SYLLABUS

For

MASTER OF SCIENCE (M.Sc.)

in

PHYSICS

[As per CBCS pattern recommended by UGC]

Effective from Academic Session: 2022-2023

VEER BAHADUR SINGH PURVANCHAL UNIVERSITY

JAUNPUR

COURSE STRUCTURE

SEMESTER-VII

Course Code	Title of the Paper	Credit	Nature (T/P)	Marks Allotment		
				CIA	End Sem.	Total
B010701T	Mathematical and computational Physics	4	T	25	75	100
B010702T	Classical Mechanics	4	T	25	75	100
B010703T	Thermodynamics and Statistical Physics	4	T	25	75	100
B010704T	Electronics	4	T	25	75	100
B010705P	Physics Lab-I	4	P	25	75	100
B010706R	Research Project cum Dissertation	4	R	-	-	-

SEMESTER-VIII

Course Code	Title of the Paper	Credit	Nature (T/P)	Marks Allotment		
				CIA	End Sem.	Total
B010801T	Nuclear and Particle Physics	4	T	25	75	100
B010802T	Atomic and Molecular Physics	4	T	25	75	100
B010803T	Condensed Matter Physics -I	4	T	25	75	100
B010804T	Quantum Mechanics-I	4	T	25	75	100
B010805P	Physics Lab-II	4	P	25	75	100
B010806R	Research Project cum Dissertation	4	R	-	-	100

SEMESTER-IX

Course Code	Title of the Paper	Credit	Nature (T/P)	Marks Allotment		
				CIA	End Sem.	Total
B010901T	Laser and Modern Optics	4	T	25	75	100
B010902T	Electromagnetic Theory and Plasma Physics	4	T	25	75	100
B010903T	Quantum Mechanics - II	4	T	25	75	100
B010904T	Advanced Electronics - I	4	T	25	75	100
B010905P	Electronics Lab-I	4	P	25	75	100
B010906R	Research Project cum Dissertation	4	R	-	-	-

SEMESTER-X

Course Code	Title of the Paper	Credit	Nature (T/P)	Marks Allotment		
				CIA	End Sem.	Total
B011001T	Classical Electrodynamics	4	T	25	75	100
B011002T	Condensed Matter Physics -II	4	T	25	75	100
B011003T	Advanced Electronics - II	4	T	25	75	100
B011004T	Atmospheric and Space Physics Or Physics of Renewable Energies	4	T	25	75	100
B011005P	Electronics Lab-II	4	P	25	75	100
B011006R	Research Project cum Dissertation	4	R	-	-	100

B010701T: MATHEMATICAL AND COMPUTATIONAL PHYSICS

UNIT - I

Complex Variables

Analytic function, Cauchy-Riemann conditions and their applications. Complex integrals, Cauchy's integral and residue theorem, Cauchy's integral formula, Taylor and Laurent expansion of Complex function, Principal value of an integral.

UNIT - II

Special Functions

Bessel function, Legendre, Hermite, and Laguerre functions – generating function, recurrence relations and their differential equations, orthogonality properties, Bessel's function of first kind, Spherical harmonics

UNIT - III

Fourier Series and Integral Transforms

Fourier series, Definition, Dirichlet's Condition, Fourier Integral and Fourier transform, convolution theorem, Parseval's identity, Application to the solution of differential equations, Laplace transform and its properties.

UNIT - IV

Numerical Techniques

Interpolation, solution of algebraic equation, Simpson's method, least-square curve fitting, linear algebra and matrix manipulations, inversion, eigenvectors and eigenvalues, numerical differentiation, numerical integration, Numerical solution of ordinary differential equations: Euler and Runge-Kutta methods, Numerical computing using Matlab.

References:

1. Mathematical methods for physicists by Arfken, Weber and Harris (Academic Press).
2. Mathematical Physics by H. K. Dass (S. Chand & Company Pvt. Ltd).
3. Mathematical Physics by B. S. Rajput (Pragati Prakashan).
4. Complex Variable (Schaum's outline series), M.R. Spiegel (McGraw Hill).
5. Numerical Methods by E. Balgurusamy (TATA McGraw Hill).
6. Introductory methods of numerical analysis by S. S. Sastry (PHI Learning Pvt. Ltd.).
7. Computer oriented numerical methods by V. Rajaraman (PHI Pvt. Ltd).

B010702T: CLASSICAL MECHANICS

UNIT- I

Lagrangian and Hamiltonian Dynamics

Mechanics of a system of particles, constraints of motion, generalized coordinates, constraints, principle of virtual work, D'Alemberts Principle and the generalized equation of motion, cyclic Co-ordinates, Variational principle and its applications to problems like shortest distance, geodesics etc.

Lagrangian and Hamiltonian equations of motion - derivation using Hamilton's principle of least action and their applications to various problems. Hamiltonian for a charged particle.

UNIT- II

Canonical Transformations and Poisson Brackets

Canonical transformations and their applications. Canonical transformations of the free particle Hamiltonian. Poisson Brackets. Jacobi-Poisson theorem

on Poisson Brackets. Invariance of Poisson brackets under canonical transformations.

UNIT- III

Central Forces and Non-inertial Frames of Reference

Lagragian formulation of motion under central forces. Kepler problem. Stability of orbits. Motion of satellites. Rotating frames of reference. Coriolis force.

