Department of Physics, Kumaun University

C.B.C.S Semester Pattern (2020-21 onwards)

COURSE CONTENTS

for

M.Sc. (Physics)

A TWO YEAR FULL-TIME PROGRAMME (Four-Semester Course)

Department of Physics

(Faculty of Science)

Kumaun University (Uttarakhand)

Department of Physics, Kumaun University

Course Structure of M.Sc. (Physics) Programme as per C.B.C.S.(Revised)

Number of Semesters : 04 (02 years)

1. Semester- I

Course Nature	Course Name	Credits	Marks
Lecture Core Course (LCC) (Including lectures, tutorials, assignments & internal assessment)	LCC1. Mathematical Physics LCC2. Classical Mechanics LCC3. Quantum Mechanics LCC4. Statistical Physics LCC5. Atomic & Molecular Physics	4 4 4 4 4	100 100 100 100 100
Practical Course (PC)	PC1. Practical Course – I (including expt. work, data analysis, internal assessment & viva-voce)	8	200
Total (L+P+T)		**28**	**700**

2. Semester- II

Course Nature	Course Name	Credits	Marks
Lecture Core Course (LCC) (Including lectures, tutorials, assignments & internal assessment)	LCC6. General Relativity and Cosmology LCC7. Advanced Quantum Mechanics LCC8. Nuclear Physics LCC9. Elementary Particle Physics LCC10. Condensed Matter Physics	4 4 4 4 4	100 100 100 100 100
Practical Course (PC)	PC2. Practical Course – II (including expt. work, data analysis, internal assessment & viva- voce)	8	200
Self Study Course (SSC)	SSC1} 1 out of the list	-	100
Total (L+P+T)		**28**	**800**

****Note: Self-study course are non-credit courses and are of qualifying nature only and grades will be provided for the same.**

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3. Semester- III

Course Nature	Course Name	Credits	Marks
Lecture Core Course (LCC) (Including lectures, tutorials, assignments & internal assessment)	LCC11(a-e). Special Paper-I LCC12(a-e). Special Paper-II LCC13. Electrodynamics	4 4 4	100 100 100
Lecture Elective Course (LEC)	LEC1, LEC2} 2 out of the list enclosed	08 (04 credit each)	200
Practical Course (PC)	PC3. Practical Course – III (including expt. work, data analysis, internal assessment & viva voce)	8	200
Self Study Course (SSC)	SSC2} 1 out of the list enclosed	-	100
Total (L+P+T)		**28**	**800**

****Note: Self-study course are non-credit courses and are of qualifying nature only and grades will be provided for the same.**

4. Semester- IV

Course Nature	Course Name	Credits	Marks
Lecture Core Course (LCC) (Including lectures, tutorials, assignments & internal assessment)	LCC14(a-e). Special Paper-III LCC15(a-e). Special Paper-IV	4 4	100 100
Lecture Elective Course (EC)	LEC3} 1 out of the list enclosed	04	100
Practical Course (PC)	PC4. Practical Course – IV (including expt. work, data analysis, internal assessment & viva voce)	8	200
Dissertation/Project	DC/PC	08	-
Self Study Course (SSC)	SSC3} 1 out of the list enclosed	-	100
Total (L+P+T)		**28**	**600**

****Note: Self-study course are non-credit courses and are of qualifying nature only and grades will be provided for the same.**

Grand Total: Total Credits: 112

Total Marks: 2900

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Lecture Elective Courses (LEC)

LEC1. Communication Electronics

LEC2. Plasma Physics

LEC3. Digital Electronics and Computer Architecture

LEC4. Atmospheric Physics

LEC5. Introduction to Nanoscience and Nanotechnology

Self Study Courses (SSC)

SSC1. Advances in High Energy Physics

SSC2. Advances in Laser Physics

SSC3. Advances in Solar Physics

SSC4. Bio-Physics

SSC5. Computer Applications in Physics

SSC6. Medical Physics

SSC7. Optical Communication

****Note: Self-study course are non-credit courses and are of qualifying nature only and grades will be provided for the same.**

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Syllabus for M. Sc. (Physics) Semester-I

LCC1. Mathematical Physics Course credits 04 (Marks 100) (Semester-I)

Unit I: Special Functions

Series solution of differential equations, Legendre, Bessel, Hermite, and Laguerre differential equation and related polynomial, physical integral form of polynomials and their orthogonality relations. Generating Function and recurrence relation.

Unit II: Curvilinear Coordinates and Tensors

Curvilinear Coordinates and various operators in circular, cylindrical and spherical co-ordinate systems, classification of Tensors, Rank of a Tensor, covariant and contra-variant tensors, symmetric and anti-symmetric Tensors, Kronecker delta symbol. Contraction of Tensor, metric Tensor and Tensor densities, covariant differentiation and Geodesic equation (variational Method).

Unit III: Complex Variables

Function of complex variable, Cauchy's Riemann differential equation, Cauchy's integral theorem, residues and Cauchy's residues theorem, singularities, evolution of residues and definite integral.

Unit IV: Integral Transforms

Fourier integral and Fourier Transform, Fourier integral theorem, finite and infinite integral, Laplace transform of elementary function (Dirac delta & Green's function), Solution of simple differential equations.

Book recommended:

B. S. Rajput: Mathematical Physics (Pragati Prakashan, Meerut)
L. I. Pipes: Mathematical Physics (McGraw Hill)
P. K. Chattopadhyay: Mathematical Physics (Wiley Eastern, New Delhi)
G Afriken.: Mathematical methods for Physics
Harper Charlie: Introduction to Mathematical Physics
Mathews and Walker: Mathematical Methods of Physics (Benjamin press)
Morse and Feshbach : Methods of Theoretical Physics (McGraw Hill)

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LCC2. Classical Mechanics **Course credits 04 (Marks 100)** **(Semester-I)**

Unit I: Mechanics of a System of Particles

Constraints and generalized coordinates, D Alembert's principle, Lagrange equations for holonomic and non holonomic systems and their applications, conservation laws of linear momentum, energy and angular momentum.

Unit II: Hamiltonian Formulation and Hamilton Jacobi Theory

Hamiltonian equations of motion and their physical significance, Hamilton's principle, principle of least action, canonical transformations Hamilton-Jacobi theory, Poisson brackets, properties of Poisson bracket, Poisson's Theorem, Lagrange bracket.

Unit III : Dynamics of a Rigid Bodies

Motion of a rigid body, body and space Reference system, angular momentum and Inertia tensor, Principle axes- Principle moments of Inertia, spinning tops, Euler angles, Infinitesimal rotations.

Unit IV : Central Force Problem

Action and angle variables, phase integral, small oscillations, Kepler's laws of Planetary motion and their deduction, scattering in a Central field, Rutherford scattering cross section.

Book recommended

B S Rajput : Mathematical Physics
H. Goldstein : Classical Mechanics
N.C. Rana & P. S. Jog : Classical Mechanics
Landau and Lifshitz : Mechanics, Pergamon
Sommerfeld : Mechanics, Academic Press
Whittaker : Analytical Dynamics of Particles and Rigid Bodies - Cambridge
Raychaudhuri : Classical Mechanics, Oxford
Bhatia : Classical Mechanics, Narosa.

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LCC3. Quantum Mechanics Course credits 04 (Marks 100) (Semester-I)

Unit I: Non-Relativistic Quantum Mechanics and Schrödinger Equation

Schrödinger's equation, Probability and current densities, continuity equation, physical interpretation of wave function, orthogonality of eigen functions, Principle of superposition, wave packet, normalization, Schrödinger's equation in three dimensions, centrally symmetric square well and harmonic potentials, harmonic oscillator and its wave functions, Hydrogen atom.

Unit II: Operator Formulation of Quantum Mechanics

State vectors and operators in Hilbert Space, Eigen values and Eigen vectors of an operator, Hermitian ,Unitary and Projection operators, commuting operators, BRA and KET Notations, Postulates of Quantum Mechanics, co-ordinate Momentum and Energy representations, dynamical behavior, Heisenberg, Schrödinger and interaction Pictures.

Unit III: Theory of Angular Momentum

Orbital Angular momentum operator, its eigen value and eigen functions, space quantization, spin angular momentum, Pauli's theory of spin, Addition of angular momentum, Clebsch-Gordan coefficients.

UNIT- IV: Approximation Methods and Time independent Perturbation Theory

Stationary Perturbation, first and second order corrections, WKB approximation methods, connection formula and boundary conditions, Bohr Sommerfield quantization rule, Penetration of potential barrier, Time independent perturbation theory and anomalous Zeeman effect, variation method and its application to the ground state of helium atom, and harmonic oscillator.

Books recommended:

B. S. Rajput: Advanced Quantum Mechanics
Schiff: Quantum Mechanics
Thankppan: Quantum Mechanics
Loknathan & Ghatak: Quantum Mechanics

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LCC4. Statistical Physics Course credits 04 (Marks 100) (Semester-I)

Unit-I : Foundation of Statistical Mechanics

Microscopic and macroscopic states, density of states, micro-canonical, canonical and grand canonical ensembles, canonical ensemble and Gibb's distribution, Boltzmann–Planck method, partition function and statistical definition of thermodynamic quantities, computation of partition functions of some standard systems.

Unit-II : Statistical Properties

System of linear harmonic oscillators in the canonical ensemble; grand canonical ensemble and its partition function; chemical potential; Partition function and distribution for perfect gas; Gibb's paradox; Free energy, entropy, equation of state and specific heat determination of perfect gas.

Unit-III : Statistical Models

Theory of phase transitions, First order phase transition, Second order phase transitions and higher order phase transitions (elementary discussion), Ising model, one dimensional (with exact solution), Two dimensional (with exact solution) & three dimensional model (elementary idea), Landau theory of phase transition, Weiss theory of Ferro-magnetism, Heisenberg model. Virial equation of states.

Unit-IV : Quantum Statistics

Bose-Einstein and Fermi- Dirac distributions, degeneracy, gas degeneration, degenerate Bose gas, Bose Einstein condensation, highly degenerate B-E and F-D gases; examples of Molecular Hydrogen, liquid helium and electron gas in metals.

