GOVERNMENT OF KARNATAKA

DEPARTMENT OF COLLEGIATE EDUCATION

GOVERNMENT COLLEGE (AUTONOMOUS)

KALABURAGI – 585 105

[ACCREDITED BY NAAC WITH 'A' GRADE]

BoS Approved copy of the Syllabus of

M.Sc. in Physics Course (CBCS)

w.e.f. 2018-19

Department of Postgraduate Studies in Physics

Approved by Academic Council

PRINCIPAL
Govt. College
Kusnoor Road, GULBARGA-585 105

Government College (Autonomous), Kalaburagi

Course Structure for Master of Science Programmes

Name of the Master Degree: **M.Sc. in Physics**

Course Code	Title of the Course	Total Credits	Teaching Hours / week	Marks Allocation					Total Max. Marks
				Internal		Semester end Exam			
				Max. Marks	Minimum Marks	Duration	Max. Marks	Minimum Marks	
Semester – I									
CCT1.1	Classical Mechanics	4	4	20	--	3 hrs	80	32	100
CCT1.2	Condensed Matter Physics	4	4	20	--	3 hrs	80	32	100
CCT1.3	Electrodynamics	4	4	20	--	3 hrs	80	32	100
DSET1.1 a) / DSET1.1 b)	Mathematical Methods of Physics / Fundamentals of Astrophysics	4	4	20	--	3 hrs	80	32	100
Practical 1.1	Practical 1.1	4	8	20	--	4 hrs	80	32	100
Practical 1.2	Practical 1.2	4	8	20	--	4 hrs	80	32	100
	Total	24							600
Semester – II									
CCT2.1	Quantum Mechanics - I	4	4	20	--	3 hrs	80	32	100
CCT2.2	Nuclear & Particle Physics	4	4	20	--	3 hrs	80	32	100
DSET2.1 a) / DSET2.1 b)	Statistical Mechanics / Plasma Physics	4	4	20	--	3 hrs	80	32	100
GET2.1	Modern Physics	4	4	20	--	3 hrs	80	32	100
Practical 2.1	Practical 2.1	4	8	20	--	4 hrs	80	32	100
Practical 2.2	Practical 2.2	4	8	20	--	4 hrs	80	32	100
	Total	24							600

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Semester – III									
CCT3.1	Quantum Mechanics - II	4	4	20	--	3 hrs	80	32	100
CCT3.2	Electronics & Experimental Methods in Physics	4	4	20	--	3 hrs	80	32	100
DSET3.1 a) / DSET3.1 b)	Biophysics I / Nanophysics I	4	4	20	--	3 hrs	80	32	100
GET3.1	Applied Physics	4	4	20	--	3 hrs	80	32	100
Practical 3.1	Practical 3.1	4	8	20	--	4 hrs	80	32	100
Practical 3.2	Practical 3.2	4	8	20	--	4 hrs	80	32	100
	Total	24							600
Semester – IV									
CCT4.1	Atomic & Molecular Physics	4	4	20	--	3 hrs	80	32	100
CCT4.2	Materials Physics	4	4	20	--	3 hrs	80	32	100
DSET4.1 a) / DSET4.1 b)	Biophysics II / Nanophysics II	4	4	20	--	3 hrs	80	32	100
Practical 4.1	Practical 4.1	4	8	20	--	4 hrs	80	32	100
Practical 4.2	Practical 4.2	4	8	20	--	4 hrs	80	32	100
CCPR 4.1	PROJECT WORK	6	6	30	--	--	120	48	150
	Total	26							650

CCT – Core Course Theory DSET – Discipline Specific Elective Theory GET – General Elective Theory CCPR 4.1 – Project Work

In the beginning of the Semester III & IV, the Department will notify the actual DSET course that it wants to offer depending on the availability of staff and facility. Accordingly, the students will be allotted the DSET Course.

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M.Sc. Physics – Semester I
CCT 1.1: CLASSICAL MECHANICS

Unit 1: Newtonian Mechanics **[16 hours]**

Mechanics of system of particles: Centre of mass, total angular momentum and total kinetic energy of the system of particles, conservation laws for linear momentum, angular momentum and energy.

Motion in a central force field: Equivalent one –body problem, reduced mass of the system, equation of motion and first integrals, The Kepler problem: inverse-square law of force, scattering cross-section, impact parameter, Rutherford scattering, centre of mass and laboratory co-ordinate systems and transformations.

Unit 2: Lagrangian Formalism **[16 hours]**

Constraints and their classification, degrees of freedom, generalized co-ordinates, principle of virtual work, D'Alemberts principle, Lagrange's equations of motion, Newton's laws of motion from Lagrange's equations, simple applications.

Symmetries of space and time and their connection with conservation laws, cyclic co-ordinates, Hamilton's variational principle and Lagrangian equations of motion from variational principle,

Unit 3: Hamiltonian Formalism **[16 hours]**

Hamilton's equations from variational principle and Legendre transformation, Hamiltonian and its physical significance, application of Hamiltonian formulation to harmonic oscillator and simple pendulum (with and without moving support).

Canonical transformations: generating functions, Poisson brackets and their properties, canonical equations in terms of Poisson bracket notation, angular momentum Poisson brackets, invariance under canonical transformations, Noether's theorem, Hamilton-Jacobi equation and its application to harmonic oscillator problem.

Unit 4: Rigid Body Dynamics **[16 hours]**

Angular momentum and kinetic energy of a rigid body, moment of inertia tensor, classification of rigid bodies as spherical, symmetric and asymmetric, Euler's equation of motion, motion of a symmetric top.

Relativistic mechanics: Four dimensional formulations: four-vectors, four-velocity, four-momentum and four-acceleration, Lorentz covariant form of equation of motion.

References:

1. Introduction to Classical Mechanics - R G Takwale and P S Puranik (Tata Mcgraw Hill, 1983)
2. Classical Mechanics - H Goldstein (Addison Wesley, 1980)
3. Classical Mechanics - N C Rana and P S Joag (Tata Mcgraw Hill, 1991)
4. Classical Mechanics of Particles and Rigid Bodies - Kiran C. Gupta (*New Age International Publishers*)
5. Classical Mechanics - JC Upadhyaya (*Himalya Publishers*)
6. Mechanics - A Sommerfeld (Academic Press, 1952)

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M.Sc. Physics – Semester I
CCT 1.2 CONDENSED MATTER PHYSICS

Unit 1 **[16 hours]**

Crystal structure:

Crystal systems, crystal classes, concept of point and space groups, Bravais lattice, unit cell, Wigner-Seitz cell, notations of planes and directions, Miller indices, Reciprocal lattice, NaCl, ZnS and diamond crystal structures.

Crystal binding:

Types of binding – Van der Waals-London interaction, repulsive interaction, Madelung constant, Born's theory for lattice energy in ionic crystals, ideas of metallic binding, Hydrogen bonded crystals.

Unit 2 **[16 hours]**

Lattice vibrations:

Vibrations of monoatomic and diatomic lattices, Brillion zone, quantization of lattice vibration, concept of phonon, phonon momentum, specific heat of lattice.

Energy bands in solids:

Formation of energy bands, free electron model: free electron in one and three dimensional potential wells, paramagnetism, Kronig-Penny model, Fermi-Dirac distribution, concept of Fermi energy.