UNIT- IV

Rigid Body Dynamics and Small Oscillations

Moment of inertia tensor, Euler angles, Euler equation of motion for rigid body motion. Symmetric top. Small oscillations. System of couple oscillators. Normal modes and normal coordinates.

Reference Books:

1. Classical Mechanics by H. Goldstein, C. Poole and. J Safko (Pearson India, 2011).
2. Classical Mechanics by N. C. Rana and P.S. Joag (McGraw-Hill Education (India) Pvt Limited, 2001).
3. Mechanics (Course of Theoretical Physics, Volume 1) by L. D. Landau and E.M. Lifshitz (Butterworth Heinemann, An imprint of Elsevier, 1997).
4. Classical Mechanics by John R. Taylor (University Science Books, 2004).
5. Classical Mechanics by Padmakar V. Panat (Alpha Science International, 2005).
6. Classical Mechanics by V.R. Waghmare (Prentice-Hall India, 1990).

7. Classical Mechanics by J.C. Upadhyaya (Himalaya Publishing House, 2016).

B010703T: THERMODYNAMICS AND STATISTICAL PHYSICS

UNIT- I

Thermodynamics

Thermodynamics of first and second order phase transition. Thermodynamic properties of liquid Helium II. The Lambda transition. Tisza two fluid model, second sound.

UNIT- II

Statistical Mechanics

Ensembles. Canonical, microcanonical and grandcanonical ensembles and their partition function. Partition function for monoatomic and diatomic gases. Gibb's paradox, Maxwell-Boltzman, Bose-Einstein and Fermi-Dirac statistics. Degenerate bosons and Bose-Einstein condensation. Black body radiation, electron gas and its thermodynamic properties. White dwarfs and their limiting mass.

UNIT- III

Fluctuations

Mean square deviation, Fluctuation in ensembles; Concentration fluctuation in quantum statistics, one- dimensional random walk and Brownian motion. Wiener-Khintchine theorem. The Nyquist theorem.

UNIT- IV

Cooperative Phenomena

Phase transition of second kind. Ising model. Bragg-Williams approximations. Kirkwood Method. Order-disorder in alloys. structural phase change.

References:

1. A treatise on Heat by M. N. Saha and B. N. Srivastava (Indian Press Limited. Allahabad).
2. Thermal Physics by C. Kittel (John Wiley, New York).
3. Statistical Mechanics by B. K. Agrawal and Melvin Eisner (Wiley Eastern Ltd., Delhi).
4. Statistical Mechanics by R. K. Pathria (Pergmon Press).
5. Statistical Mechanics by Kerson Huang (Wiley Student Edition).
6. Fundamentals of Statistical & Thermal Physics by Reif (Mc Graw Hill, London).
7. Statistical Physics Part I and Part II by Landau and Lifshitz (Pergmon Press. Oxford).

B010704T: ELECTRONICS

UNIT- I

Power Devices

SCR: basic structure, I-V characteristics and two transistor model. DIAC and TRIAC: basic structure. operation and equivalent and I-V characteristics. TRIAC as high power switch, DIAC as triggering device of TRIAC, SCR controlled half and full wave rectifier circuit and their analysis. UJT in over voltage protection, saw tooth wave generation using UJT.

UNIT- II

Operational amplifier

Characteristics of Op-Amp, inverting and non-inverting inputs, input offset current and input offset voltage, slew rate and power band width. Op-Amp as an amplifier, Bode plot and frequency response of Op-Amp.

UNIT- III

Operational Amplifier Applications

Op-Amp as voltage follower, current follower, integrating and differentiating circuits, frequency to voltage and voltage to frequency converter, voltage controlled oscillator and wave shaping circuits (Triangular and square wave), Astable, Monostable and Bistable Multivibrators, clipping and clamping circuits.

UNIT- IV

Logic Circuit Design

Boolean algebra, composite function and their algebraic simplification, De-Morgans theorem, universality of NAND and NOR gates, Standard representation of logic function, SOP and POS terms and design of logic circuits using these terms, Karnaugh Map, half adder and full adder, serial and parallel adder, half and full subtractors.

References:

1. Integrated Electronics by Jacob Millman, Christos Halkias, Chetan Parikh (McGraw Hill Education, 2017).
2. Hand Book of Electronics by S. L. Gupta and V. Kumar (Pragati Prakashan, 1980).
3. Op-Amps and Linear Integrated Circuits by Ramakant A. Gayakwad (Prentice-Hall of India Private Limited, 2002).
4. Digital Computer Electronics by Albert Malvino, Jerald Brown (McGraw Hill Education, 2017).

5. Modern Digital Electronics by R P Jain (Deceased). Kishor Sarawadekar (McGraw Hill, 2022).

B010705P: PHYSICS LAB-I

1. Wavelength of Sodium light by Michelson Interferometer
2. Wavelength of Sodium light by Fabry Perot Interferometer
3. Young modulus of metal rod by Newton's Ring
4. Wavelength of Laser light and thickness of wire.
5. Lande's g factor by E.S.R
6. Study of R-C Coupled Amplifier
7. Study of Multivibrator
8. Study the characteristics and determination of h-Parameter of PNP transistor in CE.
9. Study of saw tooth wave generator by UJT.
10. Study of Clipping – Clamping circuit.