Books Recommended-

A.S. Davidov:	Quantum Mechanics
B.S. Rajput:	Quantum Mechanics
Paul Roman:	Quantum Mechanics
Glastohn	Theoretical Chemistry
Landau and Lifshitz:	Statistical Mechanics
Pathira:	Statistical Mechanics

Huang: Statistical Mechanics

LCC5. Atomic and Molecular Physics Course credits 04 (Marks 100) (Semester-I)

Unit-I

Fine structure of hydrogen spectrum, L-S and J-J coupling, Spectroscopic terms**,** Hund's rule and time reversal, Pauli's exclusion principle.

Unit- II

Alkali spectra, spin-orbit interaction and fine structure in alkali Spectra, Equivalent and non-equivalent electrons, Normal and anomalous Zeeman effect, Paschen Back effect, Stark effect, Hyperfine structure (qualitative).

Unit- III

Molecular spectra of diatomic molecules, Born Oppenheimer approximation, elementary idea of quantization of rotational and vibrational energy, rotational spectra for rigid and non rigid rotations, vibrational spectra (harmonic and an-harmonic), intensity and selection rules and molecular constants.

Unit- IV

Atomic Polarizability, Raman spectra, Quantum theory of Raman spectra, Determination of molecular structure, Electronic spectra, band system, Progression and sequences, band head formation, Condon parabola, Franck Condon Principle dissociation energy and its determination.

Books Recommended

C. B. Banwell: Fundamentals of Molecular Spectroscopy
Walker and Stranghen: Spectroscopy Vol. I, II, & III
G.M. Barrow: Introduction to Molecular Spectroscopy
Herzberg: Spectra of diatomic molecules
Jeanne L Mchale: Molecular Spectroscopy
J. M. Brown: Molecular Spectroscopy
P. F. Bemath: Spectra of atoms and molecules
J. M. Holias: Modern Spectroscopy
K. Thyagrajan and A.K. Ghatak: Lasers: Theory and applications
A Yariv: Quantum Electronics
M. D. Levenson: Intoduction to non-linear laser spectroscopy

B. B. Laud: Laser and non-linear optics

PC1. Practical Course-I Course credits 8 (Marks 100) (Semester-I)

List of Experiments

1. Study of RC circuit with an AC source using phase diagrams.
2. Absorption Spectrum of $KMnO_4$ using Hilger-Nutting Photometer.
3. Young's modulus by Interference method.
4. NPN and PNP Transistor Characteristics with (a) Common base (b) Common emitter configurations/ h – parameter.
5. Study of RC- coupled/ Transformer Coupled Amplifier.
6. Study of B-H curve.
7. Study of Amplitude Modulation /Demodulation.
8. Verification of the Hartmann's Formula.
9. Frank-Hertz experiment.
10. e/m by Zeeman effect.
11. Determination of susceptibility.
12. Study of CRO.
13. Velocity of Ultrasonic waves.
14. Linear Air track.
15. Leacher Wire

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Syllabus for M. Sc. (Physics) Semester-II

LCC6. General Relativity Theory and Cosmology Course credits 04 (Marks 100)
(Semester-II)

Unit- I: **Foundations of General Relativity**

Elements of Special relativity, Tensors as geometrical objects, Mach's Principle, non-inertial frames of reference, Gravity and space-time, Principle of equivalence and principle of general covariance, Metric tensor and gravity, Geodesics and Affine parameters (Christoffel symbols), covariant derivative and its geometrical interpretation, parallel transport, space-time curvature and curvature tensor, Riemann curvature tensor, Bianchi identity, Ricci tensor, classification of space-time curvature (in different dimensions).

Unit -II: Einstein's Field Equations and Gravitational Dynamics

Christoffels connection as Einstein's connection, Gravitational action, field equations and their general properties, Newtonian limit of Einstein's field equations, Metric in spherically symmetric space-time (Schwarzchild metric), Orbits in the Schwarzschild metric, gravitational collapse of a dust sphere, Schwarzschild black holes.

Unit-III: Gravitational Radiation

Introduction of Gravitational radiation, Wave equation in linearized theory and plane waves, propagating modes of gravity, gravitational waves in a flat space-time background, propagation of gravitational waves in the curved space-time, Energy and momentum of the gravitational waves, Detection of gravitational waves.

UNIT- IV: Cosmology

Basic Concepts and elementary idea of big-bang and steady state cosmologies, Seagull static models, Cosmological principle, Friedmann space-time, Robertson-Walker line element, Weyl's postulate, expansion of the universe, Hubble's law, dynamical equation of cosmology and their consequences, the primordial fire and the remnant radiation, Big-bang and steady state models of the universe.

Book Recommended:

R.R. Patharia : Theory of Relativity
S.K. Bose : An Introduction to General Relativity

J.V. Narlikar : An Introduction to Cosmology
C. Moller: The theory of Relativity
T. Padmanabhan: Gravitation
Raychaudhuri: Theoretical cosmology
M. Carmeli: Classical fields: General Relativity and Gauge Theory

LCC7. Advanced Quantum Mechanics Course credits 04 (Marks 100) (Semester-II)

UNIT-I: Relativistic Quantum Mechanics

Discrepancies faced by Schrödinger equations, Klein-Gordon equation and its drawbacks, Dirac's equation for a free particle, Dirac matrices, covariant form of Dirac equation, Probability and current densities, Free particle solutions of Dirac equation, Non conservation of Orbital Angular momentum and idea of spin, Interpretation of negative energy and hole theory.
Dirac equation in electromagnetic fields, Magnetic moment of charged particle, Gauge invariance of Dirac equation in electromagnetic fields, Symmetries of Dirac Equation, Lorentz covariance of Dirac Equation, Parity, Time reversal and charge conjugation, Bilinear covariants

UNIT-II: Identical Particles and Quantum Field Theory

Identical particles, exchange degeneracy, symmetric and anti symmetric functions for many particle system
Classical Fields, Schwinger's action principle, Lagrangian and Hamiltonian densities, Field equation, quantum structure of free fields and the particle concept, Quantization relations, Quantization of non relativistic Schrödinger matter field, System of identical bosons and fermions, Commutation and anti-commutation relations, Occupation number representation, creation and annihilation operators.

UNIT-III: Time Dependent Perturbation Theory

Time dependent perturbation theory, constant perturbation, Fermi Golden rule, coulomb excitation, sudden and adiabatic approximation, Harmonic perturbation, radiative Transition in atoms. Einstein's A and B coefficients and spontaneous emission of radiation.

UNIT-IV: Quantum Theory of Scattering

Scattering Theory, Scattering cross section, method of partial wave analysis, phase shift, Optical theorem, scattering length, effective range; low energy scattering, Resonance, scattering from a square potential well and a rigid sphere, Born approximation, Validity of Born approximation, Born approximation through time dependent perturbation, its application to square well potential.

Books Recommended
Davydov : Quantum Theory
Messiah : Quantum Mechanics Vols. I & II

Rajput B. S. : Advanced Quantum Mechanics
Roman P. : Advanced Quantum Mechanics
Trigg : Quantum Mechanics
Thankappan V.K. : Quantum Mechanics
Sakurai J.J. : Quantum Mechanics

LCC8. Nuclear Physics Course credits 04 (Marks 100) (Semester-II)

Unit-I : Nuclear Properties and Nuclear Models

Concepts of Atomic Nuclear-Size, Shape, charge distribution, spin & parity, magnetic moment; electric quadrupole moment; binding energy; semi-empirical mass formula, mirror nuclei, Liquid drop model, Experimental evidence for shell effects, Shell model, Magic numbers, Spin orbit coupling, Single particle shell model-its validity and limitations; collective model.

Unit-II : Nuclear Forces and Nuclear Interactions

Theory of Deuteron and nuclear level properties, nucleon - nucleon interactions, low & high-energy nucleon-nucleon scattering, Yukawa's Meson theory of nuclear forces, Spin dependence and charge independence of nuclear forces.

Unit-III : Nuclear Reactions

Kinds of nuclear reactions; Conservation laws; Nuclear reaction Kinematics; charge particle reaction spectroscopy; neutron spectroscopy; nuclear cross-section; compound nucleus; Nuclear transmutations, continuum theory of nuclear reaction, Nuclear fission, Chain reactions, Nuclear fusion, Thermonuclear reactions.

Unit-IV : Nuclear Decays

Basic understanding of and - decay, Fermi theory of beta decay, selection rules in -decay, Neutrino hypothesis, Parity violation in beta decay, K capture and internal conversion.

Book Recommended:

W. E. Burcham: Nuclear Physics
Ervin Kapalan: Nuclear Physics
Roy & Nigam: Nuclear Physics
S. N. Ghoshal: Atomic and Nuclear Physics
H.A.Enge: Nuclear Physics
R.D. Evans: Nuclear Physics
E. Segre: Nuclei and Particles
H.M. Agarwal: Nuclear Physics

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LCC9. Elementary Particle Physics Course credits 04 (Marks 100) (Semester-II)

Unit-I: Elementary Particles

History of elementary particles, Classification of elementary particles, Fundamental interactions, Resonances, Lepton and Baryon number; Isospin, Strangeness, Hypercharge, Gell - Mann Nishijima relations, Symmetries and conservation laws, Parity, Time reversal and charge conjugation, Parity violation, CP violation in mesons, CPT invariance.

Unit II: Unitary Symmetries and Application in the Physics of Elementary Particles

Basics of unitary groups, fundamental representation of SU(2), SU(3) diagonal generators and weights, generators of SU(2) and U(2), weight diagram of fundamental representation of SU(2), generators of SU(3) and U(3), Weight of first fundamental representation of SU(3), shift operators, I, U, V spins, complete weight diagram for the (1 0), (0 1), (3, 0), (1 1) and (2 1) representations of SU(3) , Gell Mann Okubo Mass formula.

Unit III: Method of Young Tableaux and its Applications

Young Tableaux and unitary symmetry, standard arrangements of young tableaux, Dimentaionality of the representations of SU(N), Multiplets of SU(N-1), subgroup of SU(N), Baryon multiplets in different representations, general rule and its application for reducing kronecker product of two representations, kronecker product of three particle state vectors.

Unit – IV: Nuclear and Particle Detectors

Basic principle of particle detectors, Ionization chamber, Proportional counter, Geiger-Muller Counter, Scintillation counters and-ray spectrometer, semiconductor detector, Nuclear emulsion technique, Cloud chamber, Bubble chamber.