Unit 3 **[16 hours]**

Transport properties:

Metals: Boltzmann equation, electrical conductivity, calculation of relaxation time, impurity scattering, ideal resistance, general transport coefficients, thermal conductivity, thermoelectric effects, lattice conduction, phonon drag.

Semiconductors: thermal conductivity, thermoelectric and magnetic effects, hot electron and energy relaxation times, high frequency conductivity, acoustic (deformation and piezoelectric) and optical (polar and non polar) scattering by electrons.

Unit 4 **[16 hours]**

Superconductivity:

Experimental survey, occurrence of superconductivity, effect of magnetic field, Meissner effect, persistent currents, Type I & Type II super conductors, London's equation, penetration depth, coherence length, energy gap, thermodynamics of superconducting transition, BCS theory, Josephson's tunneling effect (ac and dc), flux quantization, high T_c superconductivity,applications of superconductivity.

Reference Books

1. Introduction to Solid State Physics - Charles Kittel 7th Edition, John Wiley & Sons.
2. Solid State Physics - A.J. Dekker, Mac Millan Publications
3. Solid State Physics - H.C. Gupta, Vikas Publishing House.
4. Elementary Solid State Physics - M. Ali Omar, Addison Wesley.
5. Solid State Physics - M.A. Wahab, Narosa Publishing House.
6. Introduction to Solid - Azaroff
7. Solid State Physics - S.O. Pillai.
8. Solid State Physics - .L. Kakani and C. Hemarajan.

M. Sc. Physics – Semester I
CCT 1.3: ELECTRODYNAMICS

Unit 1: Electrostatics **[16 hours]**

Review of Columb's and Gauss law. The electrostatic scalar potential, Poisson and Laplace equations. The potential energy of charges and field energy density. The electric potential and fields due to monopole, dipole and quadrupole. The dipole in an external field and the dipole interaction energy. The multipolar expansion of potential and for the energy of localized charge distribution in an external field. The electrostatic filed in matter, polarization. The electrostatic boundary conditions.

Unit 2: Magnetostatics **[16 hours]**

The steady electric current, Biot-Savart law, magnetic field and Ampere's law. The magnetostatic field laws in integral and differential forms. The magnetic scalar and vector potentials. Potential and field of a circular current element- magnetic dipole. The dipole in an external field and the dipole interaction energy. The multipoles. Expansion for the potential of localized current distribution. Magnetic fields in matter. The energy in the magnetic field. The magnetostatic boundary conditions.

Unit 3: Electromagnetics **[16 hours]**

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

Unit 4: Electromagnetic waves **[16 hours]**

The wave equation, light and its electromagnetic character. Plane Waves in free space, waves in non conducting media and polarization. Electromagnetic waves in conducing media, skin depth. Electromagnetic waves in bounded media; Reflection and refraction of waves. Energy flux in a plane wave. The retarded potentials, Lienard-Wiechart potentials and fields for a moving point change.

Relativistic Electrodynamics: The principle of invariance-Lorentz transformations. Four-vectors in electro-dynamics and the covariant formulation of the laws of electrodynamics.

References

1. Introduction to Electrodynamics: D J Griffith (Prentice-Hall, 1981)
2. Classical Electromagnetic Radiation: J B Marion (Academic, 1968)
3. Classical Electrodynamics: C D Jackson (Wiley Eastern, 1978)
4. Electromagnetics: B B Laud (Wiley Eastern, 1987)
5. The Feynman Lectures on Physics-II: R P Feynman (Addison Wesley, 1964)
6. Classical Electricity and Magnetism: W Panofsky & M Philips (Addison Wesley, 1962)

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M.Sc. Physics – Semester I
DSET 1.1a): MATHEMATICAL METHODS OF PHYSICS

Unit 1 **[16 hours]**

Special Functions: Beta and Gamma functions- definition and properties. Legender's equation, solution, Legender's polynomials and recurrence formulae. Bessel's equation, solution, Bessel function and recurrence formulae. Laguerre's equation, solution and recurrence formulae. Hermite equation, solution and recurrence formulae.

Green's Functions: Green's function method of solving boundary value problems, Green's functions for one dimensional problems, eigen function expansion of Green's function, Green's function in higher dimensions, some applications.

Unit 2 **[16 hours]**

Tensors: superscripts and subscripts, conventions, contrvariant vectors, covariant vectors. Algebraic operations of tensors: addition & subtraction, outer product, contraction of tensor, inner product, Quotient law. Symmetric and antisymmetric tensors. Fundamental tensor: covariant fundamental tensor, contravariant fundamental tensor, mixed fundamental tensor. Raising and lowering of indices, associated tensors. Christoffel's 3-index symbols. Application of tensor theory to electrical conductivity, moment of inertia, piezoelectric strain coefficient, stress, strain, elastic moduli.

Unit 3 **[16 hours]**

Fourier Transform: Definition, properties of transform, transform of a derivative, finite sine and cosine transform, transforms of some simple functions, some physical applications.

Laplace Transforms: Definition, properties of transform, derivative of transform , transform of the derivative of a function, transform of integral, transform of periodic function, transforms of some simple functions, inverse transform, convolution theorem, some physical applications.

Unit 4 **[16 hours]**

Numerical Techniques: Curve fitting: Method of least Squares- linear fitting and non-linear curve fitting, Differentiation: Newton's formula, Integration: Trapezoidal rule, Simpson's 1/3 and 3/8 rules, Solutions of ordinary differential equations: Euler's modified method and Runge-Kutta method

C-Language and Programming: Constants and variables, arithmetic expressions, data types, input and output statements, control statements, switch statements, the loop statements, format specifications, functions. Examples for programming in C; solutions of algebraic equations-quadratic and higher order equations, linear least square fit, numerical integration - Trapezoidal rule, Simpson'sl/3 and 3/8 rules, numerical differentiation- Euler's modified method, Runge Kutta 2^{nd} and 4^{th} order methods.

References

1. Introduction to Mathematical Physics by C Harper, PHI.
2. Mathematical Physics by P K Chattopadhaya, Willey Eastern Ltd, Mumbai.
3. Mathematical Physics by Satya Prakash, S Chand and Sons, New Dehli.
4. Mathematical Physics by Arfkin
5. Mathematical Physics by R.K.Bose and M.C.Joshi
6. Introductory Methods of Numerical Analysis; S S Sastry PHI,1995.
7. Matrices and Tensors in Physics: A W Joshi

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M.Sc. Physics – Semester I
DSET 1.1b): FUNDAMENTALS OF ASTROPHYSICS

Unit 1: Introductory Astronomy **[16 hours]**

History of Astronomy; Overview of the major constituents of the universe; Solar System, Planets - laws of motion of planets, inner planets, outer planets; Extrasolar planets- Methods of detection of extrasolar planets; Black body radiation-specific intensity, luminosity; Basics of radiative transfer-emission coefficient, absorption coefficient, source function.

Unit 2: Stellar Astronomy **[16 hours]**

Stars-general distances to stars - trignometric parallax; Stellar brightness - luminosity, flux, apparent magnitude, magnitude system, distance modulus, colour index, extinction, colour temperature, effective temperature, Measuring stellar masses and radii; Stellar spectra – colours of stars, Motion of stars-radial velocity, spectral classification of stars, luminosity classification of stars, HR diagram, Stellar population- Population I and II, Star clusters-open clusters, globular clusters, Energy generation in stars: PP chain.

