PHY 401 : METHODS OF MATHEMATICAL PHYSICS I, COMPUTATIONAL METHODS AND PROGRAMMING

Unit I Vector analysis and curvilinear coordinates [12 hrs]

Integration of vector functions - line integrals, surface integrals and volume integrals - vector theorems without proof (Gauss, Green's and Stokes') and their applications in physics.

Generalized coordinates - elements of curvilinear coordinates - transformation of coordinates - orthogonal curvilinear coordinates - unit vectors - expression for arc length, volume element. The gradient, divergence and curl in orthogonal curvilinear coordinates. Laplacian in orthogonal curvilinear coordinates, spherical polar coordinates, cylindrical coordinates.

Unit II Matrices and complex variables [12 hrs]

Matrix representation of linear operators, Hermitian and unitary operators, Hilbert space. Diagonalisation of matrices – simultaneous diagonalisation – solution of system of linear equations – coordinate transformation.

Complex variables and integral transforms

Review of functions of a complex variable – Cauchy Riemann conditions. Contour integrals. Cauchy integral theorem, Cauchy integral formula. Taylor and Lorentz series. Zero isolated singular points, simple pole, m^{th} order pole. Evaluation of residues. The Cauchy's residue theorem. The Cauchy principle value. Evaluation of different forms of definite integrals. A digression on Jordan's lemma. Dispersion relations – geometrical representation – conformal mapping. Dirac delta function and its properties.

Unit III Numerical methods and software analysis (in FORTRAN 90) [12 hrs]

Solution of a system of linear simultaneous equations: Gauss - Jordan method, Gauss-Seidel iterative method.

Curve fitting: principles of least squares method. Examples (linear and general functions). Interpolation: Definition of interpolating polynomial - finite difference operators - Newton's forward and backward interpolation formulas - examples. Finite difference expression of order one and two for y' and y''. Numerical integration - Simpson's $1/3^{rd}$ rule - examples.

Solution of ordinary differential equations of first order: Runge - Kutta method of order 4 - examples.

Unit IV FORTRAN programming [12 hrs]

Basic concepts, constants, variables, I/O statements, built-in functions, decision making, branching and looping statements, one and two dimensional arrays, function sub programs, sub routines, simple programming using FORTRAN 90.

Text Books:

1. Arfken G, 'Mathematical Methods for Physicists' (Academic Press)
2. Harper C, 'Introduction to Mathematical Physics' (PHI, 1978)
3. Chattopadhyaya P K, 'Mathematical Physics' (Wiley Eastern, 1990)
4. Harry Lass, 'Vector and Tensor Analysis' (McGraw Hill, 1950)
5. Jain M K, Iyengar S R K and Jain R K, 'Numerical Methods for Engineers' (McGraw Hill, TMH)
6. Mary L Boas, 'Mathematical Methods in the Physical sciences' (John Wiley, 1983)
7. Joshi A W, 'Matrices and Tensors in Physics' (Wiley Eastern, 1995)
8. Ayres F, 'Differential Equations' (Schaum series, McGraw Hill)
9. Spiegel M R, 'Vector Analysis' (Schaum series, McGraw Hill, 1997)
10. 'Programming with FORTRAN' (Schaum Outline Series, Tata McGraw Hill, 1992)
11. Grover P S, 'Programming and Computing with FORTRAN 77/90 (Allied Publishers, 1996)

Reference Books:

1. Bose A K and Joshi M C, ‘Methods of Mathematical Physics’ (Tata McGraw Hill, 1984)
2. Sokolnikoff and Redheffer, ‘Mathematics of Physics and Modern Engineering, (McGraw Hill, 1958)
3. Irving J and Mullneu N, ‘Mathematics in Physics and Engineering’ (Academic Press, 1959)
4. Kreysig E, ‘Advanced Engineering Mathematics’ (Wiley Eastern, 1969)
5. Mathews J and Walker R L, ‘Mathematical Methods of Physics’ (W A Benjamin, Inc, 1979)

PHY 402 : QUANTUM MECHANICS I

Unit I General formulation of quantum mechanics [12 hrs]

Schrodinger wave equation - review of concepts of wave particle duality, matter waves, wave packet and uncertainty principle. Schrodinger's equation for free particle in one and three dimensions - equation subject to forces. Probability interpretation of the wave function, probability current density - normalisation of the wave function, box normalisation, expectation values and Ehrenfest's theorem.

Unit II Fundamental postulates of QM [12 hrs]

Representation of states, dynamical variables - Adjoint of an operator. Eigen value problem - degeneracy. Eigenvalues and eigenfunctions. The Dirac-delta function. Completeness and normalisation of eigen functions. Closure. Physical interpretation of eigen values, eigen functions and expansion coefficients. Momentum eigen functions.

Unit III Stationary states and eigen value problems [12 hrs]

The time independent Schrodinger equation - particle in square well - bound states - normalised states. Potential step and rectangular potential barrier - reflection and transmission coefficients - tunnelling of particles.

Simple harmonic oscillator - Schrodinger equation and energy eigen values - Energy eigen functions. Properties of stationary states.

Unit IV Angular momentum, parity and scattering [12 hrs]

Angular momentum operators, eigen value equation for L^2 and L_z - Separation of variables. Admissibility conditions on solutions - eigen values, eigen functions. Physical interpretation. Concept of parity. Rigid rotator. Particle in a central potential - radial equation.

Three-dimensional square well. The hydrogen atom - solution of the radial equation - energy levels. Stationary state wave functions - bound states. Theory of scattering - the scattering experiment, differential and total cross-section, scattering amplitude, method of partial waves, scattering by a square well potential.

Text Books:

1. Powell and Crassman, 'Quantum Mechanics'(Addison Wesley, 1961)
2. Mathews P M and Venkatesan K, 'A Text Book of Quantum Mechanics' (Tata McGraw Hill, 1977)
3. Ghatak A K and Lokanathan S, 'Quantum Mechanics', III Edn. (McMillan India, 1985)
4. Sakurai J J, 'Modern Quantum Mechanics', Revised Edn. (Addison Wesley, 1994)

Reference Books:

1. Cohen Tannoudji C, Diu B and Laloe, 'Quantum Mechanics', Vol. I (John Wiley, 1977)
2. Schiff L I, 'Quantum Mechanics', III Edn. (McGraw Hill, 1968)
3. Shankar R, 'Principles of Quantum Mechanics' (Plenum, 1980)
4. French A P and Taylor E F, `An introduction to Quantum Physics' (W W Norton, 1978)
5. Gasirowicz, 'Quantum Physics' (Wiley, 1974)
6. Wichmann E H, 'Quantum Physics' (McGraw Hill, 1971)

PHY 403 : CLASSICAL MECHANICS AND ELECTROMAGNETISM

Unit I Analytical mechanics [12 hrs]

Preliminaries, Newtonian mechanics of one and many body systems. Observation laws, work – energy theorem, Open systems (with variable mass). Constraints- their classifications. Generalized coordinates - D'Alembert's principle - Lagrange's equations of motion of the first and second kinds - variational principle, principle of least action - canonical equations of Hamilton - The Hamilton-Jacobi differential equations. Canonical transformation, generating functions, properties, group property. Examples - infinitesimal generators. Poission Bracket. Poission theorems, angular momentum PBs, small oscillations, normal modes and coordinates. Canonical equations in PB notations.

Unit II Central forces – Definition and characteristics. Motion of a particle in central force field and arbitrary potential field. Inverse square field. Two body problem – closure and stability of circular orbits, general analysis of orbits. Satellite motion. Stability of orbits. Kepler's laws of planetary motion. Newton's law of gravitation.

Mechanics of rigid bodies

Displacements of a rigid body - kinematics of rotation - Eulerian angles - Euler's equations of motion. Motion of a rigid body with one point fixed - force free motion - Motion in non-inertial reference frames - Foucault's pendulum. [12 hrs]

Unit III Electrostatics and magnetostatics [12 hrs]

Electrostatics - Poisson's and Laplace's equations. Laplace's equation in one, two and three dimensional problems. Boundary conditions and uniqueness theorem. Method of images and applications. Multipole expansion. Electric dipole field. Field inside a dielectric - special problems involving linear dielectric.

Magnetostatics - vector potential. Boundary conditions. Multipole expansion of vector potential. Review of magnetisation. Magnetic field inside matter.

Unit IV Electromagnetic theory [12 hrs]

Review of Maxwell's equations. Scalar and vector potentials. Gauge transformations. Coulomb gauge and Lorentz gauge. Energy and momentum in electrodynamics. Retarded potentials. Electric and magnetic dipole radiation. Lienard-Wiechert potentials. Fields of a point charge in motion. Power radiated by a point charge.

Motion of charged particle in (a) uniform magnetic field (b) crossed electric and magnetic fields (c) space dependent magnetic field. Magnetic mirrors. Plasma - definition, Debye shielding distance, hydromagnetic equations. Pinch effect.

Text Books:

1. Goldstein H, 'Classical Mechanics', II Edn. (Wiley Eastern, 1985)
2. Griffiths D J, 'Introduction to Electrodynamics', III Edn. (PHI, 1999)
3. Takwale R G and Puranik P S, 'Introduction to Classical Mechanics' (Tata McGraw Hill, 1979)
4. Reitz J R, Milord F J, Christy R W, 'Foundations of Electromagnetic Theory', III Edn. (Narosa Publishing House, 1990)
5. Purcell E M, `Electricity and Magnetism', II Edn. (McGraw Hill, 1985)
6. Chen Francis, 'Plasma Physics', II Edn. (Plenum Press, 1984
7. Bitten Court J A, 'Fundamentals of Plasma Physics' (Pergamon Press, 1988)

Reference Books:

1. Sommerfeld A, 'Mechanics' (Academic Press, 1964)

2. Rana N C and Joag P S, ‘Classical Mechanics’ (Tata McGraw Hill, 1991)
3. Krauss John D, ‘Electromagnetics’, II Edn. (Tata McGraw Hill, 1973)
4. Singh R N, ‘Electromagnetic Waves and Fields’ (Tata McGraw Hill, 1991)

PHY 404 : ELECTRONICS

Unit I Network analysis [12 hrs]

Review of network analysis. Phasors - Phasor relations for R, L and C - Sinusoidal steady state response of a series RLC circuit. Response as a function of frequency - resonance. Complex frequency. Fourier analysis - trigonometric form of Fourier series - complex form of Fourier series. Application of Fourier and Laplace transforms in circuit analysis.

Characteristics of a pn junction. Clipping and clamping circuits. Response of RC-differentiator and integrator circuits for sine, square and ramp wave signals. UJT characteristics and its use in a relaxation oscillator.

Unit II Semiconductor devices and circuits [12 hrs]

BJT, JFET and MOSFET devices. Voltage divider bias. Small signal analysis of BJT and FET amplifiers in CE/CS configuration. Comparison of CE/CS configuration with CB/CG and CC/CD configurations. Frequency response of BJT amplifier. SCR characteristics and its use in ac power control.

Unit III Operational amplifiers and circuits [12 hrs]

BJT differential amplifier. Operational amplifier - voltage/current feedback concepts (series & parallel). Inverting and noninverting configurations. Basic applications of opamps - comparator and Schmitt trigger. IC555 timer - monostable and astable multivibrators. Crystal oscillator using opamp. Voltage regulator using series transistor and opamp with current limiting facility. Three terminal IC regulators. Switch mode power supply (block diagram).

Unit IV Digital electronics [12 hrs]

Review of logic gates. Simplification of logic functions by Karnaugh maps. Latches and flipflops. Tristate devices. Decoders and encoders. Multiplexers and demultiplexers. Synchronous (UP/DOWN) counters. Static and dynamic RAMs. Digital to analog conversion with R/2R network. Analog to digital conversion using digital ramp technique.

Text Books:

1. Hayt W H, Kemmerly J E & Durbin S M, 'Engineering Circuit Analysis', VI Edn. (McGraw-Hill, 2002).
2. Boylestad R L, 'Introductory Circuit Analysis', VIII Edn. (Prentice Hall, 1997)
3. Boylestad R L & Nashelsky L, 'Electronic Devices & Circuit Theory', VIII Edn. (Prentice Hall, 2002).
4. Floyd T L, 'Electronic Devices', V Edn. (Pearson Education Asia, 2001).
5. Gayakwad R A, 'Opamps and Linear Integrated Circuits', III Edn. (PHI, 1993).
6. Floyd T L, 'Digital Fundamentals', VII Edn. (Pearson Education Asia, 2002).

Reference Books:

1. Alexander C K and Sadiku M N O, 'Fundamentals of Electric Circuits' (McGraw Hill International Edition, 2000)
2. Donald Neamen, 'Electronic Circuit Analysis and Design' II Edn. (Tata McGraw Hill, 2002)
3. Sedra A & Smith K C, 'Microelectronics', IV Edn. (Oxford University Press, India, 1998)
4. Horenstein M N, 'Microelectronic Circuits and Devices', II Edn. (PHI, 1996).
5. Coughlin R F and Driscoll F F, 'Operational Amplifiers & Linear Integrated Circuits' VI Edn. (Pearson Education Asia, 2001)
6. Tocci R J, 'Digital Systems, Principles and Applications', VIII Edn. (Pearson Education Asia, 2001)
7. Wakerly J F, 'Digital Design' III Edn. (Pearson Education Asia, 2002)
8. Morris Mano, 'Digital Design' III Edn. (Pearson Education Asia, 2002)

9. Zbar, Malvino A P & Miller, ‘Basic Electronics. A Text-lab Manual’, VII Edn. (Tata McGraw Hill, 1994)
10. Zbar, ‘Industrial Electronics. A Text-lab Manual’, III Edn. (Tata McGraw Hill, 1983).