Book Recommended:

D. H. Perkins: Introduction to High Energy Physics, Cambridge University Press, 2000
S. N. Ghoshal: Atomic and Nuclear Physics, S. Chand and Company Ltd, 1994
D. Griffiths : Introduction of Elementary Particles
DB Lichtenberg: Unitary Symmetry and Elementary Particles, Academic Press, 1978
Hughes: Elementary Particles
Blatt and Weiskopff : Theoretical Nuclear Physics
FE Close: Quarks and Patrons
T.P.Cheng and G.LF Li : Gauge Field Theory:

W. E. Burcham : Nuclear Physics
R. M. Singru: Introduction to experimental nuclear physics
E. Segre: Experimental nuclear physics

LCC10. Condensed Matter Physics Course credits 04 (Marks 100) (Semester-II)

Unit I: Crystal Structure

Interaction of radiation with matter (for elastic and en elastic scatterings of x- ray). Concept of reciprocal lattice point, calculation of reciprocal lattice point of SC, BCC. and FCC lattices, Application of reciprocal lattice point in diffraction technique.

Unit II: Bonding in Solids

Different types of bonding in solids, covalent, metallic, Vander Waal, hydrogen bonding & ionic bonding, Madelung constant of ionic crystals, cohesive energy.

Unit III: Lattice Vibrations

Concept of dispersion relation, quantization of lattice vibrations (Phonons), normal modes & normal coordinates, longitudinal and transverse modes of vibration, modes of vibration of monatomic and diatomic lattices. Density of states (Phonons) , Theory of specific heat of solids : classical theory , Einstein theory and Debye theory .Theory of metals : Classical theory , free electron theory and F-D distribution function , Hall effect.

Unit IV: Crystal Defects, Superconductivity and Magnetism

Point defects (Schottky & Frankel Defects) Imperfections, Line defects (Edge& Screw dislocations), Burger vector & Burger Circuit, Role of dislocation in plastic deformation and crystal growth. Elementary idea of super conductivity nearly zero resistivity, Meissner effect, Tc, Hc type I, & II, superconductors & BCS theory, ferri, ferro, and anti ferromagnetism.

Books Recommended:

A. J. Dekker: Solid State Physics
S.O. Pillai : Solid State Physics
C. Kittle : Introduction to Solid State Physics
Verma & Srivastava : Crystallography for Solid State Physics

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PC2. Practical Course-II Course credits 8 (Marks 100) (Semester-II)

List of Experiments

1. Study of the Phase measurement by superposition of voltages with LCR Circuits.
2. Study of different oscillators (Hartely, colpit, Weinbridge oscillators etc.).
3. Study of an electronically regulated power supply.
4. Study of negative Feed- back Amplifier.
5. Determination of wavelength (λ) and wavelength difference ($\Delta\lambda$) by Michelson Interferometer.
6. Study of different type of Resistances and Diodes.
7. Study of Photo Voltaic Cell.
8. Stefan's Constant
9. FET characteristics
10. Fresnel's Law
11. Cauchy Formula
12. Lattice Dynamic Kit
13. Study of Logic gates
14. Detection Efficiency of Diode
15. Fabry – Perot Interferometer
16. Four Probe method

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Self Study Course (SSC) **(Semester-II)**

SSC1 } 1 out of the list enclosed

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Syllabus for M. Sc. (Physics) Semester-III

LCC11. Special Paper-I Course credits 04 (Marks 100) (Semester-III)

LCC11(a) High Energy Physics-I

Unit I: Quantization of Scalar Fields

Lagrangian Formulation, Hamiltonian and momentum densities, Neutral and Charged scalar fields and their quantization, Momentum representation and frequency splitting, Identification of various particle operators, Charge operator, Algebra of field operators, Invariant delta function and its representations, Covariant commutation relations and their properties.

Unit II: Quantization of Spinor Field

Lagrangian formulation for Spinor field, Hamiltonian and momentum densities, Quantization of Spinor Field, Momentum representation and frequency splitting, Identification of various particle operators, Charge operator for Spinor field, Algebra of Spinor field operators, Covariant form of anti-commutation relations.

Unit III: Quantization of Electromagnetic Field

Classical electromagnetic field theory and its gauge formulation, Covariant Lagrangian formulation for EM field, Quantization of EM field, Momentum representation and frequency splitting, Identification of various particle operators, Concept of longitudinal, temporal and transverse photons, Covariant commutation relations for EM potential operators, Problems with temporal photons and Lorentz condition, Resolution through Gupta- Bleular formulation.

Books recommended

L. Ryder : Quantum Field Theory
B.K. Agarwal : Quantum Mechanics and Field Theory
F Mandel and Shaw: Quantum Field Theory
P.Roman: Quantum Field Theory
A. Das : Quantum Field theory
M. E. Peskin, D.V. Schroeder : An Introduction to Quantum Field Theory
B.S.Rajput : Advanced Quantum mechanics

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LCC11. Special Paper-I Course credits 04 (Marks 100) (Semester-III)

LCC11(b) Advanced Electronics-I

Unit I : Integrated Circuit Technology

Classification of IC's, Fabrication of IC's & components, Basic monolithic integrated circuit technology, processes used in monolithic technology, active & passive components, metal semiconductor contact, thick & thin film IC's, hybrid IC's, charge coupled devices (CCD), advantages & limitations of integrated circuits

Unit II : Operational Amplifier: Linear Analog Systems

Basic operational Amplifier, Inverting & Non inverting OP – AMP, Common Mode Rejection Ratio (CMRR), Summing Amplifier, voltage follower, current to voltage, voltage to current converter, Integrator, Differentiator, Log – Antilog Amplifier, Circuit type of OP – AMP 741, Operational Amplifier parameters, effects of offset, frequency response and stability

Unit III : Operational Amplifier: Non - Linear Analog Systems

Comparators, Discriminators, sample & hold circuits, Zero crossing detector, precision rectifier, waveform generators, OP -AMP as astable, monostable and bistable multivibrator, regenerative comparator (Schmitt trigger), IC 555 timer.

Books recommended

Coughlin: Operational Amplifiers and Linear Integrated Circuits.
Schilling and Belove: Electronic circuits Discrete and Integrated, Mcgraw Hill
Millman and Halkias: Electronic Fundamentals & Applications, Tata Mcgraw Hill
Millman and Halkias: Integrated Electronics
K.R. Botkar: Integrated Circuits, Khanna Publishers
G.K. Mithal and Ravi Mittal: Electronic Devices & Circuits, Khanna Publishers
Roychaudhary and Jain: Operational Amplifier & Linear Integrated Circuits
V.K. Mehta: Electronics for Scientists & Engineers

LCC11. Special Paper-I Course credits 04 (Marks 100) (Semester-III)

LCC11(c) Spectroscopy-I

Unit I: Rotational Spectra

Rotational spectra: rotational energy level populations, linear, symmetric, spherical and asymmetric top molecules, rotational selection rules for linear molecules, Stark effect in molecular rotation spectra, Molecular rotation-nuclear spin coupling, Positive and negative character of the wave functions of linear molecules, Symmetric-antisymmetric character and statistical weight of homo-nuclear linear molecule.

Unit II: Vibrational Spectra

Vibration spectra of polyatomic molecule, coupling of rotation and vibration, perpendicular and parallel bands, Normal modes of vibration and their analysis in Cartesian coordinates, normal coordinates and their internal coordinates, calculation of vibrational frequencies and force field of H_2O and CO_2 molecules, anharmonicity, degenerate and non-degenerate vibrations, inversion doubling, Quantized Vibrational motion of polyatomic molecules.

Unit III: Electronic Spectra

Spectroscopy of Diatomic and Polyatomic Molecules: Coupling of Electronic and Rotational motion in Diatomic Molecules and Rotational structure of 1π - 1Σ and 1Σ - 1Σ transitions. Vibronic interaction and Herzberg Teller theory for absorption spectrum of benzene vapour, Single vibronic level spectroscopy and lifetime of vibronic levels in benzene, Quantum yield, Kasha Rule and the concept of nonradiative transtions in molecules, Jablanski diagram and qualitative treatment of small molecule and large molecule limit for nonradiative transitions.

Books recommended:

C.N. Banwell: Fundamentals of Molecular Spectroscopy
Walker and Stranghen: Spectroscopy Vol. I, II, & III
Herzberg: Spectra of diatomic molecules
Jeanne L Mchale: Molecular Spectroscopy
P.F. Bemath: Spectra of atoms and molecules

J.M Holias: Modern Spectroscopy
K. Thyagrajan and A.K. Ghatak: Lasers: Theory and applications
A Yariv: Quantum Electronics

LCC11. Special Paper-I Course credits 04 (Marks 100) (Semester-III)

LCC11(d) Astrophysics-I

Unit I : Spherical Astronomy

Celestial sphere, Celestial coordinate system (equatorial and alt-azimuth): altitude and azimuth, right ascension and declination, hour angle, sidereal time, mean solar time, summer and winter solstice, seasons.

Unit II : Solar System

Idea of solar system, Study of planets and their satellites, Earth-Moon system, tidal forces, asteroids, meteors, comets and their origin, composition and dynamical evolution, extra solar planets and their detection.

Unit III: Astronomical Instruments and Multiwavelength Astronomy

Optical telescopes, Newtonian, Cassegrain, and Coude focus, plate scale, focal ratio, Radio telescopes, Infrared, Ultraviolet and X-ray telescopes, photographic plate, photomultiplier tube, Charge-Coupled Devices (CCDs), Brief idea of optical, infrared, ultraviolet, X-ray and gamma ray astronomy.

Books Recommended

Abhyankar K.D. : Astrophysics, Galaxies and Stars
Baidyanth Basu : An Introduction to Astrophysics
Motz : Astrophysics
K S Krishnaswamy : Astrophysics: A Modern Perspective
W M Smart: Spherical Astronomy
Mark A. Garlick: The Story of the Solar System

LCC11. Special Paper-I Course credits 04 (Marks 100) (Semester-III)

LCC11(e) Advanced Condensed Matter Physics -I

Unit I: Crystal Symmetry

Point group and space group. External symmetry elements (translational, rotational, reflection and inversion) and internal symmetry elements (screw axis and glide plane) of the crystal. Notation of symmetry elements of the crystals.

Unit II: Crystal Structure

Introduction and different methods of x-ray diffraction. Structure factor determination of the crystal (SC, BCC, Base centered, FCC and diamond) and its importance in crystallography. Interpretation of diffraction pattern for determining the structure of the unknown material. Particle size and strain calculation by Williamson- Hall plot method.