B010706R: RESEARCH PROJECT CUM DISSERTATION

SEMESTER: VIII

B010801T: NUCLEAR AND PARTICLE PHYSICS

UNIT- I

Nucleus and Nuclear Models

Nuclear radius and its determination, nuclear spin and parity, quadrupole moment, magnetic moment, saturation of nuclear forces, stability of nuclei, liquid drop model, Weizsacker semi-empirical mass formula and its applications, Evidence of nuclear shell structure, Nuclear potential and

sequence of energy level of nucleons, spin orbit potential and explanation of magic number, Prediction and limitation of shell model.

UNIT- II

Nuclear Forces and Two Body Problem

Nature of the nuclear force, form of nucleon-nucleon potential, charge-independence and charge-symmetry of nuclear forces. Deuteron problem, S and D states, Neutron-Proton and proton-proton scattering, Effective range theory, Spin-dependence of nuclear forces, Charge independence and charge symmetry of nuclear forces.

UNIT- III

Nuclear Reaction and Nuclear Transitions

General features and concept of cross section and Q value of nuclear reaction. Compound nucleus hypothesis, Ghoshal experiment, partial level width, resonance theory of nuclear reaction, Breit-Wigner one level formula, Nuclear fission and fusion, idea of nuclear accelerators and detectors, Gamow's quantum theory of α-decay and its predictions. Fermi theory of beta (β) decay, Neutrino properties and experimental evidence, Parity conservation in weak interaction. Electromagnetic transition, multipole order, selection rules, internal conversion, and life time of Gamma emitting states and isomerism.

UNIT- IV

Elementary Particles

Basic elementary particle interactions and classifications of elementary particles, Invariance and Conservation laws in relation to particle reaction and decays, Isospin formulation, Elementary idea of C, P & T symmetries. CPT theorem, Associated production and strangeness, Elementary idea of

Gauge theory, Quark structure of elementary particles, Gell-Mann's eight-fold classification of Hydrons, Quark Gluon interaction.

References:

1. Introduction to nuclear physics by Harald A. Enge (Addison-Wesley, 1983).
2. Nuclei and Particles by E. Segre (W.A. Benjamin, Original from Pennsylvania State University, 1974).
3. Atomic and Nuclear Physics Vol II by S.N. Ghoshal (S. Chand and Company Ltd, New Delhi 1994).
4. Nuclear Physics Vol I by Y M Shirikov and NP Yudin, (Mir Publisher, Moscow 1982).
5. Theory of Nuclear structure by M.K. Pal (Affiliated East West Press, New Delhi 1982).
6. Nuclear and Particle Physics by E.B. Paul (North Holland Publishing Company, Amsterdam 1969).
7. Nuclear Physics (Theory and Experiment) by R.R. Roy and B.P. Nigam (Wiley Eastern Ltd., New Delhi 1993).

B010802T: ATOMIC AND MOLECULAR PHYSICS

UNIT- I
Basics of Atomic Spectra

Atomic emission and absorption spectra, fine structure of hydrogen atom, relativistic correction for energy levels of hydrogen atom, mass correction, spectra of helium, deuteron and alkali atoms, hyperfine structure.

UNIT- II
Many Electron Atoms

Singlet and triplet fine structure in alkaline earth spectra, Lande interval rule, L-S and J-J coupling schemes, energy levels, selection rules. Zeeman Effect, Paschen back effect, Stark effect, Breadth of spectral lines: Natural broadening, Doppler broadening and stark broadening, Electron spin resonance. Nuclear magnetic resonance, chemical shift.

Unit- III

Rotation and Vibration Spectra

IR and Raman spectra of rigid rotator and harmonic oscillator, IR and Raman spectra of non-rigid rotator, anharmonic oscillator and vibrating rotator, Intensities in rotation–vibration spectra, Isotope effect in rotation and vibration spectra.

Unit- IV

Electronic Spectra

Electronic energy and total energy, vibration structure of electronic transitions, progressions and sequences, rotational structure of electronic bands, b and head formation and band origin, Intensity distribution in vibrational structure, Frank-Condon principle and its quantum mechanical formulation, intensity alternation in rotational lines.

References:

1. Perspectives of Modern Physics by Arthur Beiser (McGraw-Hill).
2. Introduction to Atomic Spectra by Harvey Elliott White (McGraw Hill).
3. Molecular Spectra and Molecular Structure, Vol I and Vol II by G. Herzberg (Dover Publication, London).
4. Introduction to Molecular Spectroscopy by Gordon M. Barrow (Creative Media Partners, LLC, 2021).

5. Fundamentals of Molecular Spectroscopy by C. N. Banwell, Elaine M. McCash (McGraw-Hill, 2008).
6. Modern Spectroscopy by J. Michael Hollas (Wiley, 2013).

B010803T: CONDENSED MATTER PHYSICS –I

UNIT- I

Crystal Lattices

Recapitulation of basic concepts: Bravais lattice and Primitive vectors, Primitive, Conventional and Wigner-Seitz unit cells; Crystal structures and lattices with bases, Symmetry operations, Common crystal structures of NaCl, CsCl, ZnS, graphite and diamond, Reciprocal lattice and Brillouin zones (examples of *sc*, *bcc* and *fcc* lattices), Basis of quasi crystals, Diffraction of electromagnetic waves by crystals- X-rays, Bragg's law, Von Laue's formulation.