PHY 405 : PHYSICS PRACTICALS I

1. Characteristics and efficiency of a GM counter
2. Study the beta ray attenuation in matter
3. Determination of energy gap of a semiconductor
4. Ultrasonic Interferometer
5. Michelson`s Interferometer
6. Constant deviation Spectrometer
7. Quarter wave plate
8. Diffraction Haloes
9. Susceptibility by Quinke`s method
10. Modes of vibration of a fixed free bar

PHY 406 : PHYSICS PRACTICALS II

1. Clipping and clamping circuits
2. Differentiator & integrator circuits
3. Logic gates.
4. UJT characteristics - relaxation oscillator.
5. Opamp circuits - voltage to current converter, current to voltage converter, active limiter and active clamper.
6. Active filters – high pass, low pass, band pass and band stop
7. MOSFET common source amplifier.
8. BJT differential amplifier.
9. Voltage regulator (with series pass transistor) / 3 pin regulator.
10. Wein bridge oscillator.
11. Computer Experiments.

PHY 451 : MATHEMATICAL PHYSICS II

Unit I Tensor analysis and group theory [12 hrs]

Introduction - rank of a tensor. Transformation of coordinates in linear spaces - transformation law for the components of a second rank tensor. Contravarient and covarient and mixed tensors - First rank tensor, higher rank tensors, symmetric and antisymmetric tensors. Tensor algebra - outer product - contraction - inner product - quotient law. The fundamental metric tensor - associate tensors.

Groups - subgroups - classes. Invarient subgroups - factor groups. Homomorphism and Isomorphism. Group representation - reducible and irreducible representation. Schur's lemmas, orthogonality theorem. Decomposing reducible representation into irreducible ones. Construction of representations. Representation of groups and quantum mechanics. Lie groups and Lie algebra. Three dimensional rotation group SO(3), SU(2) and SU(3) groups.

Unit II Partial differential equations [12 hrs]

Review of system of surfaces and characteristics. First order partial differential equations for a function of two variables - Cauchy's method of characteristics.

Linear second order partial differential equations. Classification into elliptic, parabolic and hyperbolic types.

Boundary value problems - solutions by method of separation of variables - solution of 1-, 2- and 3-dimensional wave equation and diffusion equation in cartesian, plane, cylindrical and spherical polar coordinates.

Unit III Fourier series [12 hrs]

Fourier integral and Fourier transform - definition - special form of Fourier integral and properties. Convolution theorem involving Fourier transform. Applications of Fourier transforms. Laplace transform - Convolution theorem involving Laplace transforms. Applications of Laplace transforms.

Unit IV Special functions [12 hrs]

Review of power series method for ordinary differential equations – description of beta and gamma functions.

Bessel functions – solution of Bessel's equation – Neumann and Hankel functions – generating function and recurrence relations – orthogonality of Bessel functions – Spherical Bessel functions.

Legendre polynomials – solution of Legendre equation – generating function and recurrence relations – orthogonality property of Legendre polynomials – associated Legendre polynomials and spherical harmonics.

Solution of Laguerre's equation – Laguerre and associated Laguerre polynomials – Solution of Hermite equation – Hermite polynomials – generating functions and recurrence relations.

Text Books:

1. Chattopadhyaya P K, 'Mathematical Physics' (Wiley Eastern, 1990)
2. Joshi A W, 'Matrices and Tensors in Physics' (Wiley Eastern, 1995)
3. Spiegel M R, 'Vector Analysis' (Schaum series, McGraw Hill)
4. Ayres F, 'Differential Equations' (Schaum series, McGraw Hill)
5. Sneddon I A, 'Elementary Partial Differential Equations' (McGraw Hill, 1957)

Reference Books:

1. Sokolnikoff and Redheffer, ‘Mathematics of Physics and Modern Engineering, (McGraw Hill, 1958)
2. Irving J and Mullneu N, ‘Mathematics in Physics and Engineering’ (Academic Press, 1959)
3. Kreysig E, ‘Advanced Engineering Mathematics’ (Wiley Eastern, 1969)
4. Mary L Boas, ‘Mathematical Methods in the Physical Sciences’ (John Wiley, 1983)
5. Mathews J and Walker R L, ‘Mathematical Methods of Physics’ (W A Benjamin, Inc, 1979)
6. Grewal B S, ‘Numerical Methods in Engineering & Science’ V Edn. (Khanna Publishers, 1999)
7. Lars E and Linde Wok, ‘Numerical Analysis-an Introduction’ (Academic Press, 1990)
8. Ralston A and Rabinowitz, ‘A First Course in Numerical Analysis’ (McGraw Hill, 1978)
9. Sreenivasa Rao K N, ‘The Rotation and Lorentz Groups and Their Representations for Physicists’ (John Wiley & sons, 1988)
10. John R Rice, ‘Numerical Methods, Software and Analysis’ (McGraw Hill ISE, 1985)
11. Pratt & Zelkowitz, ‘Programming Languages’, III Edn. (PHI, 1996)

PHY 452 : ATOMIC AND MOLECULAR PHYSICS

Unit I Spectra of single and multi electron atoms[12 hrs]

Review of atomic models. Simple spectra of hydrogen and hydrogen like ions - energy levels, quantum numbers, electron spin, Stern - Gerlac experiment, fine structure, total angular momentum, Spin-orbit coupling, hydrogen energy levels, relativistic correction, radiation corrections, transition rates, selection rules.

Exclusion principle, ground state of multi electron atoms, periodic table. Spectra of two valence atom - alkali spectra, term values, doublet structure, transition and intensity rules. Spectra of alkaline earth elements, triplet structure, penetrating and non-penetrating orbitals: LS and jj coupling. Simple spectra of trivalent atom (qualitative). Quantum mechanical treatment of fine and hyperfine structure. Zeeman effect (classical & quantum mechanical treatment) Paschen-Back effect, Stark effect.

Unit II X-ray Spectra and Resonance spectroscopy [12 hrs]

Review of emission & absorption of X-ray spectra (critical voltage, absorption coefficient, edge, filters) regular and irregular doublet law, Auger spectra.

Spin and an applied field, nuclear magnetic resonance [both hydrogen nuclei and other than hydrogen] techniques & instrumentation, structural study, electron spin resonance spectroscopy.

Unit III Microwave spectra, infra red spectra and Raman spectroscopy [12 hrs]

Theory of rotational spectra of diatomic molecules - Experimental technique - structural information. Microwave oven.

Theory of vibrating rotator, vibration - rotation spectra, IR spectrometer. Application in chemical analysis.

Rotational and vibrational Raman spectra - correlation with IR spectra - polarization of Raman lines - laser Raman studies. F T Raman spectroscopy.

Unit IV Electronic spectroscopy [12 hrs]

Electronic spectra of diatomic molecules - coarse structure - Frank-Condon principle - rotational fine structure - formation of band head and shading of bands - determination of I, r and band origin.

Fluorescence and phosphorescence: mirror image symmetry of absorption and fluorescence bands. Basic principles of photoelectron spectra-determination of ionization potential.

Mossbauer spectroscopy. Principles of Mossbauer spectroscopy. Applications.

Text Books:

1. Ghoshal S N, ‘Atomic and Nuclear Physics’, Vol. I & II (S Chand & Company, 1994)
2. Beiser A, `Concept of Modern Physics’ V Edn. (Tata McGraw Hill, 1997)
3. Banwell C N and E M McCash, ‘Fundamentals of Molecular Spectroscopy’, IV Edn. (Tata McGraw Hill, 1994)

Reference books:

1. Kuhn H G, ‘Atomic Spectra’, III Edn. (Benjamin, 1977)
2. Haken H & Wolf H C, ‘Atomic and Quantum Physics’, V Edn. (Springer-Verlag, 1997)
3. Henry Semat & John R AlBright, ‘Introduction to Atomic and Nuclear Physics’ V Edn. (Chapman & Hall, 1972)
4. Chatwall Gurdeep, ‘Spectroscopy’, III Edn. (Himalayas, 1994)

5. Robert Eisberg & R Resnick, ‘Quantum Physics of Atoms, Molecules, Solids, Nuclei & Particles’, II Edn. (John Wiley & Sons)
6. Straughan B P and Walker S, ‘Spectroscopy’, Vol. I, II and III (Chapmann & Hall, 1976)
7. Svanberg S, ‘Atomic and Molecular Spectroscopy’, II Edn. (Springer Verlag, 1992)
8. Herzberg, ‘Molecular Spectra and Molecular Structure’, Vol. I, II & III (Van Nostrand Co., 1966)

PHY 453 : NUCLEAR AND RADIATION PHYSICS

Unit I General properties of the nucleus and nuclear decay [12 hrs]

Constituents of nucleus and their properties. Mass of the nucleus-binding energy. Charge and charge distribution. Size - estimation and determination of the nuclear radius. Nuclear radius from mirror nuclei - spin statistics and parity. Magnetic moment of the nucleus. Quadrupole moment.

Nuclear decay - Alpha decay - quantum mechanical tunnelling - wave mechanical theory. Beta decay - continuous beta ray spectrum - neutrino hypothesis. Fermi's theory of beta decay - Kurie plots and ft-values - selection rules. Detection of neutrino - non-conservation of parity in beta decay. Gamma decay - selection rules - multipolarity - Internal conversion (qualitative only).

Unit II Interaction of radiation with matter and radiation detectors [12 hrs]

Energy loss of charged particles in matter, Bethe-Bloch formula. Bremsstrahlung. Interaction of gamma rays with matter - photoelectric effect, Compton scattering, Klein-Nishina formula (qualitative discussion) and pair production processes.

Radiation detectors - gas filled counters - general features - ionization chamber, proportional counter and GM counter. Scintillation detector – semiconductor detectors.

Unit III Ionising radiations and applications [12 hrs]

Sources of ionising radiations in the environment – natural and man made radiation sources. Radiation quantities and units. Applications of ionising radiations, production of radioisotopes in reactors. Radiation shielding (qualitative treatment)

Reactor physics: fission chain reaction. Slowing down of neutrons - moderators. Conditions for controlled chain reactions in bare homogeneous thermal reactor. Critical size. Effect of reflectors. Brief introduction of nuclear fuel cycle.

Unit IV Nuclear forces and nuclear models [12 hrs]

Nature of nuclear force - short range, saturation, spin dependence and charge independence. Ground state of the deuteron using square well potential - relation between range and depth of the potential. Yukawa's theory of nuclear forces and explanation of anomalous magnetic moment of the nucleus.

Review of nuclear models - liquid drop model - semi empirical mass formula - stability of the nuclei against beta decay - mass parabola. Shell model (qualitative treatment.)

Nuclear reactions - Cross section for a nuclear reaction. 'Q' equation of a reaction in laboratory system - threshold energy for a reaction. Centre of mass system for nucleus-nucleus collision. Nonrelativistic kinematics. Relation between angles and cross sections in lab and CM systems.

Text Books:

1. Segre E, 'Nuclei and Particles', II Edn. (Benjamin, 1977)
2. Knoll G F, Radiation Detection and Measurement', II Edn. (John Wiley, 1989)
3. Eisenbud M, 'Environmental Radioactivity' (Academic Press, 1987)
4. Ghoshal S N, 'Atomic and Nuclear Physics', Vol. I & II (S Chand & Company, 1994)

Reference Books

1. Patel S B, 'Nuclear Physics - An Introduction' (Wiley Eastern, 1991)
2. Krane K S, 'Introductory Nuclear Physics' (John Wiley, 1988)
3. Roy R K and Nigam P P, 'Nuclear Physics - Theory and Experiment' (Wiley Eastern Ltd., 1993)
4. Singru R M, 'Experimental Nuclear Physics' (Wiley Eastern, 1972)
5. Zweifel P F, 'Reactor Physics', International Student Edn. (McGraw Hill, 1973)

6. Kapoor S S and Ramamurthy V S, ‘Radiation Detectors’ (Wiley Eastern, 1986)
7. Henry Semat & John R AlBright, ‘Introduction to Atomic and Nuclear Physics’ V Edn. (Chapman & Hall, 1972)
8. Burcham W E, ‘Nuclear Physics’, II Edn. (Longman, 1963)
9. Mann W B, Ayres R L and Garfinkel, ‘Radioactivity and its Measurements’ (Pergamon Oxford, 1980)
10. Little field T A and Thorley N ‘Atomic and Nuclear Physics’, II Edn. (Nostrand Co., 1988)

PHY 454 : CONDENSED MATTER PHYSICS

Unit I Crystal binding and elementary crystallography [12 hrs]

Bond length, bond angle and bond energy. Primary and secondary bonds. Coordination numbers. Ionic crystals, covalent crystals, molecular crystals, hydrogen bonded crystals and metals. Lattice energy of ionic crystals. Madelung constant.