Unit III: Methods for Crystal Structure

Ion irradiation properties of crystal. Neutron scattering and its applications. Debye Waller factor. Hyperfine interactions (isomer shift, quadrupole splitting and magnetic splitting), Mössbauer effect and its applications. Basic idea about nanomaterials and nanotechnology. fabrication of nanomaterials. modiication of crystal properties in nanodimension.

Books Recommended

A. J. Dekker: Solid State Physics
S.O. Pillai : Solid State Physics
C. Kittle : Introduction to Solid State Physics
Verma & Srivastava : Crystallography for Solid State Physics
B. D. Cullity: Elements of X-ray diffraction

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LCC12. Special Paper-II Course credits 04 (Marks 100) (Semester-III)

LCC12(a) High Energy Physics-II

Unit I: Lie Groups and Lie Algebra

Symmetries, Groups and conservation laws, Lie groups and their generator, representation of the groups, Lie Algebra, Different dimensions and parameter groups-their generators and algebra, Simple and semi-simple Lie Algebra, Standard form of Lie Algebras, Root diagrams for groups of different rank.

Unit-II: Quark Model

Fermi Yang model, Sakata model, Necessity of Quark model, Shortcomings of Eight fold way, Gell - Mann Zweig model, Quark-Lepton symmetry and structure of Hadrons, Need of charm quantum number and charmed quark , Elementary idea of charm, bottom and top quarks, Baryon magnetic moments in quark model, Experimental status of Quarks .

Unit III: Gauge Field Theories

Concept of gauge fields and gauge connections, Principle of gauge invariance, Global and local Abelian gauge invariance, U(1) gauge invariance of QED, Yang- Mills gauge field, Non-Abelian gauge field theory (SU(2) case), Concept of spontaneous symmetry breaking and Goldstone Bosons, Higgs Mechanism with physical examples and mass generation for gauge fields.

Books Recommended

F.E. Close : Quarks and Patrons
D.C. Cheng and O Neil : Elementary Particle Physics
T.P.Cheng and G.LF Li : Gauge Field Theory
I.J. Aitchison and A.J. Hey : Gauge theories in Particle Physics
H. Georgi : Lie Algebras in particle Physics
D. B. Lichtenberg : Unitary Symmetry and Elementary Particles, Academic Press, 1978

Department of Physics, Kumaun University

LCC12. Special Paper-II Course credits 04 (Marks 100) (Semester-III)

LCC12(b) Advanced Electronics-II

Unit I : Digital Communication

Digital signal processing, Image processing (Basic ideas only), Pulse Modulation systems, Pulse Amplitude Modulation, Pulse Width Modulation, Pulse position modulation, Pulse code modulation, Delta modulation Frequency division multiplexing (FDM), Basic idea of digital telemetry.

Unit II : Optical communication

Principle of optical communication, Different modes of propagation of E. M. Wave through optical fibre, Brief concept, classification of fibres and ray path, Advantages of multimode fibres and cladding , Optical Fibre connectors, Optical Fibre communication Receiver, Brief Introduction , Signal path through optical data link, Block diagram of optical Receiver, Advantages of optical communication, Light propagation in cylindrical wave guide.

Unit III : Memory and optoelectronic devices

Bulk and thin films. Photoconductive devices (LDR), Memory devices, static and dynamic random access memories SRAM and DRAM, CMOS and NMOS, nonvolatile-NMOS, magnetic, optical and ferromagnetic memories, charge coupled devices (CCD), LCDS.

Books Recommended

Coughlin: Operational Amplifiers and Linear Integrated Circuits.
Schilling and Belove: Electronic circuits Discrete and Integrated, Mcgraw Hill
Millman and Halkias: Electronic Fundamentals & Applications, Tata Mcgraw Hill
Millman and Halkias: Integrated Electronics
K.R. Botkar: Integrated Circuits, Khanna Publishers
G.K. Mithal and Ravi Mittal: Electronic Devices & Circuits, Khanna Publishers
Malmstadt and Enke: Electronics for scientists
Taub and Schilling: Principal of communication systems
Simon Gayukti: Communication Systems
Martin S. Roden: Analog & Digital Communication Systems
C. K. Sarkar and D. C. Sarkar: Optoelectronics and Fibre Optic Communication.

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LCC12. Special Paper-II Course credits 04 (Marks 100) (Semester-III)

LCC12(c) Spectroscopy-II

UNIT I: Radiation and Matter

Interaction of radiation with matter, Einstein quantum theory of radiation, Einstein's coefficients, Momentum Transfer, Lifetime, Theory of optical frequencies , Coherence Spatial and temporal and Monochromaticity, kinetics of optical absorption, line width, line broadening mechanisms.

UNIT II: Basic Elements of Lasers

Spontaneous emission, Stimulated emission, Possibility of amplification, laser pumping, ,Population Inversion, Three and four level scheme, Threshold condition, rate equations, Active resonators & laser modes, gain saturation.

UNIT III: Type of Lasers and Applications

Different types of lasers, gas lasers, He-Ne laser, N2 & CO2 lasers dye lasers, solid state lasers, Nd-YAG, semiconductor lasers. Tunability of lasers, Basic application of laser spectroscopy, laser cooling and trapping of atoms etc.

Books recommended:

Laud B.B: Laser and non-linear optics, wiley eastern
Thyagrajan and Ghatak: Laser and applications
Hollas J.M.: Laser and non-linear optics
Svelto: Lasers
Demtroder: Laser Spectroscopy

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LCC12. Special Paper-II Course credits 04 (Marks 100) (Semester-III)

LCC12(d) Astrophysics-II

Unit I: Interior Properties of Stars

Hydrostatic equilibrium, Virial theorem, Polytrophic indices, Lane – Emden equation LTE, Radiative equilibrium, stability condition of convective and radiative equilibrium, Continuous spectra of stars, Stellar opacity, limb darkening, line blanketing, theory of Fraunhofer lines, curve of growth and line broadening.

Unit II: Cold Stars, their Birth and Properties

Elementary theory of white dwarfs, Chandrashekhar's limit for white dwarf stars, neutron stars their birth and properties, Pulsars, black holes, low medium mass star and high mass stars, death of high mass stars, supernova remnants.

Unit III: AGNs and Quasi-stellar Objects

Theory of AGNs, Syferts, quasars and their energy generation and redshift anomaly. Different AGN models, radio lobes and jets, Gamma ray bursts, BL – Lac objects.

Books Recommended

Abhyankar K.D.: Astrophysics, Galaxies and Stars
Baidyanth Basu: An Introduction to Astrophysics
Motz: Astrophysics
A. R. Choudhuri : Astrophysics for Physicists
K. D. Abhyankar : An Introduction to Astrophysics
T. Padmanabhan : Astrophysical Processes

LCC12. Special Paper-II Course credits 04 (Marks 100) (Semester-III)

LCC12(e) Advanced Condensed Matter Physics -II

Unit I: Lattice Dynamics and Electronics Properties

Thermal expansion and thermal conductivity, anharmonicity interaction of electrons and phonons with photons (direct and indirect transitions), optical properties of metals. Band theory of solids. Effective mass.

Unit II: Magnetic Properties of Matter

Dielectric and ferroelectric properties of matter, polarizability, clauses-Mossotti relation. Temperature and frequency dependence of dielectric constant. Detailed study of magnetism and measurements of magnetic parameters (Vibrating Sample Magnetometer). Introductory idea of magneto resistance (GMR & CMR). Hall Effect (integer and fractional) and its applications.

Unit III: Superconductivity

Introduction of superconductivity, phenomenological, semi phenomenological and microscopic theories of superconductors, Meissner effect, Type-I and type-II superconductors, Penetration depth, coherence length, Josephson effect, Isotope effect, Elementary idea of high temperature superconductors.

Books Recommended

A. J. Dekker: Solid State Physics
S.O. Pillai : Solid State Physics
C. Kittle : Introduction to Solid State Physics
B. D. Cullity: Introduction to Magnetic Materials.

LCC13. Electrodynamics Course credits 04 (Marks 100) (Semester-III)

UNIT-I: Electromagnetism

Basic equations; Electrostatics; Magnetostatics; Different Systems of Units, Preliminary notations, four- vectors, Lorentz transformations, time, space and light like separations, Lorentz invariants, Energy and Momentum.

UNIT-II : Maxwell's Equations

Maxwell's equation, Displacement current, electromagnetic waves in conducting and non-conducting medium, Poynting theorem, boundary condition at the interface of conducting and non conducting media, propagation between parallel conducting plates. Electromagnetic wave equations.

UNIT-III: Four Vector Formalism of Maxwell's Equations

Four vector potential, electromagnetic field tensor, Lorentz invariance, Lorentz force, covariant form of Maxwell's equations, four vector current, continuity equation, Gauge invariance of Maxwell equation, electromagnetic energy- momentum tensor, Motion of charge particle in electromagnetic field, Lorentz force.

UNIT-IV: Electromagnetic Radiation

Lienard-Witchert potential, conventional potential, Quantization of electromagnetic energy (virtual photon), Radiation from an Accelerated Charge, Fields of an accelerated charge; angular and frequency distributions of the emitted radiation, special cases of acceleration-parallel and perpendicular (circular orbit) to velocity; Larmor's formula and its relativistic Generalization; Bremstrahlung, Cerenkov radiation.

Book recommended:

Jackson: Classical electrodynamics; Wiley Eastern, New Delhi
Landau and Lifshitz: Classical theory of fields; Pergameon Press
Thide : Electromagnetic field Theory
Panofsky and Phillips: Classical Electricity and Magnetism

Landau & Lifshitz : Electrodynamics of Continuous Media

PC3. Practical Course-III Course credits 08 (Marks 100) (Semester-III)

List of Experiments

1. Verification of Richardson's law.
2. Study of ESR spectra of a given sample.
3. Hall Effect
4. RCS Spectrometer
5. gamma ray spectrometer
6. Radio Receiver
7. e by Millikan's oil drop method.
8. Temperature dependence of diode characteristics.
9. Elastic constants of a cubic crystal by ultrasonic waves.
10. Study of Multivibrators .
11. Study of transistor amplifier cum feedback amplifiers.
12. Study of absorption of $KMnO_4$ by Spectrophotometer
13. Study of different FETs and MOSFETs.
14. Study of Thermo luminance .
15. Study of VTVM.

