U.G. Syllabus
for
Physics (Honours)
Techno India University, 2019

Scheme of CBCS Curriculum

1.1. *Basic Courses Types under CBCS*

In CBCS there are some basic types of courses. The ones that are relevant to the B.Sc. curricula have been described below.

1. Core Course (CC): A discipline specific compulsory basic course.

2. Discipline Specific Elective Course (DSE): A discipline specific elective course which is more advanced or specialized.

3. Generic Elective Course (GE): An inter-disciplinary elective course to be opted from a discipline other than ones main discipline(s) of choice(e.g., a course in a discipline other than in which honours has been taken).

4. Skill Enhancement Course (SEC): A discipline specific elective skill enhancement course.

5. Ability Enhancement Compulsory Course (AECC): These are compulsory courses. There are two of them. AECC-1 is Communicative English / Modern Indian Language (e.g.:Bengali, Urdu, Hindi.) & AECC-2 is Environmental Science.

1.2. Credit Structure

In CBCS, all courses have credits assigned to them.

For any course, one of the following three modes teaching will be used:

1. Theory + Practical

2. Theory + Tutorial

3. Theory only

The credit structure is described below:

	Theory + Practical		Theory + Tutorial		Theory
	Theory	Practical	Theory	Tutorial	Theory
CC	4	3	5	2	
DSE	4	3	5	2	
GE	4	2	5	1	
SEC					2
AECC					2

Table-1

Class Assignments: The class assignment for different course segments (theory, practical, tutorial) are as follows:

• **Theory:** 1 credit = 1 hour / week

• **Practical:** 1 credit = 2 hours / week

• **Tutorial:** 1 credit = 1 hour / week

Duration of the Semesters: The semesters will comprise 15 to 18 weeks of direct teaching.

Grading: The evaluation and final grading will also depend crucially on the credits of the papers.

A Grade Point Average system will be used. The weight factor (or importance)with which a particular paper will contribute to the final CGPA (Cumulative Grade Point Average) will depend on the credit of the course.

Please refer to the University Regulations for details.

1.3. Selection of DSE

Honours

• A student must choose four DSE papers from his/her honours subject -two papers in the 5th semester and two papers in the 6th semester.

• There are two groups of DSE papers, DSE-A and DSE-B. Each of thesegroups are further divided into two subgroups DSE-A1, DSE-A2, andDSE-B1, DSE-B2 respectively.

• In the 5th semester a student will be expected to choose one paper fromDSE-A1 and one paper from DSE-B1.

• Similarly, in the 6th semester a student will be expected to choose onepaper from DSE-A2 and one paper from DSE-B2.

1.4. Selection of SEC

Honours

• A student must choose two SEC papers from the honours discipline – one in the 3rd semester and one in the 4th semester.

• For each subject there will be two groups of SEC papers, SEC-A and SEC-B.

• The SEC paper in the 3rd semester must be chosen from Group A and the SEC paper in the 4th semester must be chosen from Group B.

1.5. B.Sc. Honours - Semesterwise Courses

The number of different types of courses to be taken in the different semesters have been specified in the table below.

	Sem-1	Sem-2	Sem-3	Sem-4	Sem-5	Sem-6	**Total Courses**	**Total Credit**
CC	Th-2 Pr-1	Th-2 Pr-1	Th-3 Pr-1	Th-3 Pr-1	Th-2 Pr-2	Th-2 Pr-2	**Th-14 Pr-8**	**80**
DSE					Th-2 Pr/Tu-2	Th-2 Pr/Tu-2	**Th-4 Pr/Tu-4**	**28**
GE	Th-1 Pr-1	Th-1 Pr-1	Th-1 Pr-1	Th-1 Pr-1			**Th-4 Pr-4**	**24**
SEC			Th-1	Th-1			**Th-2**	**4**
AECC	Th-1	Th-1					**Th-2**	**4**
Total Credit	**19**	**19**	**23**	**23**	**28**	**28**		**140**

Table-2

[C=Course, Cr=Credit, Th-Theory, Pr-Practical, Tu-Tutorial. See Table 1 for credit division]

Note:

1. The CC for general course of a subject other than the honours subject is to be treated as GE course.

2. The four GE courses must be chosen from two interdisciplinary subjects other than Physics, taking at least one from the Science / Home Science Division (Please see University Regulation). However, any discipline may be chosen in any semester.