Unit 3: Galactic astronomy and Extragalactic Astronomy **[16 hours]**

Milky way; Hubble classification of galaxies-Spiral galaxies, Elliptical galaxies, Irregular galaxies, Dwarf galaxies; Masses of galaxies-Rotation curves of galaxies; Dark matter.

Groups and clusters of galaxies, Interacting galaxies; Active galaxies, Seyfert galaxies, radio galaxies, FR-I and FR-II sources, Quasars- accretion, accretion efficiency, superluminal motion, Eddington luminosity; radiation mechanisms in active galaxies; gravitational lensing.

Unit 4: Cosmology **[16 hours]**

Distances- direct distances-trignometric parallax; indirect distances-standard candles, main sequence fitting, cepheids variables, RR Lyrae variables, Supernovae, gravitational lensing; Expansion of the universe-Hubble's law, redshift; Newtonian Cosmology; microwave background, early universe.

References:

1. The physical universe, University of California, 1982, Shu F.
2. Astrophysics-stars and galaxies: K D Abhyankar (Tata McGraw Hill, 1990)
3. An introduction to Modern Astrophysics, Bradley W. Carroll & Dale A. Ostlie
4. Structure and Evolution of stars: M Schwarachild (Dover, 1958)
5. Astrophysical concepts, Harwit M.
6. Astrophysics vol I & II: R Bowers and T Deeming (Jones & Bartlett, 1984)
7. Radiative processes in Astrophysics, G. B. Rybicki & Lightman A. P.

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M.Sc. Physics – Semester I
List of Experiments

Practical 1.1

1. Dead time of G M Counter
2. Verification of Inverse-Square Law using G M Counter
3. Analysis of stopping power and energy Loss.
4. Alpha scattering cross-section analysis.
5. Determination of Interplanar spacing
6. Resistivity by Four probe method
7. Specific heat of metals.
8. Determination of Debye's temperature of Lead or Tin.
9. Activation energy of point defects in metals.
10. Binomial Distribution - Coin Tossing
11. Poisson's distribution
12. Gaussian Distribution
13. Faraday's laws of EMI

Practical 1.2

1. Particle size of Lycopodium powder
2. Wavelength (λ) of a laser using grating element
3. Photocell - h/e
4. Calibration of spectrometer using Talbot's band.
5. Excitation and ionization potentials.
6. e/m by Millikan's oil drop method.
7. LCR – Series & Parallel (L= 100mH, C=1μF, R=10 ohm)
8. Study of CRO
9. Inverting & Non-inverting Op-Amp
10. Logic Gates
11. Least Square Fitting (Analysis)
12. Rydberg's constant

Note: As and when developed, new experiments will be introduced.

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M.Sc. Physics – Semester II

CCT 2.1: QUANTUM MECHANICS-I

Unit 1 **[16 hours]**

Wave Mechanics: Development of Schrödinger time-independent and time-dependent wave equation. Heisenberg uncertainty principle with illustrations and applications, dual nature of wave and particle, Davisson and Germer experiment, Ehrenfest's theorem.

Formalism: Linear vector space, Hilbert space, Dirac's Bra and Ket notations. Operators: Linear, Parity, Projection, Unitary, Commutators, Hermitian and Hermitian-conjugate. Properties of Hermitian operator, Operators associated with different observables, Problems. Matrix representation of an operator, normalization and orthogonality of wave function in matrix form, matrix method solution of linear harmonic oscillator. Schrödinger, Heisenberg and Interaction pictures. Coordinate and Momentum representations.

Unit 2 **[16 hours]**

Solution of Schrödinger equation:

(i) One dimensional problems-Particle in Infinite and Finite Square potential well, Penetration of a Rectangular potential barrier of finite width and linear harmonic oscillator.

(ii) Three dimensional problems-Particle in a box, Free particle wave function, Motion of a charged particle in a spherically symmetric field, Hydrogen atom.

Unit 3 **[16 hours]**

Approximation methods: Time independent perturbation theory for non-degenerate levels-energy and wave function in the first order: Application to perturbed harmonic oscillator of the form λx^2, λx^3 and λx^4 .Variation method: Application to ground state of the Hydrogen atom and the Helium atom.

Unit 4 **[16 hours]**

Time dependent perturbation theory: Perturbation theory for zero, first and second order transition amplitudes and their physical significance. Application of first order theory: constant perturbation. Wide and closely spaced levels-Fermi's golden rule: Scattering of free particle by a potential, Harmonic perturbation, Interactions of an atom with electromagnetic radiation-dipole transitions and selection rules, Spontaneous and induced emission- Einstein's A and B coefficients, Sudden approximation.

References

1. Quantum Mechanics: L I Schiff (McGraw-Hill, NY, 1968)
2. A Text book of Quantum Mechanics: P M Mathews and K Venkateshan (TMH, 2010)
3. Quantum Mechanics: V K Thankappan (New Age Int. Pvt. Ltd.2003)
4. Quantum Mechanics Theory and Applications: A K Ghatak & S Lokanathan
5. Introduction to Quantum Mechanics: L Pauling and E B Wilson (McGraw Hill, 1935)
6. QuantumMechanics: G.Aruldas, 2nd Edn. (PHI learning Pvt Ltd. 2009)

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M.Sc. Physics – Semester II
CCT 2.2 NUCLEAR AND PARTICLE PHYSICS

Unit 1 **[16 hours]**

Basic Properties of Nuclei: Nuclear mass, mass defect, binding energy, nuclear radius. Estimation of the nuclear radius: Rutherford's scattering experiment, coulomb potential energies of mirror nuclei. Nucleon quantum numbers, nuclear spin, parity of a nuclei, nuclear magnetic dipole moment and nuclear electric quadrupole moment.

Nuclear Forces: General features of nuclear forces. Properties of deuteron. Square well solution for the deuteron. Deuteron electric and magnetic moments. Evidence for non-central nature of nuclear forces. Yukawa's meson theory of nuclear forces.

Unit 2 **[16 hours]**

Nuclear Reactions: Reaction scheme, types of reactions. Reaction kinematics: Q-value, energetics of exoergic and endoergic reactions. Bohr's compound nucleus theory of nuclear reaction. Nuclear Energy: Fission process, fission chain reaction, four factor formula, energetics of fission reaction, fission reactor. Nuclear fusion, thermonuclear reactions, source of energy in stars.

Nuclear Models: The liquid drop model: Bethe-Weizsacker's semi empirical mass formula. The shell model: Evidence for magic numbers, nuclear spin-orbit coupling, filling of nuclear shell levels. Predictions of shell model-nuclear spin and parities of nuclear ground states, magnetic dipole moments-Schmidt limits. Collective model.

Unit 3 **[16 hours]**

Nuclear Decays: Alpha decay: properties, disintegration energy, range, Geiger-Nuttall law Gamow's theory of alpha decay. Beta decay: properties, processes, continuous beta spectrum, Pauli's neutrino hypothesis, Fermi's theory of beta decay. Gamma decay: properties, selection rules.

Interaction of Radiation with Matter: Interactions of charged particles with matter-Stopping power of heavy charged particles, range energy relations; Stopping power and range for electrons. Interaction of gamma rays-photoelectric, Compton and pair production processes. Nuclear radiation detectors-G M counter and Scintillation detector.