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Lecture Elective Course (LEC) Course credits 06(Marks 200) (Semester-III)

LEC1, LEC2 } 2 out of the list enclosed

Self Study Course (SSC) (Semester-III)

SSC2} 1 out of the list enclosed

Department of Physics, Kumaun University

Syllabus for M. Sc. (Physics) Semester-IV

LCC14. Special Paper-III Course credits 04 (Marks 100) (Semester-IV)

LCC14(a) High Energy Physics-III

Unit1: **Relativistic Propagators**

Relativistic propagators using quantized formulation of free fields, Properties of quantized scalar fields(Real and complex cases), Algebra of field operators, covariant form of the field operators algebras, (Covariant commutation relations), Meson propagator and its characteristics, Properties of quantized spinor fields, Algebras of spinor field operator, Covariant form of anti-commutation relations, Fermion propagator and its characteristics, properties of quantized EM field, Covariant commutation relations of EM field operators, Photon propagator and its characteristics, EM interaction in terms of radiation field and instantaneous coulomb fields.

Unit 2: **Operator Products, Feymann Propagators and S-matrix Expansion**

Various type of operator products (Normal, Dyson products and Chronological T-products), Wick's theorem, Feynman propagators and its physical interpretation , Interacting fields, S-Matrix formulation as a perturbative series solution of collision processes, Dyson expansion of S-matrix.

Unit 3: **S-matrix Formulation of QED**

Interaction Hamiltonian in QED, Reduction of S-matrix for the case of QED, Representation and description of various first and second order processes in QED using S-matrix expansion, Compton scattering, Moller scattering, Bhabha scattering, Electron self energy, Photon self energy, vacuum configuration in QED, Feymann diagrams and Feynman Rules in QED.

Books recommended:

L. Ryder : Quantum Field Theory

B.K. Agarwal: Quantum Mechanics and Field Theory

F Mandel and G. Shaw: Quantum Field Theory
P.Roman: Quantum Field Theory
A. Das: Quantum Field theory
M. E. Peskin, D.V. Schroeder: An Introduction to Quantum Field Theory

LCC14. Special Paper-III Course credits 04 (Marks 100) (Semester-IV)

LCC14(b) Advanced Electronics-III

Unit I :- Power Supply Regulation

Servomechanism, regulation using OA, Zener reference source, The 723 regulator current regulator, short circuit and over load protection, Precision rectifier, IC regulated power supply. Three terminal voltage regulations, dual Polarity regulated power supplies using 78 XX and 79 XX series regulators (Basic ideas only). Switched mode power supply (SMPS), Active filter , PLL

Unit II :- Microwave production

Limitation of convectional electronics devices at UHF, Microwave frequencies, Principle of velocity modulation. Reflex klystron. Theory and uses an of cavity magnetron PIN & GUNN Diode, Detection of microwave measurement of power.

Unit III :- Microwave Communication

Advantages and Disadvantages of Microwave transmission, loss in free space, propagation of microwaves, atmospheric effects on prorogation , Fresnel zone problem, ground reflection, fading sowlles, detectors, components, antennas used in microwave communication system.

Books recommended:

Coughlin: Operational Amplifiers and Linear Integrated Circuits.
Schilling & Belove: Electronic circuits Discrete and Integrated, Mcgraw Hill
Millman & Halkias: Electronic Fundamentals & Applications, Tata Mcgraw Hill
Millman & Halkias: Integrated Electronics
K.R. Botkar: Integrated Circuits, Khanna Publishers
G.K. Mithal & Ravi Mittal: Electronic Devices & Circuits, Khanna Publishers

Malmstadt & Enke: Electronics for scientists
Taub & Schilling: Principal of communication systems
Simon Gayukti: Communication Systems
Martin S. Roden: Analog & Digital Communication Systems
Terman: Electronic & Radio Engineering

LCC14. Special Paper-III Course credits 04 (Marks 100) (Semester-IV)

LCC14(c) Spectroscopy-III

UNIT I: Molecular Symmetries and Group Theory

Symmetry Properties of molecule: symmetry element, symmetry operation and point group, character table, Group theory: representation of a group, reducible and irreducible representations, LCAO coefficient of a polyatomic molecule, Huckel approximation, overlap and resonance integrals, Wheal's approximation.

UNIT II: Mechanism of Fluorescence

Emission and decay mechanism, radiative & nonradiative processes, Jablonski diagram, Kasha rule, Fluorescence lifetime and quantum yield, stoke shift, Mirror image rule, Oscillator strength, Fluorescence polarisation and Anisotropy, Time scale of molecular processes in solution .

UNIT III: Instrumentation for Fluorescence Spectroscopy

Excitation and Emission spectra, An ideal spectrofluorometer Distribution in Excitation & Emission spectra, Light sources, Monochromator, Optical filters, Photomultiplier tubes, Photon counting versus Analog detection of Fluorescence Corrected Fluorescence spectra, Measurement of Fluorescence lifetime.

Books recommended:

Barrow G.M: Introduction to Molecular spectroscopy; McgrawHill co

Herzberg G: Infrared and Raman Spectra of Polyatomic Molecules; Von Nostrand

Herzberg G: Spectra of Polyatomic Molecules; on Nostrand

J. R. Lackowicz: Principle of Fluorescence Spectroscopy

King G: Molecular Spectroscopy

King G.W: Spectroscopy and Molecular Structure

LCC14. Special Paper-III Course credits 04 (Marks 100) (Semester-IV)

LCC14(d) Astrophysics-III

Unit I: Our Sun and Physics of Solar Atmosphere

Solar inner and outer atmosphere, Quiet and Active Sun, Sunspots and their formation, Solar flares, Solar filaments/prominences, Coronal mass ejections (CMEs), Solar wind, Different type of solar eruptions models, Coronal heating, Origin of solar cycle, solar geomagnetic storm.

Unit II: Heliosesmology, Asteroseismology, and Variable Stars

General idea of Helioseismology and Astroseismology, Description about p-mode and g-mode oscillations, Introduction to variable stars and their locations in H-R diagram. Classifications, Cephieds variables (classic Cephieds and W Virginis stars), RR Lyrae stars, Mira variables, Eruptive variables, Flare stars, Nebular variables, Supernovae, roAP stars,

Unit III: The Milky way and Other Galaxies

Distributions of stars in the Milky way, Morphology, Kinematics, Interstellar medium, Galactic center. External galaxies, Classification of galaxies, spiral structures, dark matter in spiral galaxies, galactic rotation.

Books Recommended

M. Stix: The Sun: An Introduction
K. D. Abhyankar : Astrophysics: Stars and Galaxies
T. Padmanabhan : Galaxies and Cosmology

Motz : Astrophysics

LCC14. Special Paper-III Course credits 04 (Marks 100) (Semester-IV)

LCC14(e) Advanced Condensed Matter Physics -III

Unit-I : Advance Methods of Crystallography

Different sources of error in Powder method of X-ray photography, Determination of error function for powder method, Accurate determination of lattice parameter, Applications of powder method, Moving film methods and advance methods of crystallography (elementary idea).

Unit-II: Methods of Electron Microscopy and Surface Topography

Observation of surface imperfections using X-ray, Electron microscopy: Transmission Electron Microscopy, Surface Scanning Electron Microscopy and Scanning-Tunneling Electron Microscopy, Atomic force microscopy (AFM).

Unit-III : Discarded Systems

Concept of order, long range and short range order, Concept of impurity states in condensed matter system, Shallow impurity states in semi conductor, deep traps in condense matter systems, color center of an ionic crystal system, Disorder in condensed Matter system : substitutional positional and topological disorders.

Book Recommended:

C. S. Kittel: Introduction to solid state Physics.
C. S. Kittel: Quantum theory of Solids.
Verma and Srivastava: Crystallography for solid state Physicists.
Madelung: Solid State Physics.

LCC15. Special Paper-IV Course credits 04 (Marks 100) (Semester-IV)

LCC15(a) High Energy Physics-IV

Unit I: Theory of Weak Interactions

Classification of weak interaction in terms of Leptonic, Semi-leptonic and Non- Leptonic weak Decays, Current-Current Interaction and VA theory, Intermediate Vector Boson (IVB) concept, Conservation of Vector Current (CVC) Hypothesis, Two Component Theory of Neutrino, W and Z bosons as weak gauge bosons.

Unit II: Theory of Electromagnetic Interactions

Electron Positron Annihilation into Hadrons, Electron- Nucleon Scattering, Rutherford and Mott scattering, Electromagnetic form factors of Hadrons, Structure of nucleons, Elementary Idea of Unification of Fundamental Interactions with reference to standard model of electro weak unification.

Unit III: Strong Interactions

Paradoxes of Naive Quark Model, Need of color quantum Number for Quarks, Color SU(3) and Gluons, Quantum Chromodynamics, Pion-Nucleon Scattering, Spin Classification of Hadrons and Regge Trajectories, Asymptotic freedom and Perturbative QCD, Experimental indication for quarks and gluons, String model of hadrons and confinement of Quarks.

Books Recommended:

FE Close : Quarks and Patrons
I.J. Aitchison and A.J. Hey : Gauge theories in Particle Physics
F. Haltzin & A.D. Martin : Quarks and Leptons
D.H. Perkins : Introduction of High Energy Physics, Cambridge University Press 2000

T.P.Cheng and G.LF Li : Gauge Field Theory
ED Commins : Weak Interactions
D.C. Cheng and O Neil : Elementary Particle Physics
B.S.Rajput : Advanced Quantum mechanics

LCC15. Special Paper-IV Course credits 04 (Marks 100) (Semester-IV)

LCC15(b) Advanced Electronics-IV

Unit I :- Analog Computation

Solution of ordinary linear differential equations with constant coefficients, Operation modes of analog computers, repetitive operation of computers, Time scaling, amplitude scaling, Generation of functions, Simulation of time varying systems.

Unit II :- Combinational Circuits

Boolean algebra, Canonical forms of Boolean, functions, Simplification of Boolean functions (K-map, Tabulation method), don't care conditions. Digital logic families; Adders & Subtractors, Magnitude comparator, Code converters; Parallel adders, Encoders, Decoders, Multiplexers, Demultiplexers, Parity bit generator and checker, Read only memory (PROM, EPROM), P.L. Digital to Analog and Analog to Digital converters.

Unit III :- Sequential Circuits

Sequential logic- Memory element, RS, JK, JKMS, T type and Edge triggered Flip flop; Registers; Shift register; Counters—synchronous and Synchronous; The memory unit; Semiconductor Random Access Memory; Inter-register transfer; Arithmetic; Logic and Shift Micro-operation; Fixed point and floatation point data.