Special Note:

Across all courses (for both, Honours and General) 70 marks will be allocated for End Semester Assessment (ESA), 20 marks will be reserved for Mid Term Assessment (MTA) and 10 marks will be reserved for Faculty Continuous Assessment (FCA).

1.6. B.Sc. Honours - Course Details

- **Core Courses (Honours)**

Sem	Course Type	Course Name	Teaching Mode	Credit	Marks			
					ESA	MTA	FCA	Total
1	CC	Mathematical Physics - I	Theory	4	70	20	10	100
	CC	Classical Mechanics - I	Theory	4	70	20	10	100
	CC	Physics Major Practical-1	Practical	3	-	-	-	100
2	CC	Electricity and Magnetism	Theory	4	70	20	10	100
	CC	Waves and Optics	Theory	4	70	20	10	100
	CC	Physics Major Practical-2	Practical	3	-	-	-	100
3	CC	Mathematical Physics - II	Theory	4	70	20	10	100
	CC	Thermal Physics	Theory	4	70	20	10	100
	CC	Digital Systems and Applications	Theory	4	70	20	10	100
	CC	Physics Major Practical-3	Practical	3	-	-	-	100
4	CC	Mathematical Physics - III	Theory	4	70	20	10	100
	CC	Classical Mechanics - II	Theory	4	70	20	10	100
	CC	Analog Systems and Applications	Theory	4	70	20	10	100
	CC	Physics Major Practical-4	Practical	3	-	-	-	100
5	CC	Quantum Mechanics and Applications	Theory	4	70	20	10	100
	CC	Solid State Physics	Theory	4	70	20	10	100
	CC	Physics Major Practical-5	Practical	3	-	-	-	100
	CC	Physics Major Practical-6	Practical	3	-	-	-	100
6	CC	Electro-magnetic Theory	Theory	4	70	20	10	100
	CC	Statistical Mechanics	Theory	4	70	20	10	100
	CC	Physics Major Practical-7	Practical	3	-	-	-	100
	CC	Physics Major Practical-8	Practical	3	-	-	-	100

Table-3

Choices for DSE (Honours)

Sem	Course Type -Group	Course Name	Teaching Mode	Credit	Marks			
					ESA	MTA	FCA	TOTAL
5	DSE-A1 (Any one)	Advanced Mathematical Methods	Theory	5	70	20	10	100
			Tutorial	2	-	-	-	
		Laser and Fibre Optics	Theory	5	70	20	10	100
			Tutorial	2	-	-	-	
	DSE-B1 (Any one)	Astronomy and Astrophysics	Theory	5	70	20	10	100
			Tutorial	2	-	-	-	
		Nuclear and Particle Physics	Theory	5	70	20	10	100
			Tutorial	2	-	-	-	
6	DSE-A2 (Any one)	Nano Materials and Applications	Theory	5	70	20	10	100
			Tutorial	2	-	-	-	
		Advanced Statistical Mechanics	Theory	5	70	20	10	100
			Tutorial	2	-	-	-	
	DSE-B2 (Any one)	Atomic & Molecular Physics	Theory	5	70	20	10	100
			Tutorial	2	-	-	-	
		Communication Electronics	Theory	5	70	20	10	100
			Tutorial	2	-	-	-	

Table-4

Choices for SEC (Honours)

Sem	Course Type -Group	Course Name	Teaching Mode	Credit	Marks			
					ESA	MTA	FCA	TOTAL
3	SEC-A (Any one)	Basics of Programming and Scientific Word Processing	Theory	2	70	20	10	100
		Electrical Circuits and Network Skills	Theory	2	70	20	10	100
4	SEC-A (Any one)	Computer Algebra System and Figure Drawing Skill	Theory	2	70	20	10	100
		Renewable Energy and Energy Harvesting	Theory	2	70	20	10	100

Table-5

SEMESTER-I

MATHEMATICAL METHODS I

1. Calculus of Several variables:
Continuity, derivative, Taylor's expansion, multiple integral, maxima & minima.

2. Transformation Properties of vectors:
Coordinate transformations, definition of vectors & Tensors, Product of vectors.