Crystal systems, Miller indices, concept of lattice. Unit cells - primitive and non-primitive. Bravais lattices. Directions and Zones. Symmetry elements. Point groups - stereographic projections. Crystal structures of NaCl, CsCl, diamond, zincblende and copper. Close packing.

Unit II X ray diffraction [12 hrs]

Scattering of X rays by an electron, by an atom and by a crystal. Atomic scattering factor. Phase conditions. Bragg law. Geometric structure factor. Systematic absences. Reciprocal lattice - its properties. Ewald's sphere - its construction. Experimental methods - Laue and powder methods.

Unit III Free electron theory and band theory [12 hrs]

Free electron theory of metals. Density of states. Fermi energy above 0 K. Electronic specific heat. Pauli paramagnetism. Electrical conductivity of metals. Wiedemann-Franz law. Hall effect.

Failures of free electron model. Kronig-Penney model. Density of states. Energy gap. Effective mass. Concept of holes. Classification of solids - metals, semi-metals, semiconductors and insulators. Intrinsic and extrinsic semiconductors. Carrier concentration in intrinsic semiconductors.

Unit IV Lattice heat capacity, magnetic properties and superconductivity [12 hrs]

Lattice vibrations - monoatomic lattice. Einstein's and Debye's theories of heat capacity.

Diamagnetism - its origin. Langevin equation. Magnetic energy of atoms. Magnetic susceptibility - experimental determination. Quantum theory of paramagnetism. Ferromagnetism - Weiss field, Curie-Weiss law.

Meissner effect. Type I and type II superconductors. Isotope effect. Energy gap. London equations. Elements of BCS theory. Applications of superconductors.

Reference Books:

1. Cullity B D and Stock S R, 'Elements of X-ray diffraction', III Edn. (Prentice-Hall, 2001)
2. Ashcroft F W & Mermin N D, 'Solid State Physics' (Harcourt, 1976)
3. Verma A R and Srivastava O N, 'Crystallography Applied to Solid State Physics', II Edn. (New Age, 1991)
4. McKelvey J P 'Solid State and Semiconductor Physics' (Robert E. Kreiger, 1982)
5. Kittel C, 'Introduction to Solid State Physics', IV Edn. (Wiley Eastern, 1974)
6. Omar M A, 'Elementary Solid State Physics' (Addison Wesley, 1975)
7. Dekker A J, 'Solid State Physics' (Macmillan, 1971).
8. Singh J, 'Semiconductor Devices' (John Wiley, 2001)

PHY 455 : PHYSICS PRACTICALS III

Study of interference and diffraction by means of He-Ne Laser
Study of Zeeman effect: determination of e/m for an electron
Fresnel's laws of reflection
Half life of K-40
Thermoelectric constant
Programming exercises in numerical methods in FORTRAN 90
Gamma ray Spectrum of Cs-137
Babinet Compensator

Ferroelectric Curie temperature

PHY 456 : PHYSICS PRACTICALS IV

1. Two stage CE amplifier
2. Voltage controlled oscillator
3. Schmitt trigger using IC
4. Decoders & Encoders (7442 & 74147).
5. Multiplexers & Demultiplexers (74151 & 74138).
6. SCR characteristics & ac power control.
7. 555 timer - monostable & bistable operation
8. Counters
9. Circuit simulation using SPICE.

PHY 501 : LASER PHYSICS, VACUUM TECHNIQUES AND CRYOGENICS

Unit I Lasers and non-linear optics [12 hrs]

Lasers - introduction - directionality, intensity, monochromaticity, coherence.

Einstein coefficients - stimulated emission. Basic principles of lasers - the threshold condition - laser pumping.

Some specific laser systems - Neodymium lasers - He-Ne laser - ion lasers - CO_2 laser - Semiconductor lasers - dye lasers - chemical lasers - X ray lasers, free electron laser, Q switching.

Unit II Holography and Non-linear optics [12 hrs]

Principle of holography - some distinguishing characteristics of holographs - practical applications of holography.

Non-linear optics: harmonic generation - second harmonic generation - phase matching - third harmonic generation - optical mixing - parametric generation of light - self focussing of light.

Multiquantum photoelectric effect - two photon processes - multiphoton processes - three photon processes.

Unit III Vacuum techniques [12 hrs]

Units of vacuum - vacuum spectrum (ranges - low - medium - high - ultra high). Applications - freeze drying - vacuum coating - industrial applications. Conductance of pipes - pumping speed - throughput - pumpdown time.

Vapour pressure - vacuum gauges and the relevant range of vacuum - Pirani gauge - thermocouple gauge - Pennning gauge.

Vacuum pumps - rotary vane pump (pumping speed and ultimate pressure) - oil diffusion pump - baffle and trap - cryopump - turbomolecular pump. Vacuum leadthroughs - vacuum valves (diaphragm valve, slide valve, ball valve).

Unit IV Cryogenic techniques [12 hrs]

Overview of the techniques of liquefaction of gases (Nitrogen, Hydrogen and Helium). Gas purification - stirling cycle refrigeration and liquefaction of helium.

Properties of cryogenic fluids (Nitrogen and Helium 4). Storage and transfer of cryogenic fluids: Dewars for nitrogen and helium. Liquid level indicators and gauges.

Measurement of temperature: Resistance thermometers (metal, alloys & semiconductors). Thermocouple - (Au + Fe) Vs chromel. Magnetic thermometer.

Cooling by evaporation of helium 4 and helium 3 - cooling by adiabatic demagnetisation. Cryostats for low temperature experiments.

Applications of cryogenics: Hydrogen bubble chamber - Rocket propulsion system - superconducting magnets.

Text Books:

1. Silfvast W T, 'Laser Fundamentals' (Cambridge University Press, 1998)
2. Ghatak A K and Thyagarajan, 'Optical Electronics' (Cambridge University Press 1991)

3. Laud B B, ‘Lasers & Nonlinear Optics’ (Wiley Eastern, 1985)
4. Mills D L, ‘Nonlinear Optics – Basic Concepts’ (Narosa Publishing, 1991)
5. Roth A, `Vacuum Technology’, II Edn. (North Holland, 1982)
6. Barron R F, `Cryogenic Systems’ II Edn. (Oxford University Press, 1985)
7. Wilks J and Betts D S, `An Introduction to Liquid Helium’ (Oxford University Press, 1987)

Reference Books:

1. Shen Y R, ‘The Principles of Nonlinear Optics’ (John Wiley, 1984)
2. Boyd R W, ‘Nonlinear Optics’ (Academic Press, 1992)
3. Zernike F & Midwinter, ‘Applied Nonlinear Optics’ (Wiley, 1973)
4. Oshea D C, Callen W R & Rhodes W T, ‘Introduction to Lasers & Their Applications’ (Addison Wesley, 1977)
5. Harris N S, `Modern Vacuum Practice’ (McGraw Hill, 1989)
6. O’Hanlon J F, `A User’s Guide to Vacuum Technology’ (John Wiley, 1980)
7. West C D, `Principles and Applications of Stirling Engines’ (Van Nostrand Reinhold, 1986)

PHY 502 : THERMODYNAMICS AND STATISTICAL PHYSICS

Unit I Thermodynamics [12 hrs]

Concept of entropy - principle of entropy increase - entropy and disorder. Enthalpy - Helmoltz and Gibb's functions. Maxwell's relations - TdS equations - energy equations - Heat capacity equations - heat capacity at constant pressure and volume. Phase space and ensembles - Lioullis theorem, probability - thermal equilibrium.

Unit II Classical statistics [12 hrs]

Boltzmann distribution - partition functions - translational partition function. Gibbs' paradox, Sackur - Tetrode equation - vibrational, rotational and electronic partition functions. Boltzmann equipartition theorems. Application to specific heats.

Unit III Quantum statistics [12 hrs]

Bosons and Fermions - Bose-Einstein and Fermi-Dirac distributions - degenerate Fermi and Bose gases - Bose-Einstein condensation - Planck's law of black-body radiation. Liquid helium - Lambda transition.

Fluctuations - Fluctuations in canonical, grand canonical and microcanonical ensembles. Number fluctuations in quantum gases.

Unit IV Brownian motion [12 hrs]

Langevin equation for random motion, Random walk problem. Diffusion and Einstein relation for mobility.

Time dependence of fluctuations: power spectrum of fluctuations, persistence and correlation of fluctuations. Wiener - Khinchin theorem, Johnson noise and Nyquist theorem. Shot noise, Fokker-Planck equation.

Text Books:

1. Zeemansky M W and Dittman R H, 'Heat and Thermodynamics', VII Edn. (McGraw Hill International Edn., 1999)
2. Gopal E S R, 'Statistical Mechanics and Properties of Matter' (Macmillan, 1976)
3. Agarwal B K and Melvine Eisner, 'Statistical mechanics' (Wiley Eastern Ltd., 1991)

Reference Books:

1. Kittel C and Kroemer H, 'Thermal Physics', II Edn. (CBS Publ., 1980)
2. Chandler D, 'Introduction to Modern Statistical Mechanics' (Oxford university Press, 1987)
3. Reichl L E, 'A Modern Course in Statistical Physics' (University of Texas Press, 1980)
4. Landau and Lifshitz, 'Statistical Physics', III Edn. (Oxford, Pergamon, 1980)
5. Gupta M C, 'Statistical Thermodynamics' (New Age, 1995)
6. Reif F, 'Fundamentals of Statistical and Thermal Physics' (McGraw Hill, 1965)

PHY 503 CM : CONDENSED MATTER PHYSICS I

Unit I Crystallography [12 hrs]

Symmetries involving translations – screw axes and glide plane symmetries. Space groups – illustrations.

X ray diffraction – powder, oscillation and rotation methods to study crystal structure. Electron diffraction – experimental methods and applications. Neutron diffraction to study crystal structure. Comparison of X ray, electron and neutron diffraction studies.

Unit II Elastic properties and thermal properties [12 hrs]

Analysis of elastic strains and stresses. Elastic compliance and stiffness constants., Energy density. Cubic crystals and isotropic solids. Elastic waves in cubic crystals. Experimental determination of elastic constants.

Thermal properties of insulators. Normal modes of diatomic lattice. Phonon momentum. Inelastic scattering of photons and neutrons by phonons. Thermal expansion. Lattice thermal conductivity - normal and Umklapp processes.

Unit III Dielectric properties of solids [12 hrs]

Polarization. Dielectric susceptibility. Dielectric constant. Complex dielectric constant. Dielectric loss and loss angle. Local electric field. Polarizability. Clausius - Mossotti relation. Electronic, ionic and dipolar polarizability. Dielectric strength.

Frequency dependent dielectric function. Optical properties of ionic crystals. LST equation. Dipole orientation in solids. Langevin function. Dipole relaxation. Debye relaxation time.

Unit IV Ferroelectric crystals [12 hrs]

Pyroelectric, piezoelectric and ferroelectric crystals. Basic properties of ferroelectrics. Classification. Barium titanate. Thermodynamics of paraelectric - ferroelectric transition. Polarization catastrophe. Soft mode. Domains, Hysteresis. Antiferroelectricity. Piezoelectricity and its applications.

Reference Books:

1. Cullity B D and Stock S R ‘Elements of X ray Diffraction’, III Edn. (Prentice Hall, 2001)
2. Verma A R and Srivastava O N, ‘Crystallography Applied to Solid State Physics’, II Edn. (New Age, 1991)
3. Woolfson M M, ‘An Introduction to X-ray Crystallography’ (Cambridge-Vikas, 1970)
4. Buerger M J, ‘X-ray Crystallography’ (John Wiley, 1942)
5. Brusch P : ‘Phonons : Theory & Experiments’, Vol I, II & III (Springer Verlag, 1987)
6. Kittel C, ‘Introduction to Solid State Physics’, IV Edn. (Wiley Eastern, 1974), VII Edn. (John Wiley, 1995)
7. Ashcroft N W and Mermin N D, ‘Solid State Physics’ (Harcourt, 1976)
8. Ibach H and Luth H, ‘Solid State Physics’, II Edn. (Springer, 1996)
9. Ziman J M, ‘Principles of the Theory of Solids’, II Edn. (Vikas Publ., 1979).

PHY 503 EL : ELECTRONICS I

Unit I Printed circuit board design techniques. Noise reduction techniques in electronic systems.

IC fabrication technologies - wafer preparation - chemical vapour deposition - diffusion - ion implantation – photolithography. Fabrication of resistors, capacitors, BJT and MOS devices.

Characteristics and simple applications of special semiconductor devices - Schottky barrier diode - varactor diode - Tunnel diode - Photo diode - LED - Thermistor - solar cell. BiMOS & GaAs devices, CMOS inverter.

[12 hrs]

Unit II Amplifiers (BJT & MOS) - cascade amplifiers - cascode amplifiers. Darlington connection. Power amplifiers - Class A, Class B & Class AB amplifiers. Power transistor heat sinking. Silicon controlled switch, DIAC and TRIAC applications.