Unit 4 **[16 hours]**

Elementary Particle Physics: Fundamental interactions in nature. Classification of elementary particles. Conservation laws: conservation of energy, momentum, angular momentum, parity, C-parity, CPT theorem, CP violation in weak interactions, isospin, strangeness. Elementary particle symmetries- SU(2) and SU(3) symmetries. Gell-Mann-Nishijima scheme. Quark hypothesis, charm, beauty and truth, gluons. Quantum chromodynamics, electroweak interaction theory, Grand Unification Theory (GUT).

References

1. The Atomic Nucleus: R D Evans (TMH)
2. Nuclear and Particle Physics: W E Burcham and M Jobes (Addison Wesley, 1998)
3. Nuclei and Particles: E Segre (Benjamin)
4. Nuclear Physics: D C Tayal (Himalaya)
5. Nuclear Physics: R C Sharma (Khanna)
6. Introduction to Nuclear Physics: S B Patel (Wiley eastern)
7. Introductory Nuclear Physics: Kenneth S Krane (Wiley)
8. Atomic and Nuclear Physics: S N Ghoshal (Chand)

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M. Sc. Physics – Semester II
DSET 2.1a): STATISTICAL MECHANICS

Unit 1: Basics of Thermo-dynamical and Statistical concepts **[16 hours]**
The laws of thermodynamics and their implications. Thermodynamic potentials, Maxwell's relations and their applications. Phase space, ensembles, Ergodic hypothesis and Liouville's theorem. Probability, probability distribution and the most probable distribution. The probability distribution and partition function. Microcanonical, canonical and grand canonical ensembles, thermodynamic potentials and the partition function.

Unit 2: Classical statistics **[16 hours]**
Partition function of a system of particles. The translation partition function, Gibbs paradox and Boltzmann equipartition theorem. Rotational and vibrational partition function. Einstein relation and electronic partition function. The various partition functions and the Corresponding thermodynamic potentials. Maxwell-Boltzmann distribution and its physical applications.

Unit 3: Quantum statistics **[16 hours]**
The symmetry and anti symmetry of the wave functions, Bosons and Fermions, Bose-Einstein and Fermi-Dirac distributions. Ideal Bose and Fermi gases- their properties at high and temperatures and densities. Bose –Einstein condensation. Blackbody radiation and photons. The phonons and specific heat of solids.

Unit 4: Fluctuations **[16 hours]**
Fluctuations in canonical, grand canonical and microcanonical ensembles.The Brownian motion and Langevin equation. Random walk, diffusion and the Einstein relation for mobility. Fockker-Plank equation. Johnson noise and shot noise. Onsager reciprocity relations.

References
1. Statistical Mechanics: K Huang. (Wiley Eastern.)
2. Statistical Mechanics and Properties of matter: E S R Gopal. (Macmillan.)
3. Elementary Statistical physics: C Kittel. (John Wiley.)
4. Fundamentals of Statistical and Thermal Physics: F Reif (Mc Graw Hall.)
5. An Introduction to Statistical physics: W G V Roser. (John Wiley.)
6. Thermodynamics of irreversible Processes: S R de Groot.
7. Statistical physics: L D Landau and E M Lifshitz. (Pergamon)

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M.Sc. Physics – Semester II
DSET 2.1b): PLASMA PHYSICS

Unit I: Plasma properties [16 hours]
Occurrence of plasma in nature, definition of Plasma, Debye shielding, plasma parameters, criteria for plasma. Single particle motions: uniform E and B fields, non uniform B field, non uniform E field, time-varying E field time-varying B field, guiding centre drifts, adiabatic invariants.

Unit II: Plasma as fluids [16 hours]
Relation between Plasma Physics and Electromagnetics, the fluid equation of motion, fluid drift perpendicular to B, fluid drifts parallel to B, plasma approximation.

Unit III: Kinetic approach to Plasma [16 hours]
Equations of kinetic theory, derivation of the fluid equations, Plasma oscillations and Landau damping (physical derivation), ion Landau damping, kinetic effects in a magnetic field.

Unit IV: Waves in Plasma [16 hours]
Representation of waves, plasma oscillations, electron plasma waves, sound waves, ion waves, plasma approximation and its validity, comparison of ion and electron waves, electromagnetic waves in magnetized plasma. Hydromagnetic waves, magneto sonic waves.

References:
1. Introduction to Plasma Physics and controlled fusion: F F Chen (Plenum, 1984)
2. Principles of Plasma Physics: N A Krall and A W trivelpiece (McGraw Hill, 1973)
3. Plasma Physics: R A Cairns (Blackie, 1985)
4. Introduction to Plasma theory: D R Nicholson (John Wiley, 1983)
5. The Theory of Plasma Waves: T H Stix(McGraw Hill, 1962)
6. Magneto hydrodynamics: T G Cowling(Interscience, 1957)
7. Foundations of Plasma Dynamics: E H Holt and R E Huskell (McGraw Hill, 1965)
8. Plasma diagnostic techniques:RH Huddlestone&LSLeonard (Eds, Academic, 1965)
9. Methods in Non-linear Plasma Physics: R C Davidson (Academic, 1972)
10. MHD Instabilities: G. Bateman (MIT, 1978)

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M.Sc. Physics – Semester II
GET 2.1: MODERN PHYSICS

Unit 1:Basics of Quantum Mechanics **[16 hours]**
Inadequacy of classical physics, postulates of quantum mechanics, wave particle dualism, Heisenberg's Uncertainty Principle, Schrodinger wave equation in one dimension and three dimensions, physical interpretation of wave function, energy eigen values and eigen functions, applications: particle in 1D square well potential and harmonic oscillator.

Unit 2: Elements of Nuclear Physics **[16 hours]**
Basic properties of nucleus: composition, charge, mass, size, density, spin, atomic mass unit, mass defect, binding energy, nuclear forces, Yukawa meson theory.
Radioactivity: natural and artificial. Laws of radioactivity, half life period, average life time, radioactive equilibrium, types of radiations and their properties: alpha, beta and gamma decay (qualitative), medical, industrial and agricultural applications of nuclear radiations, nuclear fission and fusion processes (qualitative).

Unit 3: Elements of Solid State Physics **[16 hours]**
Crystal structures: lattice, basis, unit cell, Bravais lattice and crystal systems, Miller indices, NaCl and ZnS crystal structures.
X-ray diffraction: Bragg's law, Bragg's x-ray spectrometer.
Semiconductors: Intrinsic and extrinsic semiconductors, concept of majority and minority carriers, electrical conductivity.
Superconductors: Superconductivity, zero resistance, Meissner effect, persistent currents, classification into Type I and Type II superconductors,, applications of superconductors.