Defects and Diffusion in Solids: Point defects: Imputities, Vacancies and Interstitials, Frenkel and Schottky defects, Concentration of Schottky and Frankel defects as a function of temperature, color centers, line defects and dislocations.

UNIT- II

Crystal Binding

Bond classifications– types of crystal binding, covalent, molecular and ionic crystals, van der Waals bonding, hydrogen bonding, cohesive and Madelung energy.

UNIT- III

Thermal Properties of Metals and Lattice Dynamics

Drude theory, DC conductivity, thermal conductivity, thermoelectric effects, Sommerfeld theory for an electron gas, Wiedemann Franz law, critique of free-electron model. Lattice vibrations of linear mono-atomic and diatomic chains, Quantization of lattice vibrations and phonon, Einstein and Debye theories of specific heat, Lattice thermal conductivity.

UNIT- IV

Band theory of Solids

Motion of electrons in periodic potential, Bloch's theorem, Kronig Penny Model, Density of states in different dimensions, Fermi surface and Brillouin zones, Origin of energy bands, band gaps of metals, semiconductors and insulators, Effective mass, Tight-binding approximation and calculation of simple band-structures.

References:

1. Introduction to Solid State Physics by C. Kittel (Wiley Eastern, New Delhi).
2. Crystallography Applied to Solid State Physics by A. R. Verma and O.N. Srivastava (New Age International Private Limited).
3. Elementary Solid State Physics: Principle and Application by Omar Ali (Addison Wesley, London).
4. Solid State Physics by S. O. Pillai (Wiley Eastern Ltd).
5. Solid states Physics by A-J. Dekkar (McMillan and Co., London).
6. Introduction to Lattice Dynamics by Ajoy Ghatak, L.S. Kothari (Addison-Wesley Educational Publishers Inc).
7. Materials Science and Engineering by V. Raghvan (Prentice Hall India Learning Pvt. Ltd.).

B010804T: QUANTUM MECHANICS - I

UNIT- I

Linear Vector Spaces

de Broglie's hypothesis- matter waves and experimental confirmation, wave packets, Linear vector spaces- inner product, Hilbert space, Wave Functions, Linear operators- Hermitian operators, projection operators, commentator algebra, unitary operators, Eigenvalues and eigen vectors of a Hermitian operator, Basis- representation in discrete bases, matrix representation of kets, bras, and operators, change of bases and unitary transformations, Matrix representation of the eigenvalue problem, Representation in position bases.

UNIT- II

Postulates of Quantum Mechanics

Postulates of Quantum Mechanics- State of a System, probability density, Superposition Principle, Observables as operators, Position and Momentum operators, Position and momentum representation of state vector, Connecting the position and momentum representations, Measurements in quantum mechanics, Expectation values, Commuting operators and Uncertainty relations, Time evolution of the state- Time-independent potentials and Stationary States, Time evolution operator, infinitesimal and finite unitary transformations, Conservation of probability, Time evolution of expectation values- Ehrenfest theorem, Poisson's brackets and commentators, Matrix and Wave mechanics- Heisenberg matrix mechanics and its application to harmonic oscillator, Equivalence of wave mechanics and matrix machines.

UNIT- III

Time independent 1D and 3D Problems

Discrete, continuous and mixed spectrum, symmetric potentials and parity. Infinite square well potential. Symmetric potential well. Finite square well potential, Scattering and bound state solutions- Free particle. Delta function potential, Harmonic oscillator, Free particle in 3-dimensions, spherically symmetric solution, Particle in a 3D box.

UNIT- IV

Angular Momentum

Angular momentum, infinitesimal rotation operator, orbital and spin momentum operators, commutation relation, Ladder operators (J_+ and J_-) and their commutation relation with themselves, J and J^2, Eigen values of J, J^2, J_+ and J_-, Explicit forms of angular momentum matrices, Eigen functions of J^2 and J, coupling of two angular momenta and Clebsh-Gordon coefficients, Addition of orbital and spin angular momentum and p-states of an electron, recursion relation of Clebsh-Gordon coefficients.

References:

1. Quantum Mechanics: Concepts and Applications by Nouredine Zettili (Wiley, 2022)
2. Introduction to Quantum Mechanics by David Jeffery Griffiths, Darrell F. Schroeter (Cambridge University Press, 2018).
3. Modern Quantum Mechanics by J. J. Sakurai, Jim Napolitano, (Cambridge University Press, 2020).
4. Principle of Quantum Mechanics by R. Shankar (Springer US, 2012).
5. Textbook of Quantum Mechanics by P M Mathews, K. Venkatesan (McGraw-Hill Education (India) Pvt Limited, 2010).
6. Quantum Mechanics by V.K. Thankappan (New Academic Science Limited, 2015).
7. Principle of Quantum Mechanics by P. A. M. Dirac (Oxford University Press).

B010805P: PHYSICS LAB– II

1. Excitation energy and wavelength by Frank Hertz experiment.
2. Study of Hall effect.
3. Study of G. M. Counter.
4. Study of Zeeman Effect (e/m).
5. Study of Lattice Dynamics.
6. Study of Energy band gap of Semiconductor.
7. Study of High pass and Low pass Active Filter.
8. Study of TTL gates.
9. Study of Audio Frequency Oscillator.
10. Study of Linear and Square wave detector.