[12 hrs]

Unit III Operational amplifiers: Voltage references (5V) - voltage level detector - Comparator IC 311 - Phase shifter - precision rectifier - peak detector - instrumentation amplifier - examples of low noise and low drift amplifiers. Active filters - 40 dB/decade roll off (low pass, high pass & band pass).

Precision triangle & square wave generator - IC AD630. Voltage to frequency and frequency to voltage converter – IC9400. Analog multiplier - IC AD633 - squaring a dc voltage and doubling the frequency of ac

[12 hrs]

Unit IV Digital IC technologies and interfacing different logic families. Programmable logic devices - Programmable array logic PAL 16L8 - Generic array logic GAL 22V10. PLD programming using ABEL – implementation of a logic expression. OLMC mode selection of GAL 22V10 – implementation 8 bit serial in/parallel out shift register. Digital to analog converter AD558. Analog to digital conversion - Successive approximation ADC - Flash ADC - microprocessor compatible ADC AD670. Frequency multiplier using phase locked loop IC565.

[12 hrs]

Text Books:

1. Walter C Bosshart, 'Printed Circuit Boards - Design and Technology' (Tata McGraw Hill, 1983)
2. Henry W Ott, 'Noise Reduction Techniques in Electronic Systems' (John Wiley, 1989)
3. Jaspreet Singh, 'Semiconductor Devices' (McGraw Hill, 1994)
4. Boylestad R & Nashelsky L, 'Electronic Devices and Circuit Theory' VIII Edn. (PHI, 2002)
5. Coughlin R F & Driscoll F F , 'Operational Amplifiers and Linear Integrated Circuits', VI Edn. (Pearson Education Asia, 2002).
6. Gayakwad R A, 'Opamps and Linear Integrated Circuits' IV Edn. (PHI, 2002)
7. Floyd T L, 'Digital Fundamentals', VII Edn. (Pearson Education Asia, 2002)

Reference Books:

1. Neamen Donald, 'Electronic Circuit Analysis and Design' II Edn. (Tata McGraw Hill, 2002)
2. Floyd T L, 'Electronic Devices', V Edn. (Pearson Education Asia, 2001)
3. Sedra A & Smith, 'Microelectronics' IV Edn. (Oxford University Press, India, 1998)
4. Franco S, 'Designing with Operational Amplifiers and Analog Integrated Circuits', III Edn. (McGraw Hill, 2001)
5. Tocci R J, 'Digital Systems, Principles and Applications', VIII Edn. (Pearson Education Asia, 2001)
6. Wakerly, 'Digital design', III Edn. (Expanded), (Pearson Education Asia, 2002)
7. Winzer J, 'Linear integrated circuits' (Saunders College Publ., 1992).

PHY 503 NP : NUCLEAR PHYSICS I

Unit I Nuclear properties [12 hrs]

Nuclear size and shapes - estimation of nuclear radii by different methods - nuclear shapes - nuclear moments - magnetic dipole moment - electric quadrupole moments - molecular beam experiments for determination of nuclear moments.

Beta decay - selection rules - classification of beta transitions into allowed and forbidden types - the shape factor – universal Fermi interaction.

Electromagnetic interaction with nuclei - multipole transition - transition probability in nuclear matter - structure effects - selection rules - internal conversion. Photodisintegration of deuteron and radiative capture of neutron by proton.

Unit II Interaction of radiation with matter [12 hrs]

Interaction of heavy charges particles - stopping power - energy loss characteristics, particle range - energy loss in thin absorbers. Scaling laws. Interaction of fast electrons - specific energy loss. Electron range and transmission curves.

Interaction of gamma rays - interaction mechanisms - photoelectric absorption, Compton scattering and pair-production. Gamma ray attenuation - attenuation coefficients, absorber mass thickness, cross sections.

Interaction of neutrons - general properties - slow down interaction, fast neutron interaction, neutron cross sections. Radiation exposure and dose – dose equivalent.

Unit III Nuclear detectors [12 hrs]

Gas filled counters, Scintillation detectors - different types of scintillators - photomultiplier tubes, measurement with scintillation detectors - NaI(Tl), plastic scintillator - Scintillation spectrometer. Spectrum analysis.

Semiconductor detectors - semiconductor properties - physics of semiconductor detectors - diffused junction, surface barrier and ion-implanted detectors. Si(Li), Ge(Li) and HPGe detectors - semiconductor detector spectrometer. Pulse height analysis of spectrum, SSNTD, TLD, Superheated drop detectors. Neutron detectors - Neutron detection from nuclear reactions. BF_3 counters, ^3He counters, fission detectors, activation method for neutron flux measurement. Recoil counters - neutron time of flight technique.

Unit IV Nuclear electronics [12 hrs]

Preamplifier circuits, linear and pulse amplifier, pulse shaping, pulse stretching. Wilkinson type analog to digital converter. Pulse discriminators - coincidence and anticoincidence circuits - memories, single and multichannel analysers – on-line data processing - time to amplitude converter - charge sensitive amplifier. Basic principles of measurement techniques such as collimation, shielding, geometry and calibration.

Text Books:

1. Emilio Segre, 'Nuclei and Particles', II Edn. (Benjamin, 1977)
2. Ghoshal S N, 'Atomic and Nuclear Physics', Vol. II (S Chand & Company, New Delhi, 1994)
3. Kenneth S Krane, 'Introductory Nuclear Physics' (John Wiley, 1986)

4. Knoll G F, ‘Radiation Detection and Measurement’, II Edn. (John Wiley, 1989)
5. Evans R D, ‘Atomic Nucleus’ (Tata McGraw Hill, 1972)
6. Delaney, ‘Electronics for Physicists’

Reference Books:

1. Enge H, ‘Introduction to Nuclear Physics’ (Addison Wesley, 1988)
2. Paul E B, ‘Nuclear and Particle Physics’ (North Holland, 1969)
3. Singru R M, ‘Experimental Nuclear Physics’ (Wiley Eastern, 1972)
4. Kapoor S S and Ramamoorthy V S, ‘Radiation Detectors’ (Wiley Eastern, 1986)
5. Burcham W E, ‘Nuclear Physics’, II Edn. (Longman, 1963)
6. Marmier D and Sheldon E, ‘Nuclear Physics’, Vol. I, II (Academic Press, 1969)

PHY 503 RP : RADIATION PHYSICS I

Unit I Interaction of radiation with matter [12 hrs]

Interaction of charged particles : Classical theory of inelastic collisions with atomic electrons, energy loss per ion pair by primary and secondary ionization. Dependence of collisional energy losses on the physical and chemical state of the absorber. Cerenkov radiation, Electron absorption process, scattering, excitation and ionization. Value of w. Radiative collision, Bremsstrahlung, range and energy relation, energy straggling, range straggling, absorption of beta particles, backscattering.

Passage of heavy charged particles through matter : Energy loss by collision, maximum energy loss in a single collision, range energy relation, Bragg curve, Specific ionization, mean excitation energies, Bethe-Bloch formula collision stopping power, radiation stopping power.

Interaction of electromagnetic radiations : Mechanism of interactions, Thomson scattering, photoelectric absorption, Compton effect, pair production, energy momentum requirements, photonuclear reactions, attenuation, absorption and scattering coefficients, cross sections and numerical problems.

Interaction of neutrons : Neutron sources, General properties, energy classification, elastic and inelastic scattering, nuclear reaction, neutron activation and induced activity, radioisotope production, Nuclear fission.

Unit II Radiation detectors [12 hrs]

Characteristics of organic and inorganic scintillation counters, Resolving time, Semiconductor devices - physics of semiconductors, diffused junction, surface barrier and ion-implanted detectors, Examples, Semiconductor spectrometer, Analysis of pulse height of spectra, SSNTD, TLD, superheated drop detectors.

Neutron detectors : BF_3 counters, fission chambers, activation methods, Neutron time of flight method. Preamplifier circuits, noise, linear pulse amplifier, pulse shaping, pulse stretching, operation amplifier, Pulse discriminators, coincidence and anti-coincidence circuits. Scalers, single and multichannel analyser, charge sensitive amplifier. Principles of measurement (collimation shielding, geometry, calibration)

Radiation survey instruments.

Unit III Measurement of radiation exposure and dose [12 hrs]

Particle flux and fluence, energy flux and fluence, cross section, linear and mass absorption coefficient, stopping power and LET. Exposures and its measurement, absorbed dose and its relation to exposure. Electronic equilibrium, Bragg-Gray principle and air wall chamber, Kerma, Kerma rate constant. Biological effectiveness, Equivalent dose, effective dose, Committed equivalent dose, Ambient and directional equivalent dose. Tissue equivalence.

Unit IV Internal and external dosimetry [12 hrs]

Biological half-life, effective half-life, selectivity of organs, beta particle dosimetry. Calculation of integral dose due to internal deposition, specific effective energy, annual limit on intake, derived air concentration.

Dosimeters : Primary and secondary dosimeters. Pocket dosimeters, films, solid state dosimeters (TLD and RPL). Chemical and calorimetric devices.

Text Books:

1. Knoll G F, 'Radiation Detection and Measurements' (Wiley, New York, 1989)
2. Kapoor S S and Ramamurthy V S, 'Nuclear Radiation Detectors' (Wiley Eastern Ltd., New Delhi, 1986)
3. Herman Cember, 'Introduction to Health Physics' (Pergamon Press, 1983)

4. Attix F H et al, ‘Radiation Dosimetry’, Vol. I, II and III (Academic Press, NY, 1968)

Reference Books:

1. Glasstone S, ‘Source book on Atomic Energy’ (East West Press, New Delhi, 1975)
2. Greening J R, Bristol, Adam Hilger, ‘Fundamentals of Radiation Dosimetry’ (Medical Physics Hand Book 6, 1981)
3. Morgan K Z and Turner J E, ‘Health Physics’ (Wiley, NY, 1978)
4. Horowitx Y S, Boca Raton (eds.), ‘Thermoluminescence and TL Dosimetry’, Vol. I, II and III, (CRC Press, 1984)
5. Mann W B, Et al, ‘Radioactivity and its Measurements’ (Pergamon Oxford, 1980)
6. Dillman L T, et al, ‘Radionuclide Decay Scheme and Dose Estimation’ Society of Nuclear Medicine, NY, MIRD Pamphlet No. 10, 1975
7. Taylor L S, ‘Radiation Protection Standards’ (CRC Press, Cleveland, Ohio, 1971)
8. Richard F. Mould, ‘Radiation Protection in Hospitals Medical Sciences Series’ (Adam Hilger Ltd, Bristol and Boston, 1985)
9. Kenneth R Kase, Bjarngard B E and Attix F H, ‘The Dosimetry of ionising radiation’, Vol I & II (Academic Press, 1985 & 1987)
10. Ronald L. Kathren, ‘Radiation Protection’ (Adam Hilger Ltd. International Publishers Services, 1985)
11. Merril Eisenbud, ‘Environmental Radioactivity’ (Academic Press, Orlando, 1987)
12. James E Turner, ‘Atoms, Radiation & Radiation Protection’ (Pergamon Press, 1986)

PHY 504 CM : CONDENSED MATTER PHYSICS II

Unit I Band theory of solids [12 hrs]

Bloch theorem. Nearly Free electron approximation, tight binding approximation - application to cubic crystals. Effective mass tensor. Constant energy surface. Fermi surface. Brillouin zones. Density of states. The de Haas – Van Alphven effect, Landau levels. Structural transitions in binary alloys - Jones explanation.

Unit II Transport properties [12 hrs]

Boltzmann transport equation. Electrical conductivity, thermal conductivity, thermoelectric power. Scattering of electrons. Temperature variation of electrical resistance. AC conductivity of metals. Plasma frequency and plasmons. Hall effect, magnetoresistance and cyclotron resonance.

Unit III Semiconductors I [12 hrs]

Extrinsic semiconductors. Ionisation potential of impurities. Fermi energy - variation with impurity density and temperature. Electrical conductivity. Cyclotron resonance in semiconductors.

Excess carriers, continuity equation. Metal semiconductor contact - rectification, surface states. p-n junction - rectification, junction capacitance.

Unit IV Semiconductors II [12 hrs]

Degenerate, amorphous and organic semiconductors, lower dimension semiconductor structure. Quantised Hall effect.

Devices - Zener diode, Esaki diode, Semiconductor Lasers, - LDR, photodiode , solar cell, phototransistor, LED.

Reference **Books:**

1. Kittel C, 'Introduction to Solid State Physics', IV Edn. (Wiley Eastern, 1974), VII Ed (John Wiley, 1995)
2. Ashcroft N W and Mermin N D, 'Solid State Physics' (Harcourt, 1976)
3. Ibach H and Luth H, 'Solid State Physics' II Edn. (Springer, 1996)
4. Mott N F and Jones H, 'The Theory of the Properties of Metals and Alloys' (Dover, 1958)
5. Ziman J M, 'Principles of the Theory of Solids' II Edn. (Vikas Publ., 1979)
6. Mckelvey J P, 'Solid State and Semiconductor Physics' (Robert E Kreiger, 1982)
7. Seeger K, 'Semiconductor Physics', IV Edn. (Springer-Verlag, 1989)
8. Roy D K, 'Physics of Semiconductor Devices' (Univ. Press, 1992)
9. Sze S M, 'Semiconductor Devices Physics and Technology' (John Wiley, 1985)
9. Singh J, 'Semiconductor Devices' (John Wiley, 2001)
10. Neamen D, 'Physics of Semiconductor Devices' (McGraw Hill, 1996)

PHY 504 EL : ELECTRONICS II

Unit I Transmission lines [12 hrs]

Distributed parameters, types of transmission lines, calculation of line parameters. Inductance and capacitance of parallel round conductors, coaxial cables. Voltage, current and impedance relations. Characteristic impedance, reflection coefficient, propagation constant. Line distortion and attenuation. Line parameters at high frequencies, Line termination. Standing wave ratio. Quarter and half wavelength lines. Impedance matching, quarter wave transformer, stub matching. Smith chart and its applications.