Unit 3: Elements of Biophysics **[16 hours]**
Bio-potential – Nervous system and neuron, Electric properties of Nerve, Electrical potential of nerve, Nernst Equation, Biopotentials - ECG, EEG, Magnetic signals from heart and brain.
Biomaterials – Introduction, Bio-ceramics, Bio-polymer, Bio-steel, Bio-chip, Blood as a Biomaterial,

References

1. Quantum Mechanics - L I Schiff [McGraw-Hill, NY, 1968]
2. A Text book of Quantum Mechanics - P M Mathews and K Venkateshan [TMH,1994]
3. Nuclear Physics - D C Tayal (Himalaya)
4. Nuclear Physics - R C Sharma (Khanna)
5. Introduction to Nuclear Physics - S B Patel (Wiley eastern)
6. Elementary Solid State Physics - Principles and Applications, MA Omar, Addison
7. Introduction to Solid State Physics - C. Kittel, Wiley Eastern
8. An introduction to biophysics: C Sybesma (Academic, 1977)
9. Biophysics and human approach: I W Sherman and V G Sherman (Oxford, 1979)

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M.Sc. Physics – Semester II
List of Experiments
Practical 2.1

1. Wavelength (λ) of a Laser –Single Slit
2. Wavelength (λ) of Sodium light- Michelson Interferometer
3. Analysis of line spectra using Hartman's formula.
4. Raman Spectrum (Analysis)
5. Summing & Difference -OP-Amp
6. Integrator & Differentiator-OP-Amp
7. Timer IC-555 & Flip-Flop
8. Voltage to Current Converter using OP-Amp
9. Current to Voltage Converter using OP-Amp
10. Spectral response analysis of solid state Detector
11. Mosley's Law (Analysis)

Practical 2.2

1. Determination of Half-life of Potassium
2. Attenuation of gamma rays
3. Study of scintillation detector
4. Gamma ray spectrum using Scintillation Detector
5. Study of beta ray spectrum
6. Attenuation of Beta-rays
7. Ultrasonic velocity in solids
8. Thermoelectric power of a semiconductor
9. Thermoelectric Power of a metal
10. Thermistor Characteristics
11. Curie temperature of a Ferromagnetic material
12. Magnetic Susceptibility of liquid –Quinke's method
13. Energy Gap of a Semiconductor diode

Note: As and when developed, new experiments will be introduced.

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M.Sc. Physics – Semester III
CCT 3.1: QUANTUM MECHANICS-II

Unit 1 **[16 hours]**

Theory of Scattering: Differential scattering cross section, scattering amplitude and their relation. Method of partial wave analysis: Scattering amplitude in terms of phase shifts, Optical theorem, Applications- Scattering by a hard sphere and attractive square potential well. Born approximation: condition for validity of Born approximation, Applications-scattering by square potential well and screened coulomb potential.

Unit 2 **[16 hours]**

Identical particles and spin: Indistinguishability of identical particles, symmetric and antisymmetric wave functions, Pauli's exclusion principle and spin of electrons. Pauli spin operators and matrices, singlet and triplet states of Hydrogen molecule and He atom, spin angular momentum.

Angular momentum: Angular momentum operators, commutation relations, eigen values and eigenvectors, matrix representation, orbital angular momentum. Addition of angular momenta, Clebsch-Gordon coefficients for simple cases.

Unit 3 **[16 hours]**

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

Relativistic wave equations: Klein-Gorden equation for free particle and electromagnetic field. Dirac's relativistic equation: free particle, properties of Dirac matrices, free particle solutions. Negative energy states. Dirac's equation in electromagnetic field, Dirac's equation for central field. Spin orbit energy. Separation of the equation. Hydrogen atom. Classification of energy levels.

Unit 4 **[16 hours]**

Quantization of wave fields: Classical and quantum field equations; co-ordinates of the field. Lagrangian formulation. Hamiltonian formulation. Quantum equations for the field. Second quantization. Quantization of non-relativistic Schrödinger wave equation: Quantum equations.

References

1. Quantum Mechanics: L I Schiff (McGraw-Hill, 1968)
2. A Text book of Quantum Mechanics: P M Mathews & K Venkateshan (TMH, 2010)
3. Quantum Mechanics: V K Thankappan (New Age Int. Pvt. Ltd.2003)
4. Quantum Mechanics: B K Agarwal and Hariprakash (Prentice-Hall, 1997)
5. Quantum Mechanics – B.H. Bransden and C.J. Joachain, 2nd Edn. Pearson Edu., 2007.
6. Quantum Mechanics Theory and Applications: A K Ghatak & S Lokanathan
7. Quantum Mechanics : G Aruldas, 2nd Edn. (PHI Learning Private Ltd. 2009)
8. Quantum Mechanics: Chatwal & Anand (Himalaya Publishing House)

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M. Sc. Physics – Semester III

CCT 3.2: ELECTRONICS AND EXPERIMENTAL TECHNIQUES IN PHYSICS

Unit 1: Digital Electronics **[16 hours]**

Boolean algebra, minimization of Boolean functions; logic gates; digital IC families (DTL, TTL, ECL, MOS, CMOS). Combinatorial circuits: arithmetic circuits, code converters, multiplexers, decoders. Sequential circuits: latches and flip-flops, counters, comparators and shift-registers. ADCs and DACs. Semiconductor memories. Microprocessor (8085): architecture, programming, memory and I/O interfacing.

Unit 2: Electronic Instruments **[16 hours]**

Transducers (temperature, pressure/vacuum, magnetic fields, vibration, optical, and particle detectors). Measurement and control. Impedance matching, amplification (Op-amp based, instrumentation amp, feedback), filtering and noise reduction, shielding and grounding. Fourier transforms, lock-in detector, box-car integrator, modulation techniques. High frequency devices (including generators and detectors).

Unit 3: Structural Characterization and Thermal Analysis **[16 hours]**

X-ray Diffraction – Production of X-rays, Types, Bragg's diffraction condition.

XRD Techniques – Laue's method, Rotating crystal method, Debye-Scherrer method, x-ray diffractometer, Scherrer formula for crystal size determination.

Thermal Techniques: Principle, Instrumentation and working of Thermo-gravimetric (TGA), Differential Thermal Analysis (DTA), Differential Scanning Calorimetry (DSC).

Unit 4: Morphological, Spectroscopic and Magnetic Characterization **[16 hours]**

Electron Microscopy: Principle, Instrumentation and Working of Scanning Electron Microscope (SEM), Transmission Electron Microscope (TEM).

Scanning Probe Microscopy: Principle, Instrumentation and Working of Scanning Tunnelling Microscope (STM), Atomic Force Microscope (AFM) and Magnetic Force Microscopy (MFM).

Spectroscopic Techniques: Principle, Instrumentation and Working of X-ray Absorption (XPS), Electron Spin Resonance (ESR), Nuclear Magnetic Resonance (NMR).

Magnetic Techniques: Principle, Instrumentation and Working of Vibrating Sample Magnetometer (VSM).

Reference Books:

1. Instrumentation: Devices and Systems, C.S. Rangan, G.R. Sarma and V.S.V. Mani, Tata Mc Graw Hill Publishing Co. Ltd.
2. Instrumental Methods of Chemical Analysis, G. Chatwal and S. Anand, Himalaya Publishing House
3. Instrumental Methods of Analysis by H.H. Willard, L.L. Merritt, J.A. Dean, CBS Publishers
4. Characterization of Materials, John B. Wachtman & Zwi. H. Kalman, Pub. Butterworth Heinemann (1992)
5. Elements of X-ray diffraction, Bernard Dennis Cullity, Stuart R. Stock, (Printice Hall, 2001 - Science)
6. Operational Amplifiers: G. B. Clayton (5th edition)
7. OPAMPS and Linear Integrated Circuits: Ramakant Gayakwad, Prentice Hall
8. Electronic Principles: A. P. Malvino, TMH

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M. Sc. Physics – Semester III
DSET 3.1a): BIOPHYSICS –I

Unit 1: Physico-chemical Principles **[16 hours]**
Thermodynamic equilibrium, laws of thermodynamics and living system, Entropy, Enthalpy and free energy, Internal energy, Carnot cycle, Oxidation reduction potential. 0^{th}, 1^{st}, 2^{nd} & 3^{rd} order reaction, Activation energy and Rate constant, Diffusion, Osmosis, Osmotic pressure, Osmoregulation, Surface tension, Adsorption, Viscosity, Thermal conduction, Sedimentation filtration of biological fluid, Colloids & their types, Kinetic & electrical properties of colloids, Stability of colloids, Gibbs Donnan Equilibrium in living systems.

