the II Semester; Students shall work for the project during the mid-term vacation of III semester examinations and IV Semester.

Note: Any new experiments can be introduced by the staff member in all the practical papers depending upon the availability of equipment and other facilities.

POE-4.5: Atmospheric Science

Unit – I **13 Hours**

Meteorology: Atmospheric composition, laws of thermodynamic of the atmosphere. Adiabatic process, potential temperature. The Clausis Clapyeron equation, laws of black body radiation, solar and terrestrial radiation, albedo Green house effect, Heat balance of earth atmosphere system.

Dynamic meteorology: Fundamental forces, non-inertial reference frames and apparent forces, structure of static atmosphere. Momentum, continuity and energy equations. Thermodynamics of the dry atmosphere, elementary applications of the basic equations. The circulation theorem, voracity, potential vorticity, vorticity and potential vorticity equations.

Unit – II **13 Hours**

Monsoon dynamics: Wind, temperature and pressure distribution over India in the lower, middle and upper atmosphere during pre, post and mid-monsson season, monsoon circulation in the meridonal (Y-Z) and zonal (X-Y) planes, energy cycle of monsoon. Dynamics of monsoon depressions and easterly waves. Intra seasonal and internal variability of monsoon. Quasi- bc weekly and 30-60 day oscillations. Enso and dynamical mechanism for their existances.

Unit – III **13 Hours**

Numerical methods for atmospheric models: Flitering of sound and gravity waves, filtered forecast equations, basic concepts of quasi geostropic and primitive equation models, one level and multi level models. Basic concepts of initialization and objective analysis for wave equation, advection equation and diffusion equation.

Atmospheric pollution: Role of meteorology on atmospheric pollution atmospheric boundary layer, air stability, local wind structure, Ekman spiral, turbulence boundary layer scaling, residence time and reaction rates and of pollutants, sulphur compounds, nitrogen compounds, carbon compounds, organic compounds, acrosols, toxic gases and radio active particles trace gasses.

Unit – IV **13 Hours**

Atmospheric instrumentation systems: Ground based instruments for the measurement of temperature. Pressure, humidity wind and rainfall rate. Air borne instruments-radisonde, rawinsode, rockestsonde-satelite instrumentation (space borne instruments)

Radar meteorology: Basic meteorology radar principles and technology radar signal processing and display -weather radar observation of precipitating systems estimation of precipitation radar observation of tropical cyclones, use of weather radar in aviation, clear in air radars-observation of clear in phenomena- other radar systems and applications.

References:

1) The Atmosphere by Frederick K I Utgens and Edward K Turbuk (for chapter I and VI)
2) The Physics of Monsoons by R V Keshwamurthy and M Shankar Roy: Allied publishers, 1992(for chapter 3)
3) Dynamic meteorology by Holton J R edition 3rd academic press N.yf 1992.
4) Numerical weather prediction by G J Haltiner and R T Villians, John Wiley and Sons. 1980 (for chapter 4)
5) Principles of Air pollution meteorology by Tom Layons and Prillscott, CBS publishers and distributors (P) Ltd Radar Meteorology by Henry Sangagcot