3. Vector Calculus:
Differentiation and integration of vectors with respect to a parameter, Vector fields, lineintegrals, conservative fields and potential, surface integrals, volume integrals, integralforms for gradient, divergence and curl, the divergence theorem, Stokes' theorem, Green's theorem with simple applications to physical problems. Orthogonal curvilinear coordinate systems: coordinate curves, scale factors, gradient, divergence & curl in curvilinear coordinates: Velocity & acceleration.

4. Matrices & linear vector spaces:
Vector spaces – basis vectors, inner product & some useful inequalities. Linear operators, Matrices, Complex & Hermitian conjugate of a matrix, some special types of matrix – diagonal, triangular, symmetric and antisymmetric, orthogonal, Hermitian & antiHermitian, unitary & normal, Eigenvectors and Eigenvalues. Change of basis and similarity transformations, Diagonalization of matrices. Quadratic and Hermitian forms.

CLASSICAL MECHANICS-I

1. Mechanics of single Particle
Kinematics in 3D, velocity and acceleration of a particle in plane polar coordinates radialand crossradial components, Simple applications, Conservative forces & concept of potential; Conservation principles, Variable mass problems.

2. Mechanics of a system of Particles
Linear momentum, angular momentum and energy, Centre of mass decomposition; Equations of motion, conservation principles, Two body system, Collision problems.

3. Rotational Motion
Rotational motions of rigid bodies, Energy and angular momentum of rotating rigidbodies, Ellipsoid of inertia and inertia tensor, Moment of inertia, Calculation for simple symmetric bodies. Parallel and perpendicular axes theorems, setting up of principal axes in simple symmetric cases.

4. Central Force
Motion under a central force, Nature of orbits – detailed discussion for the case of attractive inversesquared force field, Stability of orbits, Kepler's laws of planetary motion.

5. Noninertial frames of reference

Noninertial frames of reference Coriolis and centrifugal forces, simple examples, Foucault's Pendulum, Euler's equation of motion for a rigid body, simple application

PHYSICS MAJOR PRACTICAL-1

1. Determination of Young's modulus of a metallic bar by the method of flexure.
2. Determination of the rigidity modulus of a metallic wire by dynamical method.
3. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
4. To determine the value of g using Bar Pendulum.
5. Determination of the moment of inertia of a flywheel.
6. To determine the elastic constants of a material by Searle's method.
7. Determination of the time period of oscillation of a bar magnet using vibrating magnetometer.

SEMESTER-2

ELECTRICITY AND MAGNETISM

1. Electrostatics:

Coulomb's law and Principle of superposition, Definition of Electrostatic Field. Field lines. Divergence of the Electrostatic field. Flux, Gauss's theorem of electrostatics. Applications of Gauss theorem to find Electric field due to charge configurations with spherical, cylindrical and planar symmetry. Curl of the Electrostatic Field and its conservative nature. Electric potential. Potential for a uniformly charged spherical shell and solid sphere. Calculation of electric field from potential. Laplace's and Poisson equations. Uniqueness Theorems. Method of Images and its application to: (1) Plane Infinite Sheet and (2) Sphere. Electric field and charge density inside and on the surface of a conductor. Conductors in an electrostatic field. Force per unit area on the surface. Capacitance of a conductor. Capacitance of an isolated spherical conductor. Parallel plate condenser.Electrostatic energy of system of charges. Electrostatic energy of a charged sphere. Energy per unit volume in electrostatic field.

2. Dielectric properties of matter:

Electric potential and field due to an electric dipole. Electric dipole moment. Force and torque on a dipole. Electric Fields inside matter: Electric Polarization. Bound charges. Displacement vector. Relations between E, P and D. Gauss's theorem in dielectrics. Linear Dielectric medium. Electric Susceptibility and
Permittivity. Capacitor (parallel plate, spherical, cylindrical) filled with dielectric.