B010806R: RESEARCH PROJECT CUM DISSERTATION

SEMESTER: IX

B010901T: LASER AND MODERN OPTICS

UNIT- I

Laser and Holography

Laser theory, Light Amplification, threshold condition, Optical pumping, population inversion and coherence length, Laser Rate Equations-two, three and four level systems, Laser power around threshold, optimum output coupling, Line Broadening Mechanisms–Natural, Collision and Doppler, Optical Resonators – Modes of a rectangular cavity and open planar resonator, Principles of He-Ne, Co_2, Dye, Nd: YAG and Semi-conductor Lasers.

Basic principle of holography and holograms, methods of hologram recording, reconstruction of object waveform by hologram, Basic theory of

plane hologram; Typical arrangement for hologram reconstruction, practical consideration of holography and its application.

UNIT- II

Non-Linear Optics

Essential criterion to observe non linear optical effects, First experimental demonstration of non- linear phenomena, Classical theory of non-linear response in one dimension, Generalization to three dimensions, Non-linear polarizability tensors, coupled amplitude equation, Manley Rowe relations and their significance, Parametric amplification and parametric oscillation, Phase matching, second harmonic generation, Sum and difference frequency generation, Basic idea of self-focusing.

UNIT- III

Fibre Optics

Optical fiber as a guiding medium, Total Internal reflection, Acceptance angle Numerical aperture, Types of fiber, Refractive index profiles, Concept of modes, Electromagnetic analysis of guided modes in symmetric step index planar wave guide and step index fiber, Concept of Normalized Frequency, V-Parameter, Pulse dispersion in step index fibers. dispersion and loss in fibre, principles of optical communication.

UNIT- IV

Liquid Crystal

Liquid crystal: Physics, structure and classification, Polymorphism in theromotropic liquid crystals, orientational distribution function. symmetry and order parameters. Optical properties of Colestric, Smectic and nematic liquid crystals, liquid crystal displays, electro-optic effect, Lyotropic liquid crystal and biological membrane.

References:

1. Lasers and Non-Linear Optics by B.B. Laud (Wiley Est. Ltd., New Delhi).
2. Quantum Optics by S.H. Kay and A. Maitland (Academic Press. London).
3. Non-Linear Optics by P.G. Harper and B.S. Wherret (Academic Press. London).
4. Laser and holographic Data processing by N.G. Bosov (Mir Publisher. Moscow).
5. Introduction to fiber optics by A. Ghatak and K. Thyagrajan (Cambrige University Press, 1998).
6. Optical Fiber Communications by Gerd Keiser (McGraw-Hill 2000).
7. Optical Fiber Communications: Principles and Practice by John M. Senior (Pearson Education, 2010).
8. Introduction to Liquid Crystals edited by E.B. Priestley, Peter J. Wojtowicz, Ping Sheng (Springer US, 2012).
9. Liquid Crystals by S. Chandrashekhar (Cambridge University Press).
10. Liquid Crystals Vol. I, II & III by Birendra Bahadur (World Scientific. Singapore).
11. Liquid Crystals: Fundamentals by Shri Singh (World Scientific. 2002).

B010902T: ELECTROMAGNETIC THEORY AND PLASMA PHYSICS

UNIT- I

Maxwell Equations, Potential and Gauges

Microscopic and Macroscopic fields, Maxwell equations. Fields **D** and **H**. Dielectric tensor, Principal Dielectric axes, Scalar and vector potentials.

Gauge transformation, Lorentz gauge and [illegible] equations in terms of electromagnetic potentials.

UNIT- II

Propagation of Electromagnetic Waves

Propagation of electromagnetic waves in free space, conducting and non conducting medium. Reflection and refraction at a plane surface, normal and dielectrics. Polarization by reflection, dispersion (Normal and anomalous), Metallic reflection. Electromagnetic waves propagation in bounded media.

UNIT- III

Plasma State & its Properties

Elementary ideas of plasma state of matter. Motion of charge particle in uniform E & B fields, non-uniform fields. Adiabatic invariants. Plasma confinements (Pinch effect, Mirror confinement, Van Allen belts). Elementary idea of fusion technology.

UNIT- IV

Hydrodynamical Description of Plasmas

Hydrodynamical description. Equation of magneto-hydrodynamics. Low frequency plasma oscillations. Short wavelength limit and Debye shielding distance.

Wave Phenomenon in Magneto-Plasma

Electromagnetic waves perpendicular to B_0, phase velocity, Polarization, Cut-off and resonances. Electromagnetic waves parallel to B.