Unit 2: Bioenergetics **[16 hours]**
The biological energy cycle and the energy currency, thermodynamic concepts; free energy of a system-Gibb's free energy function, chemical potential and redox potentials. Energy conversion path ways-Kreb's cycle; respiratory chain, oxidative phosporylation. Photosynthesis- mechanism of energy trapping and transfer; photo phosporylation.

Unit 3: Membrane Biophysics **[16 hours]**
Cell membranes- Structure, function and models; transport across membranes- passive and active processes; chemiosmotic energy transduction, Van't Hoff equations; ionic equilibrium-electrochemical potential; Nernst's equation; Flow across membranes- membrane permeability. Neurophysics: The nervous system. Synaptic transmission; information processing in neural systems. Physical basis of biopotentials; Action potential; Nernst- Planck equation. Nerve excitation and conduction; Hodgkin-Huxley model. Membrane Channels, voltage gated channels, ligand gated channels, channel conductance.

Unit 4: Physiological Biophysics **[16 hours]**
Physics of sensory organs- the transmission of information; Generator potentials. Visual receptor- mechanism of image formation; Auditory receptor- mechanism of sound perception; mechanisms of chemical, somatic and visceral receptors. Mechanism of muscle contractility and motility. Temporal organization- basis of biorhythms.

References

1. An introduction to Biophysics: C Sybesma (Academic,1977).
2. Biophysics: V Pattabhi and N Gautham, (Narosa,2002).
3. Essentials of Biophysics: P Narayan, (New Age,2001).
4. Molecular Biophysics: R B Setlow and E C Polland, (Addition Wesey, 1962).
5. Biophysics: W Hoppe, W Lohmann, H. Markl, H Ziegler, (Springer Verlag, 1983).
6. Biophysical Principle of Structure and Function: F M Snell, Shulman, R P Spensor and Moos, (Addison Wesley, 1965).
7. Principles of Protein Structure: G E Schultz and R H Shirmer, (Springer.1969).
8. Principles of nucleic acid structures: W. Saenger, (Springer Verlag, 1984).

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M. Sc. Physics – Semester III

DSET 3.1b): NANO-PHYSICS – I

Unit 1: Band Structure and conduction mechanism at Nanoscale **[16 hours]**

Introduction. Classification, structure, properties. Energy bands. Density of states at low-dimensional structures. Electronic transport in nanostructures. Various conduction mechanisms in 3D(bulk), 2D(thin film) and low dimensional systems, Arrhenius type thermally activated conduction, variable range hopping conduction, polaron conduction. Thermionic emission, field enhanced thermionic emission(Schottky effect), field assisted thermionic emission from traps (Poole-Frenkel effect)

Unit 2: Quantum mechanical concepts at Nanoscale **[16 hours]**

Introduction, size effects in smaller systems. Pre-quantum, quantum behaviour of nanometric world. Applications of Schrödinger equation-infinite potential well a confined particle in 1D, potential step: reflection and tunneling. Quantum leak; Nanodot, electron trapped in 2D plane, electron moving in 1D, Quantun confinement in nanomaterials.

Unit 3: Synthesis of Nanomaterials - Physical methods **[16 hours]**

Mechanical methods, methods based on evaporation, sputter deposition, chemical vapor deposition (CVD), electric arc deposition. Ion beam techniques (ion implantation). Molecular Beam Epitaxy(MBE). Lithography: Introduction. Lithography using photons (UV-VIS, Laser or X-rays), lithography using particle beams, scanning probe lithography, soft lithography.

Unit 4: Synthesis of Nanomaterials - Chemical & Biological methods **[16 hours]**

Chemical methods: Colloids and colloids in solutions. Growh of Nanoparticles – synthesis of metal nanoparticles by colloidal routes, synthesis of semiconductor nanoparticles by colloidal routes, Langmuir Blodgett(L-B) method, microemulsions, Sol-Gel method.
Biological methods: Introduction to biomaterials. Synthesis using micro-organisms, synthesis using plant extracts, use of proteins and templates like DNA.

Reference Books:

1. Introduction to Nanoscience & Nanotech.– K.K.Chatopadhyay & A.N.Benerjee, PHI
2. Nanotechnology: Principles and Practices – Sulabha K Kulkarni. Capital Publishing Company, New Delhi.
3. Nanostructured Materials and Nanotechnology – Hari Singh Nalwa. AP.
4. Nanostructures and Nanomaterials-Synthesis, Properties and Applications – Cao, Guozhong, Imperial College Press.
5. Introduction to Nanotechnology, by Charles P. Poole, Jr. Frank J. Owens, John Wiley & Sons Inc. Publication

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M.Sc. Physics – Semester III
GET 3.1: APPLIED PHYSICS

Unit 1: Laser and Optical Fibers **[16 hours]**
Principle of lasers, Einsteins coefficients, population inversion techniques, building up of laser action criteria for lasing and threshold condition, laser beam characteristics: spatial and temporal coherence (qualitative), types of lasers: He-Ne laser, semiconductor laser, applications of lasers, holography: principle, recording and reconstruction, applications of holography. Non-linear optics, harmonic generation, fiber optics communication.

Unit 2: Solid State Devices **[16 hours]**
PN junction as diode, Zener diode as a voltage regulator, LED, use of LED in display, liquid crystals and their use in display, tunnel diode, transistors: transistor characteristics for common emitter configuration, amplification, FET, semi-conductor diode laser, radiation detectors (photo-determinations, I.R. detectors, photovoltaic device), solar cells: fabrication and application to energy conversion.

Unit 3: Radiation Physics **[16 hours]**
Interaction of radiation with matter; radiation detection, measurement and dose estimation; Biological effects of ionizing radiations- effects at the molecular, cellular and tissue levels. Biological effects of nonionizing radiations. Radiation hazards and safety standards for radiation protection. Diagnostic and therapeutic uses of ionizing radiations- Nuclear medicine. Medical uses of nonionizing radiation.

Unit 4: Nano Materials **[16 hours]**
Nano materials: principles of nanotechnology, nano structures, properties, classification and applications of nano materials.
Smart materials: Basics of smart materials, Physics of smart materials, properties and applications: smart glasses, sensors, actuators, shape memory alloys.

References

1. Lasers- Theory and Applications - K Thyagarajan and A K Ghatak (Mcmillan, 1984).
2. Principles of Lasers - O. Svelto (Plenum,1956).
3. Lasers and Nonlinear Optics - B B Laud (New age, 1996).
4. Introduction to Solid State Physics - C. Kittel, Wiley Eastern.
5. Semiconductor Physics - P. S Kireev, MIR Publishers.
6. Fundamentals of Solar Cells - Fahrenbruch and Bube.
7. Nanoscience - Gabor L Hornyak, Joydeep Dutta, Harry F T & Anil K Rao- CRC Press
8. Nanomaterials - Syn, Prop & Applications - A.S Edelstein, R C Cammarada (IOP Pub.)