3. Magnetism:

Biot-Savart's law. Force on a moving point charge due to a magnetic field: Lorentz force law. Application of Biot-Savart's law to determine the magnetic field of a straight conductor, circular coil. Force between two straight current carrying wires. Divergence of the magnetic field - its solenoidal nature. Magnetic vector potential.Curl of the magnetic field. Ampere's circuital law. Its application to (1) Infinite straight wire, (2) Infinite planar surface current, and (3) Solenoid.

4. Magnetic properties of matter:

Potential and field due to a magnetic dipole. Magnetic dipole moment. Force and torque on a magnetic dipole in a uniform magnetic field. Magnetization. Bound currents. The magnetic intensity - H. Relation between B, H and M. Linear media. Magnetic Susceptibility and Permeability. Brief introduction of dia-, para- and ferro-magnetic materials. B-H curve and hysteresis.

5. Electro-magnetic induction:

Ohm's law and definition of E.M.F. Faraday's laws of electromagnetic induction, Lenz's law. Self-Inductance and Mutual Inductance. Reciprocity Theorem. Introduction to Maxwell's Equations.

Charge conservation. Displacement current and resurrection of Equation of Continuity. Energy stored in magnetic field.

6. Electrical circuits:
AC Circuits: Kirchhoff's laws for AC circuits. Complex Reactance and Impedance. Series LCR Circuit: (1) Resonance, (2) Power Dissipation and (3) Quality Factor, and (4) Band Width. Parallel LCR Circuit

WAVES AND OPTICS

1. Oscillations:
Introduction to Simple Harmonic Oscillations (SHM). Differential equation of SHM and its solution. Kinetic energy, potential energy, total energy and their time-average values. Damped oscillation. Forced oscillations. Transient and steady states; Resonance, sharpness of resonance; power dissipation and Quality Factor.Superposition of Harmonic Oscillations. Superposition of Collinear Harmonic oscillations: Linearity and Superposition Principle. Superposition of two collinear oscillations having (1) equal frequencies and (2) different frequencies (Beats). Superposition of N collinear Harmonic Oscillations with (1) equal phase differences and (2) equal frequency differences. Superposition of two perpendicular Harmonic Oscillations: Graphical and Analytical Methods. Lissajous Figures with equal an unequal frequency and their uses.

2. Wave motion
Plane and Spherical Waves. Longitudinal and Transverse Waves. Plane Progressive (Traveling) Waves. Wave Equation. Particle and Wave Velocities. Differential Equation. Pressure of a Longitudinal Wave. Energy Transport. Intensity of Wave. Water Waves: Ripple and Gravity Waves. Velocity of Transverse Vibrations of Stretched Strings. Velocity of Longitudinal Waves in a Fluid in a Pipe. Newton's Formulafor Velocity of Sound. Laplace's Correction. Superposition of Harmonic Waves (a) Standing (Stationary) Waves in a String: Fixed and Free Ends. Analytical Treatment. Changes with respect to Position and Time. Energy of Vibrating String. Transfer of Energy. Normal Modes of Stretched Strings. Plucked and Struck Strings. Melde's Experiment. (b) Longitudinal Standing Waves and Normal Modes. Open and Closed Pipes. (c) Superposition of N Harmonic Waves. Phase and Group Velocities.

3.Basic Idea of Wave optics
Electromagnetic nature of light. Definition and properties of wavefront. Huygens Principle. Temporal and Spatial Coherence.

4. Interference:
Division of amplitude and wavefront. Young's double slit experiment. Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings: Measurement of wavelength and refractive index. Michelson and Fabry-Perot interferometer.

5. Diffraction:
Fraunhofer diffraction: Single slit. Circular aperture, Resolving Power of a telescope. Double slit. Multiple slits. Diffraction grating. Resolving power of grating.Fresnel Diffraction: Fresnel's Assumptions. Fresnel's Half-Period Zones for Plane Wave. Explanation of Rectilinear Propagation of Light. Theory of a Zone Plate: Multiple Foci of a Zone Plate. Fresnel's Integral, Fresnel diffraction pattern of a straight edge, a slit and a wire.