References:

1. The Classical Theory of Fields by L.D. Landau and E.M. Lifshitz (Pergmon Press, Oxford).

2. Foundation of Electromagnetic Theory by [illegible] (Pearson Delhi)
3. Classical Electrodynamics By J.D. Jackson (Wiley [illegible])
4. Introduction to Plasma Physics and Controlled Fusion by F. F. Chen (Springer 2016)
5. Fundamentals of Plasma Physics By J. A. Bittencourt (Springer 3rd ed. 2013)

P0109031: QUANTUM MECHANICS – II

UNIT- I

Approximation Methods

Time independent perturbation theory: non-degenerate and generate case. first order and second order perturbation. first-order Stark effect in hydrogen atom. WKB approximation. Variation method. Time dependent perturbation theory: transition probability. Semi-classical theory of radiation, transition to continuum of states. Fermi's Golden rule. Einstein's coefficients. spontaneous and stimulated emission

UNIT- II

Relativistic Quantum Mechanics

Relativistic wave equations. Klein Gordon equation. KG equation for a particle with coulomb potential. Dirac equation and free particle solution. Algebra of Dirac Matrices. Negative energy and Antiparticle. non relativistic limit of Dirac equation. Dirac equation for a particle in central field. prediction of electron spin and spin magnetic moment. fine structure of hydrogen atom. elementary idea about field quantization.

UNIT- III

Scattering Theory

Non-relativistic scattering theory, differential and total scattering cross section, Born approximation method with examples of scattering by Coulomb, Gaussian, Square well and Yukawa potentials. Partial wave analysis, optical theorem, phase shift, example of scattering by square well potential.

UNIT- IV

Concept of Field and Interaction Theory

Field Quantization- Classical Field Theory, Lagrangian and Hamiltonian formalism of a particle in an electromagnetic field, Second quantization, Algebra of annihilation and creation operators, S-matrix expansion, Interaction picture, Feynman diagram.

References:

1. Principle of Quantum Mechanics by P. A. M. Dirac (Oxford University Press).
2. Quantum Mechanics by L. I. Schiff (Mc Graw Hill, New York).
3. Quantum Mechanics by J. L. Pawel and B. Craseman (Narosa Publishing House, London).
4. Introduction to Quantum Mechanics by A. K. Ghatak (MacMillan India Ltd., New Delhi).
5. Quantum Mechanics (non-relativistic theory) by L. D. Landau and E. M. Lifshitz (Pergamon Press, Oxford).
6. Quantum Mechanics and field Theory by B. K. Agrawal (Lok Bharti Publication, Allahabad).
7. An Introduction to Relativistic Quantum Field Theory by S.S. Schweber (Harper and Row, New York).
8. The Classical theory of Fields by L. D. Landau and E.M. Lifshitz (Pergmon Press, Oxford).

B010904T: ADVANCED ELECTRONICS – I

UNIT- I

Analog Electronics and Combinational Logic Design

Phase Locked Loop (PLL) (IC565) and its applications, Analog to digital and digital to analog convertor; Encoder and decoder, multiplexer and demultiplexer circuit.

UNIT- II

Sequential Logic Circuits

(i) Basic definition, finite state model, SR, JK, T, D, Edge Triggered flip-flop, Race condition, Master Slave flip-flop, Clocked flip-flop, Characteristic table and characteristic equation.

(ii) Registers and Counters: Register, Shift register, Universal shift register, Ring counter, Twisted ring or Johnson counter, synchronous and asynchronous counters, UP/Down and scale of 2n counters.

UNIT- III

Memory

Basic idea of magnetic memory. Ferrite core memory, Semi-conductor memory viz, RAM, ROM, PROM, EPROM, EEPROM.

UNIT- IV

Microprocessor

Introduction to Intel 8085 microprocessor, microprocessor architecture, instruction and timings, assembly language programming, stack and subroutines, code conversion, interrupts.

References:

1. Integrated Electronics by Jacob Millman, Christos Halkias, Chetan Parikh (McGraw Hill Education, 2017).
2. Digital Integrated Electronics by H. Taub & D. L. Schilling (McGraw Hill).
3. Microprocessor, Architecture, Programming and Applications by R. S. Gaonkar (Prentice Hall, 2013).
4. Fundamental of Microprocessors and Microcomputers by B. Ram (Dhanpat Rai Publications).
5. Digital Computer Electronics by Albert Malvino, Jerald Brown (McGraw Hill Education, 2017).
6. Digital Technology: Principles and Practice by Virendra Kumar (Wiley).

B010905P: ELECTRONICS LAB- I

1. Study of Encoder and Decoder.
2. Study of Mux and Demux.
3. Study of Register and Counter.
4. Study of A/D and D/A converter.
5. Study of Microprocessor.
6. Study of Arithmatic logic unit (ALU)
7. Study of Combinational logic.
8. Programming on PC.
9. Study of Sequential logic.
10. Study of Memory (RAM).

B010906R : RESEARCH PROJECT CUM DISSERTATION

References:

1. Integrated Electronics by Jacob Millman, Christos Halkias, Chetan Parikh (McGraw Hill Education, 2017).
2. Digital Integrated Electronics by H. Taub & D. L. Schilling (McGraw Hill).
3. Microprocessor, Architecture, Programming and Applications by R. S. Gaonkar (Prentice Hall, 2013).
4. Fundamental of Microprocessors and Microcomputers by B. Ram (Dhanpat Rai Publications).
5. Digital Computer Electronics by Albert Malvino, Jerald Brown (McGraw Hill Education, 2017).
6. Digital Technology: Principles and Practice by Virendra Kumar (Wiley).

B010905P: ELECTRONICS LAB- I

1. Study of Encoder and Decoder.
2. Study of Mux and Demux.
3. Study of Register and Counter.
4. Study of A/D and D/A converter.
5. Study of Microprocessor.
6. Study of Arithmatic logic unit (ALU)
7. Study of Combinational logic.
8. Programming on PC.
9. Study of Sequential logic.
10. Study of Memory (RAM).