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M.Sc. Physics – Semester III
List of Experiments
Practical 3.1

1. Particle size of Lycopodium powder
2. Band Spectrum of PN-molecule (Analysis)
3. Slit width –Young's double slit
4. Sodium doublet separation, RI and thickness of the film using Michelson interferometer.
5. Spectral response analysis of scintillation detector
6. Determination of rest mass energy of electron from gamma ray spectrum
7. Multi channel analysis of gamma ray spectrum
8. Beta spectrum using scintillation detector
9. Nuclear unit Radius (Analysis)

Practical 3.2

1. Solar Cell
2. Fermi energy of Copper wire
3. Specific heat of graphite
4. Study of creep behavior in Lead
5. Magnetic susceptibility by Gouy's method
6. Hall effect
7. Magneto resistance
8. Solar spectrum and determination of solar constant
9. A/D Converter
10. Full- Adder & Full- Subtractor
11. Half-Adder & Half-Subtractor
12. RC coupled transistor Amplifier

Note: As and when developed, new experiments will be introduced.

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M. Sc. Physics – Semester IV
CCT 4.1: ATOMIC AND MOLECULAR PHYSICS

Unit 1: One and Two-electron system **[16 hours]**
Einstein's A and B coefficients transition probabilities, Hydrogen atom: Electron spin inter action terms, vector model and lamb shift Electrostatic interaction and exchange degeneracy, ground state and excited states of helium, electron spin functions and Pauli exclusion principle. Central-field approximation, Thomas-Fermi potential, gross structure of the alkalis. Angular problems in many electron atoms: LS coupling-approx., allowed terms, fine structure and relative intensities; jj coupling approximation.

Unit 2: Interaction with static external fields **[16 hours]**
Zeeman effect in LS coupling, relative intensities in Zeeman effect, quadratic and linear Stark effect. Hyperfine structure and isotope shift: Magnetic dipole interaction, hyperfine structure nuclear spin, and nuclear magnetic moment; hyperfine structure in two-electron spectra, electric quadrupole interaction, Zeeman effect of hyperfine structure and isotope shift.

Unit 3: Microwave, Infra-red and UV-Visible Spectra **[16 hours]**
Types of molecules- linear, symmetric top, asymmetric top and spherical top molecules. Theory of rotational spectra for rigid and non-rigid rotator diatomic molecules, energy levels, intensity of rotational lines. Vibrational energy of diatomic molecule as simple harmonic and anharmonic oscillators, energy levels and vibrational spectra. Double beam IR spectrometer and FTIR spectrometer. Electronic spectra of diatomic molecules, Born-Oppenheimer approximation, vibrational coarse structure- band progressions and sequences, Frank-Condon principle-intensity of vibrational-electronic spectra. Selection rules for electronic transitions. Double beam UV-Visible Spectrometer. Raman Effect, principle and instrumentation of Raman Spectrometer.

Unit 4: Lasers **[16 hours]**
Principle of lasers, population inversion techniques, building up of laser action criteria for lasing and threshold condition. Laser beam characteristics, spatial and temporal coherence (Quantitative). Types of lasers: Nd: YAG laser, nitrogen laser, dye laser, semiconductor laser. Applications of lasers: Principle of holography, recording and reconstruction of holograms, applications of holography. Non-linear optics, harmonic generation, fibre optics communication.

References

1. Elementary Atomic Structure : G K Woodgate (Oxford,)
2. Introduction to Atomic Spectra : H B White (McGraw Hill)
3. Fundamentals of Molecular Spectroscopy : C N Banwell (TMH)
4. Molecular Spectra and Molecular Structure Vol.1: Spectra of diatomic molecules: G.Herzberg (Von Nostrand)
5. Spectroscopy-1, 2 & 3: B P Straughan and walker (Chapman and Hall)

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M.Sc. Physics – Semester IV
CCT 4.2: MATERIALS PHYSICS

Unit 1: Crystal Growth **[16 hours]**

Nucleation and growth, homogeneous and heterogeneous nucleation, crystal growth techniques: crystal growth from melt, Bridgemann technique, crystal pulling by Czochralski's method, growth from solutions, hydrothermal method, gel method.

Imperfections: Classification, point defects: Schottky and Frenkel defects, expressions for equilibrium defect concentrations, line defects: dislocations, concept of Burger vector and Burger circuit, plane defects: grain boundary and stacking faults, colour centres.

Unit 2: Solid Phases and Phase Diagrams **[16 hours]**

Single and multiphase solids, solid solutions, Hume-Rothery rules, solid solutions phase diagram, Gibbs phase rule, Lever rule, eutectic, eutectoid, peritectic and peritectoid systems, phase diagrams: Pb-Sn and Fe-Fe_3C.

Diffusion in solids, self-diffusion, Fick's law of diffusion (derivation), activation energy for diffusion (derivation), applications of diffusion, Kirkindal effect.

Unit 3: Amorphous Materials **[16 hours]**

Glasses: Glass forming constituents, structure of glasses, glass transition, types of glasses: soda lime glass, lead glass, borosilicate glasses, fiber glasses, optical and electrical properties of glasses. **Ceramics:** Classification and their structures, mechanical and thermal properties, application of ceramics. **Polymers:** Basic concepts, polymerization techniques, structure and properties of polymers.

Unit 4: Dielectric, ferroelectric and magnetic properties **[16 hours]**

Ideas of static dielectric constant, loss, types of polarization: electronic, ionic, orientational and space charge, lorentz field, complex dielectric constant, applications of dielectrics.

Ferroelectrics and their properties, types of ferroelectrics, dipole theory of ferroelectricity and its drawbacks, ferroelectric domains, relaxor ferroelectrics.

Magnetic materials: dia, para, ferro, domains, hysteresis, hard and soft materials, applications.

References

1. Elements of Materials Science and Engg.- L.H. van Vleck, Addison-Wesley, 6th edition.
2. Materials Science and Engineering - V. Raghvan, Printice Hall of India, 3rd edition.
3. Materials Science and Processes - S. K. Hajra Chaudary, Indian Distr Co., 1977.
4. Introduction to Ceramics - W.D. Kinnery et al, John Wiley
5. Polymer Science - V. R Gowarikar, N. V Vishwanathan, Wiley Eastern (1986).
6. An introduction to Polymer Physics - Perbechko, MIR publisher, Moscow, 1989.
7. Advances in Ferrites - V.R. K. Murthy and B, Vishwanath, Narosa Pub.
8. Principles of Polymer Science - P. Bahadur & N V Sastry, Narosa, 2002.
9. Crystal Growth - B.R. Pamplin, Pergmon Press.
10. Crystal Growth from High Temperature Solutions - D. Elwell and H.J.Scheel,Academic Press

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M. Sc. Physics – Semester IV
DSET 4.1a): BIOPHYSICS –II

Unit 1: Biophysical methods **[16 hours]**
Principle, working and applications of ultracenterifugation, electrophoretic and chromatographic techniques. Optical electron and Atomic Force Microscopy. Principles of absorption and fluorescence spectroscopy, optical rotary dispersion and circular dichroism. X-ray spectrometer and structure analysis. Nuclear Magnetic Resonance and Electron Spin Resonance spectrometers. Radiotracer techniques.

Unit 2: Biophysics of the immune system **[16 hours]**
The immune system; cellular basis of immunal responses; antibodies and antigens; immunological memory. Genetic engineering: Gene- structure, expression and regulation; Genetic code and genome organization; recombinant technology, transgenic systems. Cybernetics.