Books Recommended:

M. Morris Mano: Digital Logic & Computer Design
Rajaraman: Introduction to Digital Computer design
Malvino & Leech Sloan: Computer Hardware & Organization
V. Rajaraman: Analog Computation & Simulation Integrated Circuits.

Schilling & Belove: Electronic circuits Discrete and Integrated, Mcgraw Hill
Millman & Halkias: Electronic Fundamentals & Applications, Tata Mcgraw Hill
Millman & Halkias: Integrated Electronics
K.R. Botkar: Integrated Circuits, Khanna Publishers
G.K. Mithal & Ravi Mittal: Electronic Devices & Circuits, Khanna Publishers

LCC15. Special Paper-IV Course credits 04 (Marks 100) (Semester-IV)

LCC15(c) Spectroscopy-IV

Unit-I: **Ultrashort Pulses and Dynamics of Laser Processes**

Production of giant pulse, Q-switching by different types of shutters, giant pulse dynamics, laser amplifiers, mode locking, mode pulling, ultra shot pulses, hole burning, holography.

Unit-II: Non-Linear Optics

Harmonic generation, phase matching, second harmonic generation, third harmonic generation, optical mixing, parametric generation of light, self focusing of light.

Unit-III : Multi Photon Processes

Multi quantum photoelectric effect, two photon processes, frequency up-conversion, stimulated Raman effect, coherent stokes & anti-stokes Raman scattering, photo acoustic spectroscopy.

Books recommended:

M.D. Levenson: Introduction to non-linear laser spectroscopy

B.B.Laud: Laser and non-linear optics

Svelto: Lasers
Demtroder: Laser Spectroscopy

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LCC15. Special Paper-IV Course credits 04 (Marks 100) (Semester-IV)

LCC15(d) Astrophysics-IV

Unit I: Basic Properties of Stars: Mass, radius, distance, luminosity, temperature, magnitude system, Wien-displacement colour indices, filters, H-R diagram, classification of stellar spectra, luminosity classification, stellar motion, stellar populations.

Unit II: **Star Formation and Stellar Evolution:** Birth of stars, protostar, nebula, Hyashi tracks, zero age main sequence (ZAMS), energy generation in stars – gravitational contraction, pp chain, CNO cycle and triple alpha process, stellar life, cycles-Premain sequence, main sequence, giants.

Unite III: Star Cluster and their Properties

Star clusters : open, globular and stellar association, stellar population, population I and population II type objects, inter-stellar extension, reddening determination from colour-colour diagram, age and distance determination of star clusters, luminosity function, mass function, mass segregation, dynamical evolution in clusters, mass-luminosity relation.

Books Recommended

Abhyankar K.D. : Astrophysics, Galaxies and Stars
Baidyanth Basu : An Introduction to Astrophysics
Motz : Astrophysics
T. Padmanabhan : Stars and Stellar Systems
M L Kutner: Astronomy: A Physical Perspective

LCC15. Special Paper-IV Course credits 04 (Marks 100) (Semester-IV)

LCC15(e) Advanced Condensed Matter Physics -IV

Unit-I : Exotic solids

Structure and symmetry of liquids, Amorphous solids, Glass, Aperiodic solids and Quasi-crystals. Definitional and proprieties of nano-structured materials, quantum size effect, special carbon solids, carbon nano tubes and Fullerene.

Unit-II : Soft Matter

Definition of Soft matters, Properties, phases and applications of liquid crystals, Polymer, Polymer systems and its Physical aspects, Universal Properties of a single polymer chain, Bio-polymers and applications of Polymer systems.

Unit-III : Thin film and Surface States

Definition and proprieties of thin films, Difference in the properties of a thin film from it's corresponding bulk material, Boltzmann Transport equation for diffused Scattering of electron in the thin film, surface states, and surface reconstruction, metallic surface.

Books Recommended

C. S. Kittel: Introduction to solid state Physics.
C. S. Kittel: Quantum theory of Solids.
Poole: Nanotechnology
K. L. Chopra: Thin Film
Steinhardt and Ostulund: The Physics of Quasicrystals
Chandrasekhar: Liquid-Crystal

PC4. Practical Course-IV Course credits 08 (Marks 100) (Semester-IV)

List of Experiments: (a) High Energy Physics

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

List of Experiments: (b) Advanced Electronics

1. Study of regulated power supply (723).
2. Study of operational amplifier (741).
3. Study of Timer (555).
4. A to D and D to A converter
5. 1 of 16 Decoder/Encoder
6. Study of Multiplexer/Demultiplexer
7. Study of Logic gates (Different types)
8. Study of Comparator and Decoder
9. Study of amplitude and frequency modulations and demodulations.
10. Study of different flip- flop circuits (RS, JK, Dk type, T-type, Master slave).
11. Study of Digital combinational and sequential circuits
12. Study of Microprocessor (8085)
13. Study of SCR, DIAC, TRIAC
14. Study of IC- Based Power supply
15. Microwave experiment.
16. Shift Registers
17. Fiber Optics communication

List of Experiments: (c) Spectroscopy

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

List of Experiments: (d) Astrophysics

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

List of Experiments: (e) Advanced Condensed Matter Physics

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

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Lecture Elective Course (LES) Course credits 03 (Marks 100) (Semester-IV)

LEC3} 1 out of the list enclosed

Dissertation/Project (DC/PC) Course credits 06 (Semester-IV)

Self Study Course (SSC) (Semester-IV)

SSC3 } 1 out of the list enclosed

Lecture Elective Courses (LEC)

LEC1. Communication Electronics Course credits 04 (Marks 100)

UNIT I : Modulation

AM and FM (Transmission and reception): Modulation, AM generation, Power consideration, Balanced modulator, SSB transmission, AM detection, AGC, Radio receiver characteristics, signal to noise ratio, FM analysis, noise considerations, generation, direct method and reactance tube method, FM transmitter, AFC, FM Propagation, phase discriminator.

UNIT II : Propagation of Radio Waves

Ground wave, sky wave and space wave propagation. Ionosphere (Ecclr- larmer theory, magneto ionic theory.

UNIT III : Antenna and TV

Antenna, HF antenna, Yagi antenna, loop antenna, Satellite communication, parabolic reflector, dish antenna, Fundamentals of image transmission, vestigial transmission, TV camera tubes, image orthicon, vidicon, TV transmitter, TV receiver and picture tubes.

UNIT IV : Transmission Lines

Voltage and current relations on transmission line, propagation constant, characteristic impedance, impedance matching, quarter wave T/L as impedance transformer, attenuation along coaxial cable, cables of low attenuation, propagation of radio waves between two parallel lines, wave guide modes, TE10 mode and cut off wavelength, cavity resonator, light propagation in cylindrical wave guide, step index and graded index fibers, attenuation and dispersion in fibers.

Books Recommended:

George Kennedy & Davis: Electronics Communication Systems
Millar & Beasley: Modern Electronics Communication
R.R Gulani: Monochrome and colour television (Wiley Eastern Limited)
Taub and Schilling: Principle of Communication Systems (TMH)
Simon Gaykuti: Communication Systems (John Wiley & Sons Inc. 1994)

LEC2. Plasma Physics **Course credits 04 (Marks 100)**

UNIT-I: Introduction to Plasma

Elementary concept: Derivation of moment Equation from Boltzmann Equation, Plasma Oscillation, Debye Shielding, Plasma parameter, Magneto plasma, Plasma confinement

UNIT-II: Magneto Hydrodynamics

Hydrodynamical description of Plasma: fundamental equation, hydromagnetic waves, magneto-sonic and Alfven waves.

UNIT-III: Magneto Plasma

Wave phenomena in Magneto plasma: Polarization, Phase velocity, group velocity, cutoff, resonance for electromagnetic wave propagating parallel and perpendicular to the magnetic field.

UNIT-IV: Plasma Propagation and Fluid Plasma

Propagation at finite angle and CMA diagram, Propagation through ionosphere and magnetosphere, Helicon, Faraday rotation, Fluid equations for a plasm**a,** Continuity equation**,** Momentum balance equation**,** Equations of state**,** Two-fluid equations, Plasma resistivity

Book recommended:

Jackson: Classical Electrodynamics; Wiley Estern, New Delhi
Bittencourt: Plasma Physics
Chen: Plasma Physics
Robert J Goldston and Paul H. Rutherford: Introduction to Plasma Physics

LEC3. Digital Electronics and Computer Architecture Course credits 04 (Marks 100)

UNIT-I: Digital Circuit & Microprocessor

Elementary idea of combinational and sequential circuits, Overview of Microcomputer organization and operation, Microprocessor evolution and types, Fundamental knowledge of Microprocessor (8085/8086), Architecture and its operation, Basic idea of logic devices for interfacing 8085/8086.

UNIT-II: Computer Organization and Architecture

Central Processing Unit, Computer organization, Instruction formats (e.g. Three address, Two address etc), addressing modes, Timing diagram, Interconnection of different units, I/0 to processor and processor to memory communication, Interrupt structures, Multiprogramming, processor features RISC, CISC, cache memory, real and virtual memory.

UNIT-III: Data Communication

Computer and Communications, Need for communication networks, Internet and World Wide Web, communication protocols, Local Area Networks, Interconnecting networks, Future of Network Technology.

UNIT-IV: Computer Network

Characteristics of communication channels, Allocation of Channels, Physical Communication media, Public Switched Telephone Network, Cellular Communication Path, ATM networks,

Books Recommended:

Morris Mano : Computer system Architecture, (PHI) (Eastern Economy Edition)

V. Rajaraman : Fundamentals of computers, (Prentice Hall of India)

Morries Mano : Computer system architecture, (Estern Economy Edition)

B. Ram: Computer fundamental-architecture and organization(New Age International Publishers)

Tenan Bomm : Computer Network

Ramesh Gaonkar : Microprocessor, Architecture, programming and application with the 8085

Hafizer Rehaman: Microprocessor programming and Interfacing Intel 8085 and 8086

LEC4. Atmospheric Physics Course credits 04 (Marks 100)

Unit-I: Introduction to Earth Atmosphere and Meteorology

Elementary concept of atmospheric sciences, atmosphere and it composition, Thermal and pressure variation in earth atmosphere, Thermal structure of the troposphere, stratosphere, mesosphere and ionosphere, Hydrostatic equation, spectral distribution of the solar radiation, Green house effect and effective temperature of earth.
Meteorological process and different system, local winds, monsoons, fogs, clouds, precipitation, Cyclones and anti-cyclones, thunderstorms, Mountain Meteorology.