Unit II Wave guides and antenna [12 hrs]

Basic concepts, guided waves between parallel planes. TE & TM waves. Rectangular wave guides. Qualitative treatment of circular wave guides, comparison with coaxial cable, wave guide coupling. Matching and attenuation, cavity resonators. Directional couplers, isolators, circulators.

Electromagnetic radiation, elementary doublet, current and voltage distribution, resonant and non resonant antennas, radiation pattern, antenna gain, effective radiated power, antenna resistance, bandwidth, beam width, polarisation, grounded and ungrounded antennas. Effect of antenna height. Microwave antennas.

Unit III Analog modulation and demodulation [12 hrs]

Need for modulation, AM generation, power and bandwidth calculations. FM generation, power and bandwidth calculation. AM & FM transmitters (block diagram).

Demodulation: receivers for AM & FM signals. AVC & AFC circuits. Pre-emphasis and De-emphasis. Digital modulation: sampling theorem, PAM, PDM, PPM system comparison. PCM technique. ASK, FSK, PSK & QPSK systems.

Unit IV Microwave devices and Satellite communication (qualitative) [12 hrs]

Multicavity klystron, reflex klystron, parametric amplifiers, Gunn diode, Masers, Microwave transistors & FETs.

Communication subsystems, description of the communication system transponders, spacecraft antennas, frequency reuse antennas, multiple access schemes, frequency division multiple access, time division multiple access, code division multiple access. Tracking geostationary satellites. Examples of satellite communication systems - IRS & INSAT series.

Reference Books:

1. Ryder J D, 'Networks, Lines and Fields' II Edn. (PHI, 1997)
2. Tomasi Wayne, 'Electronic Communication Systems', (Pearson Education Asia, 2001)
3. Kennedy and Davis, 'Electronic Communication Systems', IV Edn. (Tata McGraw Hill, 1993)
4. Dennis Roddy and John Coolen, 'Electronic Communications', IV Edn. (PHI, 1995)
5. Kraus & Fleisch, 'Electromagnetics with Applications', V Edn. (McGraw Hill, 1999)
6. Taub & Schilling, 'Principles of Communication System', II Edn. (McGraw Hill, ISE, 1986)
7. Liao S Y, 'Microwave Devices and Circuits', III Edn. (PHI)
8. Roddy D, 'Satellite Communications', III Edn. (McGraw Hill, 2001).

PHY 504 NP : NUCLEAR PHYSICS II

Unit I Nuclear spectroscopy [12 hrs]

Experimental determination of beta interaction. The shape of beta spectra. The rest mass of neutrino - neutrino recoil experiment. Inverse beta decay. Double beta decay.

Gamma ray spectroscopy - life time measurements. gamma-gamma, beta-gamma correlation studies - decay schemes - angular distribution of gamma rays from oriented nuclei, polarization of gamma rays.

Unit II Neutron physics [12 hrs]

Classification of neutrons according to their energy - neutron sources. Ultrafast neutrons, slow neutron detection through nuclear reaction and induced radio activity - slow neutron cross section measurements - neutron monochromators.

Nuclear fusion - basic fusion processes - characteristics of fusion - fusion in stars. Controlled thermonuclear reactions. Hydromagnetic equations. magnetic pressure, pinch effect, magnetic confinement systems for controlled thermonuclear fusion.

Unit III Review of deuteron problem and nuclear forces [12 hrs]

Deuteron as mixture of S and D states - admixture in the deuteron wave function - magnetic and electric quadrupole moment of deuteron from S and D mixture. Ground state wave function of deuteron. Expression for Pd.

Review of nuclear forces - charge, Symmetry, spin-dependence, tensor character, exchange character. Pseudoscalar meson theory. General survey of non-central forces. Two body potential, three body and many body potentials.

Unit IV Scattering [12 hrs]

Free n-p and p-p scattering - n-p scattering formalism - partial wave analysis - theory of S wave neutron scattering by free protons - scattering length - spin dependence of n-p scattering. Effective range theory of n-p scattering - significance of sign of scattering length - coherent and incoherent scattering. Coherent scattering from hydrogen molecules and sign of scattering lengths. Cross sections for ortho and para hydrogen - comparison with experiment. The optical theorem. Low energy scattering of protons by protons. Mott's modification of Rutherford formula. Experimental results. Effective range theory for p-p scattering. Analysis of n-p and p-p scattering at low energy. High energy n-p and p-p scattering and experimental results. Photo disintegration of deuteron - dipole approximation cross-section for photo disintegration - photoelectric disintegration cross section and angular distribution studies.

Text Books:

1. Roy R R and Nigam B P, 'Nuclear Physics – Theory and Experiment' (Wiley Eastern Ltd., 1993)
2. Emilio Segre, 'Nuclei and Particles', II Edn. (Benjamin, 1977)
3. Ghoshal S N, 'Atomic and Nuclear Physics', Vol. II (S Chand & Company, 1994)
4. Singru R M, 'Experimental Nuclear Physics' (Wiley Eastern, 1972)
5. Curtis L F, 'Introduction to Neutron Physics'
6. Wong, `Introduction to Nuclear Physics' (Prentice Hall, 1997)
7. Ponearu D N and Greiner W (ed) 'Experimental Techniques in Nuclear Physics' (Walter de Gruyter Berlin, 1997)
8. Glaston S, 'Introduction to Thermonuclear Reactions'

Reference Books:

1. Kenneth S Krane, 'Introductory Nuclear Physics' (John Wiley, 1986)

2. Enge H, ‘Introduction to Nuclear Physics’ (Addison Wesley, 1988)
3. Paul E B, ‘Nuclear and Particle Physics’ (North Holland, 1969)
4. Evans R D, ‘Atomic Nucleus’ (Tata McGraw Hill, 1972)
5. Kapoor S S and Ramamoorthy V S, ‘Radiation Detectors’ (Wiley Eastern, 1986)
6. Burcham W E, ‘Nuclear Physics’, II Edn. (Longman, 1963)
7. Siegbahn Kai, Alpha, Beta & Gamma Spectroscopy’, Vol. I, II (North Holland, 1979)
8. Marmier D and Sheldon E, ‘Nuclear Physics’, Vol. I, II (Academic Press, 1969)

PHY 504 RP : RADIATION PHYSICS II

Unit I Industrial applications of radiations [12 hrs]

Industrial radiography: X-ray and isotope radiography. Radiographic exposure devices, design, operation and accessories.

Activation analysis : Basic principles, advantages and limitations. Time of irradiation Vs half life. Choice of detectors and irradiation. Method of estimation. Decay and special characteristics.

Tracer techniques : Industrial and medical sources, choice of tracer. Tracer kinetics. Principles of applications of tracers in hydrological and industrial systems. Nucleonic gauges : Principle and measurement of thickness and level in different applications, density and moisture, hydrogen in hydrocarbons, well logging - techniques and principles, based on absorption, transmission and scattering of gamma, beta and neutron radiations. Consumer products : Principle of operation of fire detectors, static eliminators, luminous paints and gas mantles.

Unit II Production of X rays and Accelerator beams [12 hrs]

Medical and industrial accelerators – Safety aspects of medical accelerators – application of radiation in industry.

Unit III Industrial radiation processing [12 hrs]

Elements of radiation chemistry - production of free radicals, radical diffusion and formation of molecular products, G-Values, Chemical transformation. Applications of radiation processing in irradiation design and food preservation, radiation sterilization and chemical processing. Electron and gamma radiation application in polymerisation and cross linking. Radiopharmaceuticals, radiation sterilization of medical products. Polymerisation - wood, vinyl monomers, fibre boards, vulcanisation of rubber.

Unit IV Radiation hazard evaluation and control [12 hrs]

Hazard evaluation by calculation, methods of calculation, area monitoring, personal monitoring. Detection and measurement of contamination on work surface and person. Methods of decontamination. Planning of medical and industrial radiation installations. Radiation scattering, albedo, sky shine, noxious gas production.

Emergency preparedness for different types of radiation installations. Graded approach. Philosophy of response. On-site emergency and Off-site emergency.

Text Books:

1. Foldiak G (ed) 'Industrial application of radioisotopes' (Elsevier Science Publishing company, New York, 1986)
2. John R Lamarsh, `Introduction to Nuclear Engineering' (Addison Wesley Publishing Company, 1983)
3. Training manual for Health Physics qualification, (Level III), (compiled by Muay C D Kathuria S P, BARC, Mumbai, 1989)
4. Stewart D C, Handling Radioactivity: a practical approach for scientists and engineers, (Wiley Interscience Publication, 1981)

Reference Books:

1. Knoll G F, 'Radiation Detection and Measurements' (Wiley, New York, 1989)
2. Greening J R, Bristol, Adam Hilger, 'Fundamentals of Radiation Dosimetry' Medical Physics Hand Book 6, 1981
3. Morgan K Z and Turner J E, 'Health Physics' (Wiley, NY, 1978)
4. Mann W B, Et al, 'Radioactivity and its Measurements' (Pergamon Oxford, 1980)

5. Dillman L T, et al, ‘Radionuclide Decay Scheme and Dose Estimation’, Society of Nuclear Medicine, NY, MIRD Pamphlet No. 10, 1975
6. Taylor L S, ‘Radiation Protection Standards’ (CRC Press, Cleveland, Ohio, 1971)
7. Richard F. Mould, ‘Radiation Protection in Hospitals Medical Sciences Series’ (Adam Hilger Ltd, Bristol and Boston, 1985)
8. Kenneth R Kase, Bjarngard B E and Attix F H, ‘The Dosimetry of Ionising Radiation’ Vol I & II (Academic Press, 1985 & 1987)
9. James E Turner, ‘Atoms, Radiation & Radiation Protection’, (Pergamon Press, 1986)
10. ‘Inter-regional Training Course on Radiation Protection’, Dec. 12, 1984 to May 17, 1985, Lecture Notes, Vol. I to IV, (Compiled by Kathuria S P and Somasundaram S, BARC, Mumbai, 1985)
11. Herman Cember, ‘Introduction to Health Physics’ (Pergamon Press, 1983)

PHY 505 CM : CONDENSED MATTER PHYSICS - PRACTICALS I

1. X-ray powder photograph
2. Birefringence of quartz
3. Elastic constants of crystals
4. Thermal expansion
5. Ferroelectricity
6. Optical constants of metals
7. Thermal conductivity of insulators
8. Lattice vibrations – electrical analog

(Additional experiments may be included)

PHY 506 CM : CONDENSED MATTER PHYSICS - PRACTICALS II

1. Magnetoresistance
2. Hall effect
3. Fermi energy of metals
4. Thermionic emission
5. Energy gap using p-n junction
6. Junction capacitance of p-n junction
7. Thermoelectric effect
8. Photodetectors
9. Photovoltaic cell
10. Energy gap by four probe method

Reference Books:

1. Silsbee R H & Drager J 'Simulation for Solid State Physics' (Cambridge 1997)
2. Jerrard H G & Mc Neill D B 'Theoretical and Experimental Physics' (Chapman & Hall 1960)
3. Wooster W A & Breton A 'Experimental Crystal Physics', II Edn. (Clarendon Press 1970)
4. Wieder H H 'Lab notes on Electric and Galvanomagnetic measurements' (Elsevier 1979).