B010906R : RESEARCH PROJECT CUM DISSERTATION

SEMESTER: X

B011001T: CLASSICAL ELECTRODYNAMICS

UNIT- I

Four Dimensional Formulation

Minkowski space, Intervals, Proper time, Lorentz transformation, Transformation of velocities, addition of velocities, relativistic Doppler effect, Four vectors, Four Tensor, Principle of least action, Four-momentum of a free particle.

UNIT- II

Charges in Electromagnetic Fields

Four Potential, Minimal coupling prescription, action of a charged particle, generalized momentum and Hamilton equation of motion, Motion in constant uniform magnetic field.

UNIT- III

Electromagnetic Field Equations

Four dimensional formulation of equation of motion, Electromagnetic field tensor, Transformation properties of electric and magnetic fields, Invariants of electromagnetic field, Four dimensional formulation of first and second pair of Maxwell equations, The equation of continuity, Energy-momentum tensor of electromagnetic field.

UNIT- IV

The Field of Moving Charges

Retarded potentials, The Lienard-Wiechart potentials, Field due to system of charges at large distances, Dipole radiation, Quadrupole and magnetic dipole

radiation, Field at near distances, Radiation from accelerated charge, Synchrotron radiation (magnetic bremsstrahlung), Radiation damping.

References:

1. The Classical theory of Fields by L. D. Landau and E.M. Lifshitz (Pergmon Press, Oxford).
2. Classical Electricity and magnetism by W. K. H. Penofsky and M. Phillips (Addison Wesley).
3. Classical Electrodynamics by J. D. Jackson (Wiley Estern Ltd., Delhi).
4. Introduction to Electrodynamics by David J. Griffiths (Cambridge University Press).
5. Electricity and Magnetism by Edward M. Purcell, David J. Morin (Cambridge University Press).

B011002T: CONDENSED MATTER PHYSICS- II

UNIT- I

Dielectric Properties of Solids

Macroscopic concept of Polarization, Dielectrics, Claussius Mossotti relation, Dipolar, Ionic & Electronic Polarizability, Dielectric constant, Ferroelectricity- Curie temperature, dielectric behaviour above curie temperature, spontaneous polarization below curie temperature, Ferroelectric hysteresis, Antiferroelectricity, Piezoelectricity, Pyroelectric effect, Applications of Piezoelectricity and Pyroelectric crystals.

UNIT- II

Optical properties of Solids

Optical reflectance, Kramers-Kronig relations, Conductivity and dielectric function of electron gas, Basic theory of luminescence,

phosphorescence, thermoluminescence, electroluminescence and photo-conductivity, Excitons in ionic and molecular crystals, Electron-hole drops (EHD) and colour centres.

UNIT- III

Magnetic Properties of Solids

Magnetic ions and magnetic excited states, Types of magnetic materials, Paramagnetism of non-interacting magnetic ions and its application to rare earth and transition metal ions in solids, Ferromagnetism. Magnetic domains, Heisenberg explanation of internal magnetic field, Basic features of Neel`s two sublattice models for antiferromagnetism and ferrimagnetic materials.

UNIT- IV

Superconductivity

Phenomenological theories of superconductivity, Meisner effect. Types of superconductors- Type-I and Type-II superconductors, Entropy and Heat capacity, Isotope effect, Thermodynamics of Superconducting transition- Rutger`s formula, Electrodynamics of superconducting transition - London equations, Superconducting tunnelling- AC and DC Josephson effect. Cooper pairs, coherence length, BCS theory, BCS ground state and energy gap, a brief introduction to high-temperature superconductors.

References:

1. Introduction to Solid State Physics by C. Kittel (Wiley Eastern, New Delhi).
2. Elementary Solid State Physics: Principle and Application by Omar Ali (Addison Wesley, London).
3. Solid State Physics by S. O. Pillai (Wiley Eastern Ltd).

4. Solid State Physics by R. Kubo and T. Nagamiya (McGraw Hill. New York).
5. Solid State Theory by W.A. Harrison (McGraw Hill. New York).
6. Solid states Physics by A-J. Dekkar (McMillan and Co., London).
7. Introduction to Magnetic Materials by B. D. Cullity , C. D. Graham (Wiley-IEEE Press).
8. Introduction to Superconductivity by Michael Tinkham (Dover Publications Inc.).

B011003T: ADVANCED ELECTRONICS – II

UNIT- I

Signal Representation and Noise

Time domain & frequency domain representation of signals. Fourier representation of periodic and non-periodic signals , Noise in communication system, Shot Noise, White Noise, Thermal Noise, Noise spectrum, Noise figure S/N ratio in an Analog Communication system.

UNIT– II

Analog Signal Transmission

Sampling of Analog signals, Sampling theorem, PAM, PPM, PWM and its generation detection and S/N Ratio, Uniform and Non-Uniform Quantization.

UNIT– III

Coded Transmission of Signal

Pulse Code Modulation, Binary Coding and PCM band width, DPCM, DM and ADM; Digital Modulation techniques: ASK, FSK, PSK system.