Unit 3: Bio-potential and Biomaterials **[16 hours]**
Bio-potential – Nervous system and neuron, Electric properties of Nerve, Electrical potential of nerve, Nernst Equation, Bio potentials EMG, ECG, EEG, EOG, ERG, Magnetic signals from heart and Brain.
Biomaterials – Introduction, Bio-ceramics, Bio-polymer, Bio-steel, Bio-chip, Blood as a Biomaterial, Introduction to Bio- Nanomaterial, New trends in Medical informatics Embedded system.

Unit 4: Radiation Physics **[16 hours]**
Interaction of radiation with matter; radiation detection, measurement and dose estimation; Biological effects of ionizing radiations- effects at the molecular, cellular and tissue levels; genetic effects. Biological effects of nonionizing radiations. Radiation hazards and safety standards for radiation protection. Diagnostic and therapeutic uses of ionizing radiations- Nuclear medicine. Medical uses of nonionizing radiation- Photomedicine; physiological and therapeutic uses of heat radiation.

References

1. An introduction to Biophysics: C Sybesma (Academic,1977).
2. Biophysics: V Pattabhi and N Gautham, (Narosa,2002).
3. Essentials of Biophysics: P Narayan, (New Age,2001).
4. Molecular Biophysics: R B Setlow and E C Polland, (Addition Wesey, 1962).
5. Biophysics: W Hoppe, W Lohmann, H. Markl, H Ziegler, (Springer Verlag, 1983).
6. Biophysical Principle of Structure and Function: F M Snell, Shulman, R P Spensor and Moos, (Addison Wesley, 1965).
7. Principles of Protein Structure: G E Schultz and R H Shirmer, (Springer.1969).
8. Principles of nucleic acid structures: W. Saenger, (Springer Verlag, 1984).
9. Radiation Biophysics: E L Alpen, (Prentice-Hall, N J, 1990).
10. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, Eds A D Baxevanis & B F Francis (John Wiley, 1998).

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M. Sc. Physics – Semester IV

DSET 4.1b): NANO-PHYSICS – II

Unit 1: Characterization Techniques **[16 hours]**

Commonly used techniques in materials analysis. Microscopes – Scanning Electron Microscope (SEM), Tunneling Electron Microscope (TEM), Scanning Probe Microscope (SPM), Scanning Tunneling Microscope (STM), Atomic Force Microscope (AFM), Magnetic Force Microscope (MFM). XRD –diffraction patterns of nanoparticles.

Unit 2: Properties of Nanomaterials **[16 hours]**

Mechanical properties, structural properties, melting of nanomaterials. Electrical conductivity. Optical properties of metallic and semiconductor nanoparticles. Luminesence in semiconductor nanoparticles,. Nanomagnetic materials.

Unit 3: Carbon based Nanomaterials **[16 hours]**

CNTs–synthesis of carbon nanotubes. Growth mechanism, electronic structure of carbon nanotubes, preparation and characterization of fullerenes and graphene. Nanodiamond, BN nanotubes. Nanoelectronics-single electron transistor, molecular machine. Porous silicon – preparation, mechanism of pores formation, properties of porous silicon. Self assembled nanomaterials, inorganic, organic and bio templates

Unit 4: Natural Nano-Machines **[16 hours]**

Examples of nano-machines in living cells; differences between macroscopic and nano machines; stochastic dynamics of nano-machines; imaging and manipulating single machines; Power stroke versus Brownian ratchet mechanism; mechano-chemistry of nano-machines; energetics and efficiency of nano-machines; intra-cellular cargo transporters; rotary motors of ATP synthesizer; molecular sensors- hair cells; nanopistons and cell crawling.

Reference Books:

1. Nanostructured Materials and Nanotechnology – Hari Singh Nalwa, AP.
2. Introduction to Nanotechnology – C.P. Poole Jr & F.J. Owens, John Wiley & Sons Inc.
3. Introduction to Nanoscience and Nanotechnology – K.K. Chattopadhyay & A.N.Benarjee, PHI.
4. Nanotechnology: Principles and Practices – Sulabha K Kulkarni, Capital Publishing Company, New Delhi.
5. Instrumental Methods of Analysis – Willard. H. Hobart
6. Physical Principles of Electron Microscopy – Ray F Egerton.
7. Carbon Nanotechnology by Liming Dai
8. Carbon Nanotubes: Properties and Applications by Michael J. O. Connell.

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M.Sc. Physics – Semester IV

List of Experiments

Practical 4.1

1. Wavelength of laser beam by diffraction due to engraving on vernier calipers
2. Velocity of light by Kerr cell method
3. Thickness & Refractive index of glass plate-Laser
4. Determination of Numerical Aperture by an Optical Fiber
5. Fraunhofer Diffraction-Circular Aperture
6. Divergence of Laser beam
7. Estimation of exponent of 'n' of Photoelectric effect
8. Spectral response analysis of solid state detector
9. Study of Bremsstrahlung radiation
10. Analysis of n-p and p-p scattering parameters
11. Nuclear structure analysis
12. Analysis of beta spectrum by multi channel analyzer
13. Positron annihilation and angular correlation of annihilation photons
14. Analysis of nuclear reaction cross section
15. Rest mass of electron (Analysis)

Practical 4.2

1. Dielectric Constant-$BaTiO_3$
2. B-H Hysteresis Loop tracer
3. Resistivity-Four Probe Method
4. Resistivity-Van der pauw's Method
5. Dielectric constant of PZT
6. Electron Spin Resonance
7. Study of lattice dynamics
8. Analysis of XRD
9. Coercivity and retentivity of given sample (B-H curve)
10. Fixed Voltage Regulation-IC
11. Variable Voltage Regulation-IC
12. D/A Converter
13. Study of Counters

Note: As and when developed, new experiments will be introduced.

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M.Sc. Physics – Semester IV
CCPR 4.1: PROJECT WORK

Compulsorily each student has to carry out a project work under the supervision of a staff member. The topic for project work can be of theoretical or experimental or computational in nature. A group of students under a staff member can work on a single topic for project. However, each student has to submit his/her own independently written original project report and face examination independently. Maximum of six credits are given for the project work. On completion of the project work and at the end of the Semester IV, a project report (certified by both supervisor and Chairman/Head of the Department/PG Coordinator) based on the project work carried out must be submitted to the Department. Project work will be valued for maximum of 150 marks (project report 72 marks, Viva-Voce 48 marks and Internal Assessment 30 marks).

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QUESTION PAPER PATTERN FOR SEMESTER END EXAMINATIONS

Question paper Pattern for theory courses (CCT, DSET and GET)

There shall be 8 questions of 15 marks each (two questions from each unit). A candidate will have to answer four questions. There shall be internal choice in each unit.

Example:

Questions 1 & 2 must be from Unit 1. Candidate will answer either Question 1 or Question 2.

Questions 3 & 4 must be from Unit 2. Candidate will answer either Question 3 or Question 4.

Questions 5 & 6 must be from Unit 3. Candidate will answer either Question 5 or Question 6.

Questions 7 & 8 must be from Unit 4. Candidate will answer either Question 7 or Question 8.

Further, there shall be four questions of 10 marks each. One question from each unit must be drawn. Students will have to answer two questions.

Example:

Question 9 must be drawn from Unit 1.

Question 10 must be drawn from Unit 2.

Question 11 must be drawn from Unit 3.

Question 12 must be drawn from Unit 4.

Duration: 3 hours

Max. Marks : 80 [= (4 x 15) + (2 x 10)]

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