PHY 505 EL : ELECTRONICS –PRACTICALS I

1. Two stage CS amplifier
2. Cascode amplifier
3. Complimentary symmetry push - pull power amplifier
4. IC 311 comparator – window detector
5. Full wave precision rectifier with equal resisters
6. Frequency multiplication using PLL565
7. Phase shifter using opamp
8. Precision voltage reference

PHY 506 EL : ELECTRONICS –PRACTICALS - II

1. Amplitude modulation using AD633 analog multiplier
2. Demodulating AM voltage using AD633
3. PLL565 – Frequency synthesis
4. Frequency modulation and demodulation using IC 8038 and 560
5. Pulse width modulation
6. Frequency shift keying using PLL565
7. Pre-emphasis and de-emphasis
8. Pulse code modulation

PHY 505 NP : NUCLEAR PHYSICS – PRACTICALS I

1. Random nature of radioactive decay
2. Absorption of beta rays
3. End point energy of beta particles - Feather analysis
4. Energy calibration and resolution of GRS
5. Attenuation of gamma rays
6. Efficiency of alpha counting system
7. Rest mass energy of electron

PHY 506 NP : NUCLEAR PHYSICS – PRACTICALS II

1. Two stage FET amplifier
2. Bistable multivibrator
3. Coincidence circuit (discrete components)
4. Anticoincidence circuits (discrete components)
5. Linear pulse amplifier
6. Monoshot using ICs
7. Data analysis using PC

PHY 505 RP : RADIATION PHYSICS – PRACTICALS I

1. Random nature of radioactive decay
2. Dead time of GCS
3. Absorption of beta rays
4. End point energy of beta particles - Feather analysis
5. Energy calibration and resolution of GRS
6. Inverse square law
7. Rest mass energy of electron

PHY 506 RP : RADIATION PHYSICS – PRACTICALS II

1. Coincidence circuit (discrete components)
2. Anticoincidence circuits (discrete components)
3. Display devices
4. Linear pulse amplifier
5. Data analysis employing PC
6. Activity calculation using NaI(Tl) spectrometer
7. Attenuation of gamma rays

PHY 551 : QUANTUM MECHANICS II

Unit I Matrix formalism of quantum mechanics [12 hrs]

Linear vector spaces - orthogonality and linear independence, bases and dimensions, completeness, Hilbert's spaces. Hermitian operators. Bra and Ket notations for vectors. Representation theory. Schwartz inequality theorem - proof of Heisenberg uncertainty relation.

Unit II Quantum dynamics [12 hrs]

Equations of motion - Schrodinger and Heisenberg picture - quantum Poisson bracket. Harmonic oscillator problem solved by matrix method.

Angular momentum - angular momentum operator, commutation relations - raising and lowering operators - eigen values and eigen functions of L^2 and L_z - addition of two angular momentum - Clebech-Gordan coefficients - the 3-j symbol - Pauli spin matrices.

Unit III Approximation methods [12 hrs]

Perturbation theory for discrete levels - equations in various orders of perturbation theory - non-degenerate and degenerate cases, simple examples. Time dependent perturbation theory.

The variation method - the hydrogen molecule - exchange interaction. The WKB method.

Unit IV Relativistic quantum mechanics and elements of second quantisation [12 hrs]

Klein-Gordan equation for a free particle - Dirac equation - Dirac matrices - Dirac equation for central fields - negative energy solution, spin and magnetic moment of the electron.

Transition from particle to field theory. Second quantisation of the Schrodinger equation. Creation and annihilation operators - commutation and anti-commutation relation and their physical implications.

Text Books:

1. Thankappan V K, 'Quantum Mechanics' (Wiley Eastern Ltd., 1985)
2. Ghatak A K and Lokanathan S, 'Quantum Mechanics' (Macmillan, India, 1984)
3. Mathews P M and Venkatesan K, 'Text Book of Quantum Mechanics' (Tata McGraw Hill, 1976)
4. Powell J L and Crasemann B, 'Quantum Mechanics' (Addison Wesley, 1961)

Reference Books:

1. Schiff L I, 'Quantum Mechanics', III Edn. (McGraw Hill, 1969)
2. Merzbecher E, 'Quantum Mechanics', III Edn. (John Wiley & Sons, 1998)
3. Shankar R, 'Principles of Quantum Mechanics' (Plenum, 1980)
4. Sakurai J J, 'Modern Quantum Mechanics' Revised Edn. (Addison-Wesley, 1994)
5. Edmonds, 'Angular Momentum in Quantum Mechanics' (Princeton University Press, 1960)

PHY 552 : ASTROPHYSICS AND RELATIVITY

Unit I Astrophysics

Introduction – constellations, solstices, equinoxes, zodiac, temperature of stars and their classification, visible and invisible astronomy.

Asteroids, Comets and Meteorites.

Doppler effect. Hubble's law. Origin and evolution of solar system. Apparent and absolute magnitudes of stars. Measurement of stellar distances – method of heliocentric parallax, statistical parallax method, apparent luminosity method, spectroscopic parallax method. Variable star distances. Nova distances.

[12 hrs]

Unit II Energy generation in stars. Contents of milkyway galaxy.

Hertzsprung – Russel diagram – it's uses. Evolution of stars – star birth, evolution to, on and off the main sequence, evolution to the end.

White dwarfs, neutron stars, stellar explosions – nova, pulsars, black holes, binary X-ray systems and quasars.

Cosmological models – steady state and Big-Bang models. Evolution of Universe. Origin of life on earth.

[12 hrs]

Unit III Theory of relativity

Special theory : review – postulates of special theory of relativity, relativity of simultaneity and Lorentz transformation equation of lengths perpendicular and parallel to relative motion; time intervals, transformation of velocities and acceleration. Stellar aberration. Doppler effect. Relativistic force law and dynamics of single particle. Equivalence of mass and energy.

4 dimensional formulation of theory of relativity - Lorentz transformation, length contraction, time dilation, covariance of laws of nature. 4 dimensional line element. 4 velocity, 4 acceleration, 4 momentum and 4 force. Fundamental equations of motion of a particle in 4 dimensional vector form.

Inertial and gravitational mass. Eotvos experiment. [12 hrs]

Unit IV General relativity

Tensor calculus – Christoffel symbols – covariant differentiation of tensors – the equation of geodesic line – the Riemann – Christoffel tensors – transformation laws for the Christoffel symbols. Stress-Strain tensors – Maxwell's equation in tensor form.

Principles of equivalence and covariance. Schwarzschild line element. Schwarzschild radius. Tests for the theory of relativity – Advance of perihelion, light trajectory in a Schwarzschild field, gravitations shift of spectral lines. Experiment of Rebka and Pound.

[12 hrs]

Text Books:

1. Introduction to Astrophysics 'Baidyanath Basu' (PHI, 1997).
2. Michael Feilik and John Gaustad 'Astronomy the Cosmic Prospective' (John Wiley & Sons, Inc., 1990)
3. Resnik R, 'Introduction to Special Relativity' (Wiley Eastern, 1972)
4. Rindler W, 'Introduction to Special Relativity', II Edn. (Oxford University Press, 1991)

Reference Books:

1. Schutz B F, ‘A First Course in General Relativity’ (Cambridge University Press, 1985)
2. Feilik M, ‘Astronomy – the Evolving Universe’ III Edn (Harper and Row, 1982)
3. Boris A Vorontsov-Vel’yaminov, ‘Essay about the Universe’ (Mir Publishers, Moscow, 1985)
4. French A P, ‘Special Relativity’ (Thomas Nelson, 1968)
5. Moller C, Theory of Relativity II Edn. (Claredon Press, 1972)
6. Jean-Pierre-Luminet ‘Black Holes’ (Cambridge University Press, 1987)
7. D Mc Gillivray ‘Physics and Astronomy’ (McMillan, 1987)
8. Michael Berry ‘Principles of Cosmology and Gravitation’ (Cambridge University Press, 1976)
9. Rosser W G V, ‘An Introduction of the Theory of Relativity’ (ELBS – Butterworth, 1972)
10. Lord EA, Tensorl, Relativity and Cosmology’ (Tata McGraw Hill, 1976)
11. Ray d’Inverno, ‘Introducing Einstein’s Relativity’ (Oxford University Press, 1992)
12. Dixon W G, ‘Special Relativity, the Foundation of Modern Physics’ (Cambridge University Press, 1978)
13. Adler R, Bazin M & Schiffer M, ‘Introduction to General Relativity’, II Edn. (McGraw Hill, 1975)
14. Hughston L P and Tod K P, ‘An Introduction to General Relativity’ (Cambridge University Press)
15. Hans Stephani, ‘General Relativity’ II Edn. (Cambridge University Press, 1990)
16. Peter Gabrial Bergmann ‘Introduction to theory of Relativity’ (PHI, 1989)
17. Nigel Henbest and Heather Couper ‘The Restless Universe’ (George Philip, 1982)
18. Jagjit Singh. ‘Great Ideas and Theories of Modern Cosmology’ (Dover Publications, Inc., 1961)

PHY 553 CM : CONDENSED MATTER PHYSICS III

Unit I Ferromagnetism [12 hrs]

Classical molecular field theory. Heisenberg exchange interaction. Ising model. Spin waves and magnons. Bloch $T^{3/2}$ law. Band theory of ferromagnetism. Magnetisation of ferromagnets. Crystalline anisotropy. Domains. Bloch wall. Ferromagnetic materials. Neutron diffraction - magnetic structure.

Unit II Antiferro and ferrimagnetism [12 hrs]

Molecular field theory. Indirect exchange interaction. Antiferromagnetic materials. Helimagnetism.

Molecular field theory for ferrimagnetic materials. Spinels and garnets. Magnetic bubbles.

Unit III Magnetic resonance [12 hrs]

Susceptibility in alternating magnetic field. Spin lattice relaxation. Spin - spin relaxation. Paramagnetic resonance - conditions, line width, fine and hyperfine structure. Spectra of transition group ions.

Nuclear magnetic resonance - introduction, line shape and width. Resonance in non- metallic solids. Influence of nuclear motion. Chemical shift. Quadrupole effects and resonance. Ferromagnetic resonance.

Unit IV Materials I - Ceramics, Composite materials & glasses [12 hrs]

Ceramics : Introduction. Processing and properties of different types of ceramics.

Composite materials : Introduction. Classification. Dispersion reinforced, particle reinforced, laminated and fibre reinforced composites.

Glasses : Glass transition, glass formers. Methods of preparation. Microscopic structure - structural models. Ionic and electronic conduction. Defect controlled properties. Applications.

Reference Books**:**

1. Morrish A H, 'The Physical Principles of Magnetism' (Robert E Kreiger, 1980)
2. Crangle J, 'Solid State Magnetism' (Edmond-Arnold, 1991)
3. Kittel C, 'Introduction to Solid State Physics', IV Edn. (Wiley Eastern, 1974), VII Edn. (John-Wiley, 1995)
4. Ibach H & Luth H 'Solid State Physics' II Edn. (Springer, 2000)
5. Ashcroft N W and Mermin N D, 'Solid State Physics' (Harcourt, 1976)
6. Rao C N R and Rao K J, 'Phase Transitions in Solids' (McGraw Hill, 1978)
7. Rogalski M S and Palmer S B 'Solid State Physics' (Gordon & Breach, 2000)
8. Budinski K G, 'Engineering Materials', V Edn. (PHI, 1996)
9. Elliot S R, 'Physics of Amorphous Materials', II Edn. (Longman, 1990)
10. Callister W D, 'Materials Science and Engineering - An Introduction', IV Edn. (John-Wiley, 1997)

PHY 553 EL : ELECTRONICS III

Unit I Review of number systems - negative number representation - floating point representation.
Basic structure of computer systems (Ch. 1.1 to 1.14).
Introduction to CPU architecture. Interfacing devices (Ch. 2.1 to 2.55)
8085 architecture - register organization (Ch. 3.1 to 3.23)
8085 instruction set (Ch. 5.1 to 5.4)
Instruction cycle, machine cycle, timing diagram (Ch. 4)

[12 hrs]

Unit II Introduction to 8085 instructions (Ch. 6)
Programming techniques with additional instructions (Ch. 7)
Counters and time delays (Ch. 8)

[12 hrs]

Unit III Stack and subroutines (Ch. 9)
Interrupts (Ch. 12)
Interfacing data converters (Ch. 13)

[12 hrs]

Unit IV Peripherals: 8255 (Ch. 15.1), 8254 (Ch. 15.4), 8259A (Ch. 15.5)
Introduction to 8051 microcontroller
Introduction to 16 bit microprocessors. 8086/8088

[12 hrs]

(Note: Topics on 8085 are based on reference 1, chapter wise.)

Reference Books:

1. Gaonkar R S, 'Microprocessor architecture, programming and applications with the 8085', IV Edn. (Penram International, 2000)
2. Hall D V, 'Microprocessors and interfacing, programming and hardware', II Edn. (Tata McGraw Hill, 1992)
3. Mazidi M A & Mazidi J G, 'The 8051 Microcontroller', (Pearson Education Asia, 2001).
4. Ayala Kenneth J, 'The 8051 microcontroller' (Penram International, 1996)
5. Ayala K J, 'The 8086 Microprocessor', (Penram International, 1995)

PHY 553 NP : NUCLEAR PHYSICS III

Unit I Nuclear models [12 hrs]

Fermi gas model: kinetic energy for the ground state-asymmetry energy - nuclear evaporation.

Independent particle model: motion in mean potential, energy levels according to harmonic oscillator potential and infinite square well potential - effect of spin-orbit interaction.

Prediction of ground state spin, parity of odd-A nuclei and odd-odd nuclei - magnetic moments of odd-A nuclei and quadrupole moment.

Unit II Nuclear shell model [12 hrs]

Shell model for one nucleon outside the core-configurations for the excited states. Model for two nucleons outside the core. Residual interaction - ^{18}O Spectrum (qualitative) for two particles in $d_{5/2}$ orbit and in $d_{5/2}$ - $s_{1/2}$ orbits.

Collective model: collective vibrations and rotations. Nuclear quadrupole moments. Nilsson model - calculation of energy levels - prediction of ground state spin.

Unit III Nuclear reactions [12 hrs]

Background information for nuclear reaction - reaction mechanisms-comparison of features of compound nucleus model and direct reaction model.