Transmission and detection of binary system and subroutine code conversion, stack and subroutine

UNIT IV

Microwave

Propagation of E-M wave in cavity, microwave generation Gunn oscillator tunnel diode, IMPATT, BARITT, TRAPATT; Microwave Components Isolators, attenuator, directional couplers;

Antenna: Current and voltage distribution in antenna. Distribution of field around vertical antenna, Half and full wave antenna. Folded dipole. Antenna arrays, Matching of antenna.

References:

1. Digital and Analog communication systems by K. San Shanmugan
2. Communication system by Simmon Haykin.
3. Principle of Communication system by H. Taub & D. L. Schilling.
4. Electronic Communication Systems by Kennedy.
5. Modulation Theory by H. S. Black.
6. Microwave by K. C. Gupta.
7. Antenna Theory by Kraus

[illegible] ATMOSPHERE & SPACE PHYSICS

UNIT I

Lower atmosphere

[illegible] composition, dynamics of air, temporal & spatial variation [illegible] and its impact on climate. Aerosols. Aerosol Optical [illegible] and seasonal variation of Temperature, Pressure and [illegible]

UNIT II

Upper Atmosphere

Ionosphere [illegible] structure & formation. Storm/substorm phenomena [illegible] irregularities. Sporadic E and Spread F irregularities and their [illegible]

Magnetosphere Its structure. Bow shock. Magnetopause. Magnetopause [illegible] distance of stagnation point. Microstructure of [illegible]

UNIT III

Structure of the sun

[illegible] solar atmosphere, photosphere, chromosphere, corona. Sunspots and their properties, solar rotation and Babcock model of sunspot [illegible]

UNIT IV

Solar cycle and solar activity

Solar wind. Solar flares. Coronal mass ejections (CMEs). Heliosphere and solar magnetic field. Space weather: causes and consequences. Solar [illegible] interaction

Text and Reference Books:

1. An introduction to Meteorology: S. Petterssen. (McGraw-Hill Book Company, USA).
2. The Physics of Atmosphere: John Houghton. (Cambridge University Press, U.K.)
3. The Earth's Ionosphere: Plasma Physics & Electrodynamics M C Kelley (Academic Press, Elsevier, USA).
4. Elements of Space Physics: R. P. Singhal, (Prentice Hall of India, New Delhi).
5. Guide to the Sun: Kenneth J. H. Philips, (Cambridge University Press P.
6. Astrophysics of the Sun: Harold Zirin, (Cambridge University Press, U. K.)

B011004T: (B) PHYSICS OF RENEWABLE ENERGIES

UNIT - I

An Overview

Introduction to Energy- definition and units of energy, power. Forms of energy. Conservation of energy, second law of thermodynamics. Energy flow diagram to the earth, Causes of energy scarcity. Solution to energy scarcity. Factors affecting energy resource development. Energy resources and classification. Renewable-nonrenewable. Green energy and clean energy. Conventional-nonconventional. Fossil fuels- origin and their limitations and need for use of new and renewable energy sources.

UNIT - II

Solar Energy

Fundamentals of photovoltaic energy conversion. Physics and material properties. Basic to photovoltaic energy conversion. Optical properties of

solids. Direct and indirect transition semiconductors. interrelationship between absorption coefficients and band gap recombination of carriers. p-n junction solar cell and elementary idea about advanced solar cells.

UNIT - III

Hydrogen Energy

Benefits of hydrogen energy. Hydrogen production technologies. Hydrogen energy storage. Uses of hydrogen energy. Advantages and disadvantages of Hydrogen Energy. Problems associated with Hydrogen energy.

UNIT - IV

Wind. Tidal. Geothermal and Biogas Energies

Fundamentals of Wind energy. Wind resources. Windmills. Wind turbines: Tidal energy resource. Tidal energy availability. Energy availability in tides. Advantages and disadvantages of Tidal power. Problems faced in exploiting Tidal energy. Geothermal systems. Classifications. Geothermal resource Utilization. Resource exploration. Biogas and its composition. Anaerobic digestion. Biogas production. Benefits of biogas.

Text and Reference Books:

1. Solar Cell Devices - Physics : Fonash.
2. Fundamentals of Solar Cells Photovoltaic Solar Energy : Fahrenbruch & Bube
3. Photoelectrochemical Solar Cells: Chandra .
4. Hydrogen as an Energy Carrier Technologies Systems Economy : Winter & Nitsch Eds .
5. Hydrogen as a Future Engery Carrier : Andreas Zuttel. Andreas Borgschulte and Louis Schlapbach.

- Non-conventional Energy Resources Shobh Nath Singh Pearson 1st Edition 2015
- Non-conventional Energy Resources B H Khan (McGraw Hill 3rd Edition)
- Renewable Energy Power for a sustainable Future Godfrey Boyle Oxford 3rd Edition 2012
- Renewable Energy Sources Their Impact on global Warming and Pollution Tasneem Abbasi S A Abbasi PHI 1st Edition 2011

B011005P - Electronics Lab-I

- Study of Amplitude modulation and demodulation
- Study of Frequency modulation and demodulation
- Study of Multivibrator using IC 555 timer
- Study of characteristics of Op-Amp
- Study of characteristics of Emitter follower
- Study of PLL circuit
- Study of Pulse coded modulation
- Study of PAM PWM PPM modulation and demodulation
- Study of Microwave
- Study of First and Second order active band pass and band reject filter