Unit-II: Atmospheric Dynamics and Thermodynamics

Introduction to atmospheric dynamics, Basic conservation laws, Applications of the basic equations, circulations and vorticity, Atmospheric oscillations, The general circulations, Tropical dynamics, Thermodynamical considerations, Adiabatic and isothermal processes, equation of state for dry and moist air, Humidity parameters, laws of thermodynamics, Entropy, Thermodynamic diagram and their uses.

Unit-III: Environmental pollution and climate change

Atmospheric pollution, type of pollutants, various sources of emissions, Trace gages, Production and loss processes of stratosphere ozone, Tropospheric ozone, Role of trace gases and their budget, motion of air-masses (back-air trajectory), tools for modeling (Box model and 3-D model), Atmospheric aerosols, classification and properties, concentration and size distribution, Absorption and scattering of radiation, optical phenomena in atmospheric, Modeling for aerosols, Estimations of radiative forcing.
Definition of climate long term changes, possible causes of climate change-External and internal, General idea of internal dynamical processes of the atmosphere, climate modeling, Review of various climate models.

Unit-IV: Instrumentation and Observational Techniques

Convectional measurements of pressure, temperature, humidity, wind speed and direction, sunshine duration, radiation clouds, upper air pressure, temperature, humidity and wind measurements, Polit balloons, radiosonde, dropsonde, ozonesonde, GPS sonde.

Application of radars to study the atmospheric phenomenon, LIDAR, SONAR, RASS (Radio- acoustic sounding system), Observational technique for aerosol.

Books Recommended

S. Pettersen: An Introduction to meteorology
H. R. Byer: General Meteorology
Miller, Thompson and Paterson: Elements of meteorology
J. M. Wallau and P. V. Hobbs: Atmospheric Science
J. A. Ratchiffe: Physics of upper atmosphere
R. B. Stull: An introduction to boundary layer Meteorology
D. H. Lenschow: Probing the atmospheric boundary
D. H. Lechow: Intruments and Techniques for probing the atmospheric boundary layer
A.A. Tsonis: An introduction to atmospheric Thermodynamics
H. J. Critchfield: General Climatology
G. T. Trewartha: An introduction to climate

LEC5. Introduction to Nanoscience and Nanotechnology

Unit-I Introduction and Synthesis Methods of Nanomaterials

Emergence of Nanotechnology – Challenges in Nanotechnology, Carbon age–New form of carbon (From Graphene sheet to CNT), Introduction to nanomaterials, evolution of nanoscience, general properties of nanomaterials, role of size in nanomaterials, semiconducting nanoparticles, nanoclusters, quantum wells, conductivity and enhanced catalytic activity compared to the same materials in the macroscopic state.

Synthesis of nano structured materials, sol-gel processing, Mechanical alloying and mechanical milling, Inert gas condensation technique, Nanopolymers, Bulk and nano composite materials, top down and bottom up approaches.

Unit-II Properties of Nanomaterials

One-, two- and three-Dimensional nanostructured materials. Influence of Nano size on mechanical, optical, electronic, magnetic and chemical properties of quantum dots and quantum wires, electronic transport in quantum wires and carbon nano tubes (CNT), types of CNT, magnetic behavior of nano particles, surface chemistry of Tailored monolayer, self assembling. Evolution of band structure and Fermi surface. Superparamagnetic behavior on nanoparticles. Metals (Au, Ag) - Metal oxides (TiO_2, CeO_2, ZnO) - Semiconductors (Si, Ge, CdS, ZnSe) - Ceramics and Composites.

Unit-III Characterization Methods

Optical Microscopy, Scanning Electron Microscopy, Transmission Electron Microscopy, HRTEM, Atomic Force Microscopy, Scanning Tunneling Microscopy, Optical Absorption and Emission Spectroscopy, Thermogravimetric Analysis, Thermomechanical Analysis, X-Ray Diffraction. Super conducting quantum interference devices. Vibrating Sample magnetometer. Raman and FTIR Spectroscopy.

Unit-IV Applications of Nanomaterials

Molecular electronics and nanoelectronics, Quantum electronic devices, Carbon Nano Tube based transistor and Field Emission Display, Biological applications, Biochemical sensor, medical applications and Membrane based water purification. Biological systems- DNA and RNA - Lipids.

Books Recommended:

C. Kittle: Introduction to Solid State Physics (John Wiley)

C.Poole and F.J.Owens: Introduction to Nanotechnology (John Wiley)

T.Varghese and K.M.Balakrishna: Nanotechnolgy: An Introduction to Synthesis, properties and Application of Nanomaterials. (Atlantic)

G. Schmidt: Nanoparticles: From theory to applications (Wiley Weinheim)

M. Wilson, K. Kannangara, G Smith, M. Simmons, B. Raguse: Nanotechnology: Basic science and Emerging technologies, Overseas Press India Pvt Lt First Edition,2005.

C.N.R.Rao, A.Muller, A.K.Cheetham (Eds): The chemistry of nanomaterials: Synthesis, properties and applications, Wiley VCH Verlag Gmbh&Co, Weinheim, 2004.

Kenneth J. Klabunde (Eds): Nanoscale Materials Science, John Wiley & Sons, InC, 2001.

C.S.S.R.Kumar, J.Hormes, C.Leuschner: Nanofabrication towards biomedical applications, Wiley –VCH Verlag GmbH & Co, Weinheim, 2004.

W. Rainer: Nano Electronics and information Technology, Wiley, 2003.

K.E.Drexler: Nano systems, Wiley, 1992.

G.Cao: Naostructures and Nanomaterials: Synthesis, properties and applications, Imperical College Press, 2004.

Self Study Courses (SSC)

SSC1. Advances in High Energy Physics

Unit I : **Gauge Theory and Unification of Fundamentals Forces**

Gauge formulation of fundamental interactions, Gauge formulation of Weak and Electromagnetic Interactions, Standard Electroweak Model, Gauge formulation of QCD, Grand Unified Theories, Topological objects in gauge field theories: Magnetic monopoles: Dirac's monopole, Solitons, The 't Hooft-Polyakov monopole, Julia- Zee Dyons, Instantons, Skyrmions.

Unit II: **Quantum Chromodynamics**

General Properties: Lagrangian density, Feynmann rules, Quark-gluon interactions, Gluon self-interactions, Asymptotic freedom, the running coupling constant, Quark confinement, string model of hadrons, Superconductivity: Magnetic Confinement, Mechanism for quark confinement, Non-perturbative methods in gauge field theories: Dual QCD, Lattice gauge theory.

Unit-III: **Thermal Field Theory**

Need of thermal field theory, Theory of Ensembles, Partition function and its integral representation, Spontaneous symmetry breaking and restoration: Goldstone's theorem and Higgs model, Weinberg-Salam model of weak interaction and restoration, Early universe, QCD and study of phase transitions in hadronic world, Ultrarelativistic nucleus-nucleus collisions, Dense nuclear matter.

Unit-IV: **Beyond Standard Model**

Problems with Grand unified theories, Neutrino Masses, Neutrino oscillations and its implications , the Gauge Hierarchy Problem and Supersymmetry(SUSY), various

supersymmetric models and mass spectrum, SUSY and Gravity, SUSY breaking (Spontaneous and dynamical), Super space formulations, Experimental status of SUSY, Elementary idea of Theory of Everything and String theories.

Books Recommended

K, Huang: Quarks, Leptons and gauge fields
M. Guidry: Gauge field Theories
T. Morii, C. S. Lim, S. N. Mukherjee: The Physics of the Standard Model and Beyond
J. I. Kapusta, C. Gale : Finite-Temperature Field Theory, Cambridge University Press
P. Ramond: Field Theory: A Modern Primer (Addison-Wesley,Redwood City)
A. V. Smilga: Hot and Dense QCD, in At the Frontiers of Particle Physics: Handbook of QCD , World Scientific, Singapore (2001).

SSC2. Advances in Laser Physics

UNIT –I: Laser Raman Spectroscopy

Basic considerations, Experimental Techniques of linear Laser Raman Spectroscopy, Non Linear Raman Spectroscopy, Hyper Raman Effect, Resonance Raman Effect, Raman Microscopy, Time Resolved Raman Spectroscopy, Applications of Laser Raman Spectroscopy.

UNIT –II: Laser Spectroscopy in Molecular Beams

Reduction of Doppler width, Adiabatic Cooling in Supersonic Beams, Non linear Spectroscopy in Molecular Beams, Laser Spectroscopy in Fast Ion Beams, Application of FIBLAS.

UNIT –III: Modern Laser Spectroscopy

New Developments in Laser Spectroscopy, Elementary idea of optical cooling and trapping of Atoms, Spectroscopy of single Ions, Spectral Resolution within the Natural line width, Absolute optical Frequency Measurement.

Books recommended:

M.D. Levenson: Introduction to non-linear laser spectroscopy
B.B.Laud: Laser and non-linear optics
Svelto: Lasers
Demtroder: Laser Spectroscopy
Thyagrajan & ghatak: Laser and applications
Hollas J.M.: Laser and non-linear optics
Svelto: Lasers

SSC3. Advances in Solar Physics

Unit I: **Solar Flares: Magnetohydrodynamic Processes**

Observational features, Unified model, Triggering models (tether cutting, magnetic breakout, kink instability, torus instability), energy build-up (emergence and cancellation of magnetic flux, magnetic structures, magnetic helicity), energy release (magnetic reconnection, current sheet formation), energy transport (radiation, mass ejections, shock formation, particle acceleration, wave propagation) mechanism. Application to stellar flares.

Unit II: **Solar Cycle: Observations and theory**

Introduction, Dynamo models, cyclic variation in different activity features like as: sunspot numbers, sunspot area, total irradiance, magnetic field, cosmic rays, geomagnetic activity, solar flares, Coronal mass ejections. Long-term variability, Short-term variability, solar cycle predictions,

Unit III: **Sun-Earth Connection**

Coronal mass ejections, Solar energetic particles (SEPs), Ground level enhancements (GLEs) Geomagnetic storm, Physics of Solar activity effect on magnetosphere, ionosphere, atmosphere, and on the earth ground.