Partial wave approach: partial wave analysis of nuclear reactions-expressions for scattering and reaction cross sections and their interpretations - shadow scattering. Resonance theory of scattering and absorption. Overlapping and isolated resonance. Breit-Wigner formulae. Shape of cross section curve near a resonance.

Unit IV Perturbation approach [12 hrs]

Nuclear reaction cross section - its behaviour near threshold - inverse reactions - principle of detail balance. Electron scattering - form factor and nuclear charge radius.

Neutron induced reactions - optical model - mean free path - optical potential and its parametrisation for elastic scattering.

Transfer reactions - semiclassical description. Plane wave Born approximation (PWBA) - its predictions of angular distributions - modifications - distorted wave Born approximation (DWBA) - spectroscopic factors and their significance.

Text Books:

1. Segre E, 'Nuclei and Particles', II Edn. (Benjamin, 1977)
2. Preston M A and Bhaduri R K, 'Structure of the Nucleus' (Addison Wesley, 1975)
3. Ghoshal S N, 'Atomic and Nuclear Physics', Vol. I & II (S Chand & Company, 1996)
4. Roy R K and Nigam P P, 'Nuclear Physics - Theory and Experiment' (Wiley Eastern Ltd., 1993)
5. Enge H, 'Introduction to Nuclear Physics' (Addison Wesley, 1988)
6. Sachler G R, 'Introduction to Nuclear Reactions', II Edn. (Macmillan Press, 1990)

Reference Books:

1. Marmier D and Sheldon E, 'Physics of Nuclei and Particle', Vol. I & II (Academic Press, 1969)
2. Blatt J M and Weisskopf V F, 'Theoretical Nuclear Physics' (John Wiley, 1952)
3. Krane K S, 'Introductory Nuclear Physics' (John Wiley, 1987)
4. Perkins D H, 'Introduction to High Energy Physics', II Edn. (Addison Wesley, 1982)
5. Soodak H and Campbell B C, 'Elementary Pile Theory' (John Wiley, 1950)

PHY 553 RP : RADIATION PHYSICS III

Unit I Radiation transport [12 hrs]

Basic concepts of radiation transport, Transport equation, Ficks's law and diffusion equation, Boundary conditions, Analytical solution to diffusion equation. Energy dependent transport and diffusion equation, slowing theory, resonance absorption. Criticality calculations. Fermi age theory. Four factor formula. Models and consequences of nuclear fission, cross sections of fission, capture, scattering and fission products.

Unit II Radiation shielding [12 hrs]

Shielding calculation for gamma radiation, choice of material, primary and secondary radiations, source geometry. Beta shielding, bremsstrahlung. Neutron shielding, scattering and absorption, activation of the shielding material, heat effects. Optimisation of shielding, shielded windows in hot cells, gamma, electron, neutron irradiation facilities. Transport and storage of containers for high activity sources. Shielding requirements for medical, industrial and research facilities including accelerator installations.

Unit III Radiation biophysics [12 hrs]

Basic aspects of cell biology and physiology. Mechanism of direct and indirect action of radiation at cellular level. Nature of radiation damage at molecular, subcellular and cellular level. Induction of chromosomal aberrations and its application in biological dosimetry of absorbed radiation. Cell killing and induction of mutations.

Target theory of cell inactivation and theoretical models for cell survival response, application of these models in therapy, food preservation, sterilization, sludge hygienization etc. Physical, chemical and biological modifiers of cellular response-dose, dose rate, dose fractionation, LET, hyperthermia oxygen, sensitizers, protectors, cell cycle stage, cellular repair processes. Law of Bergonie and Tribondeau-protocol for human cell sensitivity.

Radiation effects on human beings – deterministic and stochastic effects, parental radiation effects, radiobiological basis of risk evaluation and evolution of radiation protection standards. Dose limits.

Unit IV Principles of radiation protection [12 hrs]

Radiation protection standards : Need for protection, philosophy of radiation protection. ALARA principle. Time, distance, shielding. External and internal exposure. ICRP and AERB recommendations. Regulatory aspects of radiation protection : Atomic Energy Act, Radiation Protection Rules, Notifications, Transport regulations, Waste disposal Rules, Food irradiation rules, Licensing, Approval of devices and packages.

Text Books:

1. Glasstone S and Sesonske A, 'Nuclear Reactor Engineering' (CBS, Delhi, 1986)
2. Taylor L S, 'Radiation Protection Standards' (CRC Press, Cleveland, Ohio, 1971)
3. Kenneth J Schultz and Richard E Faw, 'Radiation Shielding' (Prentice Hall)
4. Erich J Hall, 'Radiology for the Radiologists', III Edn. (J B Lippincott Company, New York, 1988)

Reference Books :

1. Glasstone S, 'Source book on Atomic Energy' (East West Press, New Delhi, 1975)
2. Knoll G F, 'Radiation Detection and Measurements' (Wiley, New York, 1989)
3. Stewart D C, 'Handling Radioactivity: A Practical Approach for Scientists and Engineers' (Wiley Interscience Publication, 1981)
4. Dillman L T, et al, 'Radionuclide Decay Scheme and Dose Estimation', Society of Nuclear Medicine, NY, MIRD Pamphlet No. 10, 1975

5. Richard F. Mould, 'Radiation Protection in Hospitals', Medical Sciences Series, (Adam Hilger Ltd, Bristol and Boston, 1985)
6. Kenneth R Kase, Bjarngard B E and Attix F H, 'The Dosimetry of Ionising Radiation', Vol I & II (Academic Press, 1985 & 1987)
7. Arthur C. Upton et al, 'Radiation Carcinogenesis' (Elsevier, 1986)
8. Chilton A B, `Principles of Radiation Shielding' (Prentice Hall Inc)
9. Price Horton B T and Spinney, 'Radiation Shielding', (Pergaman Press)
10. Ronald L. Kathren, 'Radiation Protection', (Adam Hilger Ltd. International Publishers Services, 1985)
11. Cutler J H et al, 'The Chernobyl Accident and its Consequences', (UKAEA, II Charler II Street, London, 1987)
12. 'Nuclear Safety: After TMI and Chernobyl', Ed. by Ballard G M, (Elsevier, Applied Sciences, London, 1988)
13. 'Radiation & Health: The Biological Effects of Low Level Exposure to Ionising Radiation', Ed. by Robin Russel Jones & Richard Sourthwood, (Wiley Medical Publication, 1987)
14. James E Turner, Atoms, Radiation & Radiation Protection, (Pergamon Press, 1986)
15. Inter-regional Training Course on Radiation Protection, Dec. 12, 1984 to May 17, 1985, Lecture Notes, Vol. I to IV, (Compiled by Kathuria S P and Somasundaram S, BARC, Mumbai, 1985)
16. Training Manual for Health Physics Qualification, (Level III), (compiled by Muay C D Kathuria S P, BARC, Mumbai, 1989)
17. Herman Cember, Introduction to Health Physics, (Pergamon Press, 1983)
18. Eicholz G G and Ann Arbor Mich, `Environmental Aspects of Nuclear Power', (Ann Arbor Science, 1976)
19. Richard F Mould, `Radiation Protection in Hospitals Medical Science Series', (Adam Hilger Ltd., Bristol and Boston, 1985)
20. John R Lamarsh, `Introduction to Nuclear Engineering' (Addison Wesley Publishing Company, 1983)

PHY 554 CM : CONDENSED MATTER PHYSICS IV

Unit I Crystal defects [12 hrs]

Imperfections in crystals: classification of defects in crystals - point defects - their energy of formation - diffusion - ionic conductivity in pure and doped halides - colour centers – polorons, excitons. Dislocations - Burger's vector. Observation of dislocation - dislocations and crystal growth. Planar defects.

Luminescence in solids: Thermoluminescence – Electroluminescence.

Unit II Thin films [12 hrs]

Thin films: preparation techniques - physical vapour deposition - Knudsen cosine law. Sputtering, chemical methods, plasma processes.

Brief survey of thickness measurement techniques - quartz crystal thickness monitor.

Nucleation and growth: capillarity theory of nucleation. Growth stages and effect of deposition parameters - a brief account.

Electrical and optical properties of thin films - conduction in thin films - a qualitative description. Reflectance and transmittance of light by thin films - single layer antireflection coating. Applications.

Unit III Superconductivity [12 hrs]

Thermodynamics of superconductivity. London equations. Coherence length. Flux quantization.

Cooper Pairs. Accomplishments of BCS theory.

Basic concepts of tunnelling - one electron tunnelling in superconducting junctions. Cooper pair tunnelling. AC and DC Josephson effect - SQUIDS. High T_c superconductors.

Unit IV Materials II : Polymers & liquid crystals [12 hrs]

Polymers : Introduction. Classification. Molecular weight. Configuration. Polymerisation reactions. Polymer processing. Crystallanity. Conducting polymers. Applications.

Liquid crystals : Classification. Structure and texture. Orientational and translational order. Mechanical, optical, magnetic and electrical properties. Liquid crystal displays.

Reference Books:

1. Kittel C, 'Introduction to Solid State Physics', IV Edn. (Wiley Eastern, 1974), VII Edn. (John-Wiley, 1995)
2. Dekker A J, 'Solid State Physics' (MacMillan, 1971)
3. Ibach H and Luth H 'Solid State Physics', II Edn. (Springer, 2000)
4. Ashcroft N W and Mermin N D, 'Solid State Physics' (Harcourt, 1976)
5. Hass G and Thun R E, 'Physics of Thin Films', Vol. IV (Academic Press, 1967)
6. Chopra K L 'Thin Film Phenomena' (Robert E Kreiger, 1979)
7. Goswami A, 'Thin film fundamentals' (New Age, 1996)
8. Chopra K L and Malhotra L K (Ed) 'Thin film Technology and applications' (Tata McGraw Hill, 1985)
9. Tinkham M 'Introduction to Superconductivity' II Edn. (McGraw Hill, 1996)
10. Gowarikar V R, Vishwanathan N V and Shridhar J, 'Polymer Science' (Wiley Eastern, 1986)
11. Chandrasekhar S, 'Liquid Crystals', II Edn. (Cambridge, 1992)
12. Chiaken P and Lubensky T C, 'Principles of Condensed Matter Physics' (Cambridge, 1995)
13. Rogalski M S and Palmer S B 'Solid State Physics' (Gordon & Breach, 2000)

PHY 554 EL : ELECTRONICS IV

Unit I Optic fibre communication [12 hrs]

Relevance and advantages of OFC, description of a simple OFC link, types of optical fibres, Ray theory of light guiding in optical fibres, modal analysis of optical fibres (qualitative), single mode fibres, graded index fibres, signal attenuation and dispersion in optical fibres. Optical source to fibre coupling (basics), optical fibre splicing and connectors (basics).

Unit II Optical sources [12 hrs]

Structure and working of a laser diode. Single mode lasers (basic). Output characteristics and modulation characteristics of LED & laser diodes.

Optical detectors: Structure and working of PIN diode and avalanche photodiode. Quantum efficiency, responsivity and response speed of photodiodes. Noise characteristics of photo diodes. Optical receiver systems, digital and analog transmission systems. Power and rise time budget analysis.

Unit III Digital Signal Processing

Classification of signals, properties of discrete time signals and systems – linearity, stability and causality concepts. LTI systems – convolution. Fourier analysis of discrete time signals and systems. Sampling and modulation principles, aliasing effect, sampling theorem.
[6 hrs]

Z-transforms - transfer function – properties of Z-transform, pole-zero plot, inverse Z-transforms (partial fraction method and long division method) [5 hrs]

Unit IV Discrete Fourier transform (DFT) and IDFT. Circular convolution – properties of DFT, FFT algorithms (Radix 2) – flow charts. [7 hrs]

Discrete system realization: IIR structures - direct form I & II, CSOS and PSOS structures. Finite impulse response (FIR) structures: direct form and cascade structures. IIR filter design: qualitative analysis of impulse invariance and bilinear transformation methods. FIR filters - linear phase FIR design using window functions, Gibbs' phenomenon.
[6 hrs]

Reference Books:

1. Keiser G, 'Optical Fibre Communications', III Edn. (McGraw Hill ISE, 2000)
2. Senior J M, 'Optical Fibre Communication', II Edn. (PHI, 1996)
3. Ghatak A & Thyagarajan K, 'Introduction to Fibre Optics' (Cambridge University Press, 1999)
4. Haykin S, 'Signals and Systems' (John Wiley, 1998)
5. Oppenheim A V, Willsky A S and Nawab S H, 'Signals and Systems', II Edn. (PHI, 1997)
6. Proakis J G and Manolakis D G, 'Digital Signal Processing', III Edn., (PHI, 1992)
7. Salivahanan S, Vallavaraj A & Gannapriya G, 'Digital Signal Processing', (Tata McGraw Hill, 2001)
8. Mitra S K, 'Digital Signal Processing' (Tata McGraw Hill, 1998)
9. Oppenheim A V and Schafer R W, 'Discrete-Time Signal Processing' (PHI, 1992)
10. Roman Kuc, 'Introduction to Digital Signal Processing' (McGraw Hill, 1988).