Books Recommended:

A Bhatnagar : Fundamentals of Solar Astronomy
B V Somov : Plasma Astrophysics part I, II and III
E Priest: Magnetohydrodynamics of the Sun

SSC4. Bio-Physics

Unit I: Basic Concepts in Biophysics

Elementary ideas about the DNA structure, Forces stabilizing DNA and protein structure, sugar-phosphate backbone, nucleosides and nucleotides, three dimensional DNA structure, RNA. Proteins: primary, secondary, tertiary and quaternary structures, enzymes and their catalytic activity, DNA and protein folding, DNA denaturation, replication, mutation, intercalation, neurotransmitters, membranes.

Unit II: Technique For The Study of Biological Structure and Function

Application of experimental techniques of light scattering (tomography), FTIR and Raman spectroscopy, absorption and fluorescence spectroscopy/ microscopy, anisotropy, optical activity, circular dichroism, electrophoresis,. Photobiology: interaction of light with cell and tissues, Photosynthesis, human eye and vision, optical biopsy, optical biosensors, Laser tweezers and Laser scissors Photo-dimerization, Photodynamic therapy.

Unit III: Radiation Effects on Biological Systems

High doses received in a short time, Low-level doses limits, direct ionization of DNA, radiation damage to DNA, Biological effects (Genetic, Somatic, Cancer and sterlity). Bio-imaging: Ultrasound, MRI imaging, confocal fluorescence imaging and X-ray.

Books Recommended:

Essentials of Biophysics: P. Narayanan.
Basic Molecular Biology: Price.
Quantum Mechanics of Molecular Conformations: Pullman (Ed.).
Non-linear Physics of DNA: Yakushevich.
Biological Physics: Nelson.
Spectroscopy of biological systems
Modern Spectroscopy: J.M. Hollas.
Transmission Electron Microscopy of Metals: Gareth Thomas
Elements of X-ray Diffraction: Bernard Dennis Cullity.

Atomic Force Microscopy/Scanning Tunneling Microscopy: M.T. Bray, Samuel H. Cohen and Marcia L. Lightbody.

SSC5. Computer Application in Physics

Unit-I: Physics and Computers

Importance of Computers in Physics as third way of doing physics, Formulation of a problem for solution on a computer, paradigm for solving physics problems for solution . Algorithms and Flowcharts: Algorithm: Definition, Properties and development of Flowchart, Examples of algorithms and flowcharts: Cartesian to Spherical Polar Coordinates, Roots of Quadratic Equation, Sum of two matrices, Sum and Product of a finite series, calculation of sin x as a series, algorithm for plotting Lissajous figures, algorithm for plotting trajectory of a projectile thrown at an angle with the horizontal.

Unit-II: Scientific Programming

Development of FORTRAN, Basic elements of FORTRAN: Character Set, Constants and their types, Variables and their types, Keywords, Variable Declaration and concept of instruction and program. Operators: Arithmetic, Relational, Logical and Assignment Operators. Expressions: Arithmetic, Relational, Logical, Character and Assignment Expressions. Fortran Statements: I/O Statements[unformatted/formatted], Executable and Non-Executable Statements, Layout of a Fortran Program, Programming with C and Visual Basic, Examples from physics problems.

Unit-III: Scientific Word Processing and Modern Software's For Mathematical Computing

Introduction to LaTeX: TeX/LaTeX word processor, preparing a basic LaTeX file, Document classes, Compiling LaTeX File, LaTeX tags for creating different environments, Defining LaTeX commands and environments, Mathematical Environment: Mathematical formulae and equations, Figures and other floating bodies, Lining in columns-Tabbing and tabular environment, Generating table of contents, bibliography and citation, Introduction to Gnuplot, basic gnuplot commands: simple plots, plotting data from a file, saving and

exporting file, physics problems with gnuplot (mathematical expressions, building functions, user defined variables and functions)

Mathematica and Matlab: Introduction , Core language, Mathematics and Algorithms, Visualization and Graphics, Data manipulation, Dynamic Interactivity, Notebooks and Documents.

Unit-IV: Computer Applications to Physical Problems

One dimentional Motion: Formulation from Analytical Tools to Numerical Methods, Euler method, Freely Falling Body, Fall of a body in viscous Medium, Simulation of free fall and Numerical integration, Random numbers in computer simulation, Simulation of Radioactivity, Integro-Difference Technique vs Monte-Carlo Method, Solution for Harmonic potential, Solution of time independent Schrodinger Equation .

Book Recommended

Computer Programming in Fortran 77: V. Rajaraman (Publisher:PHI).
Computer Fundamentals: Pradeep K Sinha and Priti Sinha (BPB Publications).
LaTeX – A Document Preparation System: Leslie Lamport (Addison-Wesley, 1994).
Excel 2010-Power Programming with VBA: John Walkenbach (Wiley India Pvt Ltd).
Gnuplot in action: understanding data with graphs: Philip K Janert, (Manning 2010)
Fundamentals of Computer: V. Rajaraman (PHI Ltd.).
Computational Physics An Introduction: R. C. Verma, P. K. Ahluwala, K. C. Sharma.
The C Programming Language: H. H. Chaudhary
C Programming Language: B.W. Kernighan, D. Ritchie
Visual Basic.NET Black Book : Steve Holzner
Visual Basic. NET programming Bibble: Bill Evjen

SSC6. Medical Physics

Unit I: Mechanics of Human Body

Static , Dynamic an d Frictional forces in the Body, Composition, properties and functions of Bone, Heat and Temperature, Temperature scales, Clinical thermometer, Thermography, Heat therapy, Cryogenics in medicine, Heat losses from Body, Pressure in the Body, Pressure in skull, Eye and Urinary Bladder.

Unit II: Physics of Respiratory and Cardiovascular System

Body as a machine, Airways, Blood and Lungs interactions, Measurement of Lung volume, Structure and Physics of Alveoli, Breathing mechanism, Airway resistance, Components and functions of Cardiovascular systems, work done by Heart, Components and flow of Blood, Laminar and Turbulent flow, blood Pressure, direct and indirect method of measuring, Heart sounds.

Unit III: Electricity in the Body and Sound/Light In Medicine

Nervous system and Neuron ,Electrical potentials of Nerves, Electric signals from Muscles, Eye and Heart, Block diagram and working to record EMG, Normal ECG wave form, Electrodes for ECG, Amplifier and Recording device, Block diagram and working to record ECG, Patient monitoring, Pace maker.
General properties of sound, Stethoscope, Generation, detection and characteristics of Ultrasound ,Ultrasound imaging technique, A scan and B scan methods of ultrasound imaging ,properties of light, Applications of visible UV, IR light, and Lasers in medicine, Microscope, Eye as an optical system, Elements of the Eye, Ophthalmology Instruments.

Unit IV: Diagnostic X-Rays and Nuclear Medicine

Production and properties of X-rays, Basic Diagnostic X-ray Machine, X-ray image, Live X-ray image, X-ray computed Tomography, Characteristics of Radio activity, Radioisotopes and Radio nuclides, Radioactivity sources for Nuclear medicine, Basic Instrumentation and

clinical applications, Principles of Radiation Therapy, Nuclear medicine imaging devices, Radiation sources.

Unit V: **Medical Precision Equipments and Modern Medicines**

MRI (Magnetic Resonance Imaging), Positron emission tomography (PET) , Computed tomography (CT) scan, ventilator, Endoscopy, Cardiovascular Instrumentation- Electrodes, Amplifiers, patient Monitoring, Defibrillators, Pace makers, Principle, description, working, analysis and clinical applications of Ultrasonic imaging, ECG, EMG, EEG and ERG.

Nanotechnology-based drugs e.g. Abraxane, Doxil, C-dots (Cornell dots) and goldnano particle as a diagnostic tool, Anti-cancer polymeric nanomedicines, Use of nano-technology in Photodynamic therapy.

Books Recommended

Medical Physics by Department of Physics, St. Joseph's College,Trichy-2.

Medical Physics by John R. Cameron and James G. Skofronick, John Wiley & Sons.

Hand book of Biomedical Instrumentation : R.S.Khandpur, Tata McGraw Hill Publication Co., Delhi, 1987.

SSC7. Optical Communication

Unit - 1: Introduction To Optical Fibers

Evolution of fiber optic system- Element of an Optical Fiber Transmission link- Ray OpticsOptical Fiber Modes and Configurations -Mode theoryof Circular Wave guides-Overview of Modes-Key Modal concepts- Linearly Polarized Modes -Single Mode Fibers-Graded Index fiber structure.

Unit - 2: Signal Degradation Optical Fibers

Attenuation - Absorption losses, Scattering losses, Bending Losses, Core and Cladding losses, Signal Distortion in Optical Wave guides-Information Capacity determination -Group Delay-Material Dispersion, Wave guide Dispersion, Signal distortion in SM fibersPolarization Mode dispersion, Intermodal dispersion, Pulse Broadening in GI fibers-Mode Coupling -Design Optimization of SM fibers-RI profile and cut-off wavelength.

Unit - 3: Fiber Optical Sources And Coupling

Direct and indirect Band gap materials-LED structures -Light source materials - Quantum efficiency and LED power, Modulation of a LED, lasers Diodes-Modes and Threshold condition -Rate equations -External Quantum efficiency -Resonant frequencies -Laser Diodes, Temperature effects, Introduction to Quantum laser, Fiber amplifiers- Power Launching and coupling, Lencing schemes, Fibre -to-Fibre joints, Fibre splicing.

Unit - 4: Fiber Optical Receivers

PIN and APD diodes -Photo detector noise, SNR, Detector Response time, Avalanche Multiplication Noise -Comparison of Photo detectors -Fundamental Receiver Operation - preamplifiers, Error Sources -Receiver Configuration -Probability of Error - Quantum Limit.

Unit - 5: Digital Transmission System

Point-to-Point links System considerations -Link Power budget -Rise - time budget - Noise Effects on System Performance-Operational Principles of WDM, Solitons-Erbium-doped Amplifiers. Basic on concepts of SONET/SDH Network.

Books Recommended

Gerd Keiser, "Optical Fiber Communication" McGraw -Hill International, Singapore,

3rd ed., 2000.

Govind P. Agrawal: Fiber-Optic Communications Systems, , 2nd ed., John Wiley & Sons, Inc.

Joseph C. Palais: Fiber Optic Communications, 5th ed., Pearson Prentice Hall.

Eugene Hecht: Optics, 3rd ed., Addison-Wesley 1998.