PHY 554 NP : NUCLEAR PHYSICS IV

Unit I Reactor physics [12 hrs]

Fundamentals of nuclear fission – fission fuels. Neutron chain reaction , multiplication factor. Condition for criticality – Breeding phenomena. Different types of reactors – Fusion – Nuclear fusion in stars. Slowing down of neutrons by elastic collisions - logarithmic decrement in energy - number of collisions for thermalisation.

Elementary theory of diffusion of neutrons - spatial distribution of neutron flux (1) in an infinite slab with a plane source at one end and (2) in an infinite medium with point source at the centre. Reflection of neutrons - Albedo.

Slowing down density - Fermi age equation. Correction for absorption - resonance escape probability. The pile equations - Buckling. Critical size for spherical and rectangular piles.

Condition for chain reaction - the Four-factor formula. Thermal neutron reactor - Fast breeder reactor.

Unit II Heavy ion physics [12 hrs]

Special features of heavy ion Physics - remote heavy ion electromagnetic interaction - Coulomb excitation - close encounters - grazing interactions - particle transfer - direct and head on collision - compound nucleus and quasi molecule formations.

Unit III Particle physics [12 hrs]

Conservation laws and basic interactions relating to elementary particles - particles and antiparticles

Leptons - neutrinos, muon production and decay - muon capture, spin and magnetic moments of muons.

Pions - the Yukawa interaction, spin of pions - intrinsic parity - isotopic spin of pions. Pion-nucleon scattering and resonance. Nuclear collision, production and photo production of Pions. Rho, Omega and Eta mesons.

Unit IV Strange particles and weak interactions [13 hrs]

Strange particles: associated production – strangeness quantum number; GellMann-Nishijima formula – Kaons and Lambda, Sigma, Xi and Omega hyperons.

The Quark model – quark composition of particles.

Weak interactions: neutral Kaons. The K° - K° systems. Regeneration of the short lived component of neutral Kaons. CP violation – the CPT theorem.

Verification of electromagnetic and weak interactions – intermediate vector bosons.

Text Books:

1. Goshal S N, `Atomic & Nuclear Physics', Vol. II (S Chand & Company, 1994)
2. Wong, `Introduction to Nuclear Physics' (Prentice Hall, 1997)
3. Marmier D and Sheldon E, 'Physics of Nuclei and Particles', Vol. I, II (Academic Press, 1969)
4. Zweifel P F, 'Reactor Physics', International student Edn. (McGraw Hill, 1973)
5. Emilio Segre, 'Nuclei and Particles', II Edn. (Benjamin, 1977)

Reference Books:

1. Kenneth S Krane, ‘Introductory Nuclear Physics’ (John Wiley, 1986)
2. Glasstone S and Sesonske A, ‘Nuclear Reactor Engineering’ (CBS, Delhi, 1986)
3. Little field T A and Thorley N ‘Atomic and Nuclear Physics’, II Edn. (Nostrand Co., 1988)

PHY 554 RP : RADIATION PHYSICS IV

Unit I Anatomy, physiology and radiobiological basis of radiation therapy [10 hrs]

Anatomy and physiology relevant to radiodiagnosis and radiotherapy. Structural and functional aspects of different systems – haemopoietic, digestive, cardiovascular, skeletal, nervous, reproductive and endocrine systems.

Tumour biology – growth kinetics, tumour growth delay, tumour cure. Causes of clinical radioresistance. Fractionated radiotherapy, the 4 R's of radiotherapy-repair, reoxygenation, repopulation, reassortment. New modalities of radiation therapy.

Time dose fractionation, Concept of NSD, TDF and BED. Linear quadratic model of cell survival and its applications in the radiotherapy of cancer- values. ERD/BED doses for normal tissues and tumours. BED for fractionation and brachytherapy protocols. Correction for loss of BED, Correction for incomplete repair between fractions, designing alternative schedules.

Unit II Diagnostic radiology and modern trends in imaging techniques [10 hrs]

Physical principles of x-ray diagnosis, density, contrast, detail and definition of radiograph, choice of kV, mA, filtration, FSD, screens, films, grids, contrast media, concept of modular transfer function and its applications, radiographic techniques, special procedures: Myelography, Tomography, Fluoroscopy, Pelvimetry, Film processing, Image intensifiers and television monitoring, reduction of patient dose, quality assurance in diagnostic radiology, performance standards, acceptance and QA tests, Test tools for kV, timer, focal spot size, collimator, beam alignment, high contrast, film-screen contact and grid alignment.

CT scanners and their applications, digital subtraction radiography (DSA), Magnetic resonance imaging (MRI), ultrasound, Mammography, Xeroradiography, Thermography.

Review of algorithms used for treatment planning computation, Photon beam, electron beam, interstitial and intracavitary therapy, Factors to be incorporated in computational algorithms, Hardware and software requirements, Cost effectiveness of TPS.

Unit III Beam therapy [21 hrs]

Benign and malignant tumours, Tissue tolerance dose and tumour lethal dose, Fractionation, Palliative and Curative therapy, Spectral distribution of X-rays dose measurement, check phantom, Output calibration procedures, Backscatter and central axis depth doses, Isodose curves, Wedge filters, Shielding blocks and compensators, Treatment Planning in teletherapy, Role of computers, Corrections for body inhomogenity, Contour shapes and beam obliquity, Rotation therapy and tissue air ratio, Tissue maximum ratio, Integral dose, Telegamma therapy, Megavoltage X-ray therapy, Electron contamination, particulate beam therapy, relative merits of electron, x-ray and gamma ray beams, neutron capture therapy, Modern trends, Heavy ion therapy, Adjuncts such as hyperbaric oxygen, hyperthermia, radiosensitizers and chemotherapy.

QA in radiation therapy, Necessity for accuracy in clinical dosimetry, Dose inter-comparisons, Check of gantry and collimator movements and setting, Alignment of optical and radiation fields, isocentric shift, interlocks, control panel displays, Couch movements, timer accuracy, Check of beam directing devices, breast cones, trimmers.

Brachytherapy : Intracavitars, interstitial techniques and advantages, criteria for source selection, radium and radium substitutes, Caesium-137, Cobalt-60, Iridium-192, Iodine-125 sources, Paterson Parker and Manchester Dosage Systems. Afterloading techniques, Manual and remote, advantages radiographic localisation of implanted sources, Beta ray applicators, Use of computers in brachytherapy dosimetry, QA in brachytherapy equipment and sources. Calibration of sources, checking of source integrity and uniformity.

Unit IV Nuclear Medicine [7 hrs]

Clinical radioisotope laboratory organization, Radio-iodine in thyroid function tests, Iodine cycle, Tri-iodothyroxine test, Indices of thyroid function, use of Technetium-99m.

Iron clearance and utilization, Red cell survival, Bleeding from GI tract, Platelet survival, Absorption studies with vitamin B-12, iron, calcium and fat-use of whole body counters.

Physical principles of isotope dilution analysis, Discussion of multiple compartment systems, Measurement of circulation time, Renal, liver, lung, cerebral function studies, Placental localisation, Nuclear cardiology. Radioisotope Scanners and cameras, Single hole and Multihole collimators for scanning, Examples of organ scans. Cyclotron - produced radionuclides, SPECT and PET, In-vitro procedures, RIA kit.

Treatment of thyrotoxicosis, thyroid cancer with Iodine-131, use of Phosphorus 32 and gold 198 for therapy, patient doses. QA in preparation of radiopharmaceuticals, QA in imaging, flood phantom.

Text Books:

1. Erich J Hall, 'Radiology for the radiologists', III Edn. (J B Lippincott Company, New York, 1988)
2. Faiz M Khan, 'The Physics of Radiation Therapy'
3. Gilbert H Fletcher, 'Text book of Radiotherapy'
4. Dobbs J, Barret A , Ash D, 'Practical Radiotherapy Planning', II Ed. (Arnold, London)

Reference Books:

1. 'Inter-regional Training Course on Radiation Protection', Dec. 12, 1984 to May 17, 1985, Lecture Notes , Vol. I to IV (Compiled by Kathuria S P and Somasundaram S, BARC, Bombay, 1985).
2. 'Training Manual for Health Physics Qualification', (Level III), Compiled by Mulay C D and Kathuria S P, BARC, Bombay, 1989.
3. Meredith W J and Massay J B, 'Fundamental Physics of Radiology'
4. Govindarajan K N, Advanced Medical Radiation Dosimetry
5. Thomas S Curry, James E Dowdey, Robert C Murry, 'Christensen's Introduction to the Physics of Diagnostic Radiology'
6. Johnes H E and Cunninghum J R, 'The Physics of Radiology'
7. Schall W E, 'X-rays'
8. Young M E J, 'Radiological Physics'
9. Walter and Miller, 'A Short Book of Radiotherapy'
10. Oliver R, 'Radiation Physics in Radiology'
11. Robertson, 'Radiology Physics'
12. 'Quality Assurance and Surveillance in Diagnostic Radiology', Manual of procedures, Division of Radiological Protection, BARC, Bombay [1989)
13. Sue Griffiths and Chris Short, Radiotherapy: 'Principles to Practice-A Manual for Quality in Treatment Delivery'
14. William R Hendee and Geofferey S Ibbott, 'Radiation Therapy Physics'
15. Greene D, 'Linear Accelerators for Radiation Therapy'
16. Greening J R, 'Fundamentals of Radiation Dosimetry'
17. Mould R F, 'Radiotherapy Treatment Planning'
18. Wilks R, 'Principles of Radiological Physics'
19. Steel G C, Adams G E, Peckham M J, 'The Biological Basis of Radiotherapy' (Elsevier, Amsterdam, 1989)
20. Thames H D, Hendry J H, 'Fractionation in Radiotherapy' (Taylor and Francis, Bristol, 1987).

PHY 555 CM : CONDENSED MATTER PHYSICS - PRACTICALS III

1. Magnetic susceptibility
2. Ferromagnetism
3. Electron spin resonance
4. Phase diagram of binary alloys
5. Differential thermal analysis
6. Ionic conduction in glasses
7. Simulation experiments

PHY-556 CM : CONDENSED MATTER PHYSICS - PRACTICALS IV

1. Dislocation Density in metals
2. Thermoluminescence
3. Thin films – preparation and thickness measurement
4. Optical properties of thin films
5. Superconductivity
6. Thermally induced defects in solids
7. Polymers
8. Liquid crystals
9. Simulation experiments

Reference Books:

1. Silsbee R H & Drager J 'Simulation for Solid State Physics' (Cambridge 1997)
2. Jerrard H G & Mc Neill D B 'Theoretical and Experimental Physics' (Chapman & Hall 1960)
3. Wooster W A & Breton A 'Experimental Crystal Physics', II Edn. (Clarendon Press 1970)
4. Wieder H H 'Lab notes on Electric and Galvanomagnetic measurements' (Elsevier 1979).

PHY 555 EL : ELECTRONICS - PRACTICALS III

1. AD 630 triangular/square wave generator
2. AD 620 instrumentation amplifier
3. AD 633 Analog multiplier-Analog divider and Frequency doubler
4. ADC 670 Analog to Digital converter
5. 8085 microprocessor programming exercises:
   Data Transfer programs with all addressing modes.
   Programs using logical instruction.
   8-bit and 16-bit binary and BCD addition, subtraction, multiplication and division.
   Interfacing a D/A converter.
   Interfacing a A/D converter
   Interfacing a 7 Segment display.

PHY 556 EL : ELECTRONICS - PRACTICALS IV

1. Optic fibre communication experiments:
   Attenuation, coupler loss
   LED characteristics
   Design of a simple fibre link
2. Signal processing applications using MATLAB
3. I I R filter design (Butterworth filter)
4. F I R filter design – Gibbs phenomenon
5. Experiments using Klystrons and microwave bench

   (Additional experiments may be added)

PHY 555 NP : NUCLEAR PHYSICS – PRACTICALS III

1. Inverse square law for gamma radiation
2. Range of alpha particles in air
3. Experiments with SSNTD
4. Dead time of a Gm counting system
5. HPGe spectrometer
6. X-ray fluorescence in high Z materials
7. Scintillation characteristics

PHY 556 NP : NUCLEAR PHYSICS – PRACTICALS IV

1. Phase shifter using OP AMP
2. Pulse recorder
3. Pulse discriminator using IC
4. Display devices
5. Window Detector
6. Pulse shaping circuits
7. R-2R D/A converter

PHY 555 RP : RADIATION PHYSICS – PRACTICALS III

1. Experiments with SSNTD
2. Plastic scintillation spectrometer - beta ray source strength
3. HpGe Spectrometer
4. Efficiency of alpha counting system
5. Alpha particle spectrum using surface barrier detector
6. Frickey Dosimetry
7. Experiments using Microtron facility

PHY 556 RP : RADIATION PHYSICS – PRACTICALS IV
(Experiments to be conducted at BARC, Mumbai)

1. Internal bremsstrahlung
2. External bremsstrahlung
3. Plastic scintillation spectrometer - beta ray source strength
4. Characteristics of BF_3 / He-3 counters
5. Am-Be source strength using silver activation foil
6. Thermal neutron flux - using foil activation
7. Moderation of neutrons
8. Removal thickness for concrete and iron for neutrons