PHYSICS MAJOR PRACTICAL-2

1. Determination of resistance per unit length of a wire and value of unknown resistance using Carey-Foster's bridge.
2. To study response curve of a Series LCR circuit and determine its (a) Resonant frequency, (b) Impedance at resonance, (c) Quality factor Q, and (d) Band width.
3. To determine wavelength of sodium light using Newton's Rings.
4. To determine refractive indexof the Material of a prism and its dispersive power using sodium source.
5. Determination of the wavelength of a monochromatic light by Fresnel's biprism.
6. Determination of the strength of an unknown optically active substance using polarimeter.
7. Studying of the diffraction pattern of a Double Slit with variable slit width.

SEMESTER - III

MATHEMATICAL METHODS II

1.Ordinary Differential Equations

Solution of second order linear differential equations with constant coefficients and variable coefficients by
Frobenius' method (singularity analysis not required); Solution of Legendre and Hermite equations about x=0; Legendre and Hermite polynomials - orthonormality properties.

2. Partial Differential Equations

Solution by the method of separation of variables; Laplace's equation and its solution in Cartesian, spherical polar (axially symmetric problems), and cylindrical polar (`infinite cylinder' problems) coordinate systems.

3. Fourier Series

Fourier expansion – statement of Dirichlet's condition, analysis of simple waveforms with Fourier series.

THERMAL PHYSICS

1. Kinetic Theory of Gases

Basic assumptions of kinetic theory, Ideal gas approximation, deduction of perfect gas laws. Maxwell's distribution law (both in terms of velocity and energy), root mean square and most probable speeds.
Finite size of molecules : Collision probability, Distribution of free paths and mean free path from Maxwell's distribution. Degrees of freedom, equipartition of energy (detailed derivation not required).

2. Transport Phenomena

Viscosity, thermal conduction and diffusion in gases. Brownian Motion: Einstein's theory, Perrin's work, determination of Avogardo number.

3. Real Gases

Nature of intermolecular interaction : isotherms of real gases. van der-Waals equation of state, Other equations of state (mention only), critical constants of a gas, law of corresponding states; Virial Coefficients, Boyle temperature.

4. Conduction of Heat

Thermal conductivity, diffusivity. Fourier's equation for heat conduction – its solution for rectilinear and radial (spherical and cylindrical) flow of heat.
Radiation : Spectral emissive and absorptive powers, Kirchoff's law, blackbody radiation, energy density, radiation pressure. Stefan-Boltzmann law, Newton's law of cooling, Planck's law (no detailed derivation).

DIGITAL SYSTEMS AND APPLICATIONS

1. Components, Circuits and Systems: Active & Passive components, Discrete components,Analog systems & digital systems,Difference between Analog and Digital Circuits.

2. Basics of Integrated Circuits: Wafers, Chips,Advantages and drawbacks of ICs. Scale of integration-SSI, MSI, LSI and VLSI (basic idea and definitions only). Classification of ICs, Examples of Linear and Digital ICs.

3. Number System: Binary Number system,Decimal to Binary and Binary to Decimal Conversion, BCD, Octaland Hexadecimal numbers, conversion between numbers.

4. Digital Logic Gates: AND, OR and NOT Gates (realizationusing Diodes and Transistor). NAND and NOR Gates as UniversalGates. XOR and XNOR Gates and application as Parity Checkers.

5. Boolean Algebra: De Morgan's Theorems, Boolean Laws, Simplification of LogicCircuit using Boolean Algebra (Basic examples only), Fundamental Products, Idea ofMinterms and Maxterms, Conversion of a Truth table into Equivalent Logic Circuit by (1) Sum of Products Method and (2) KarnaughMap.

6. Digital Circuits: (a) Combinational Circuits: Basic idea of Multiplexers, De-multiplexers, Decoders, Encoders, Binary Addition. Binary Subtraction using 2'sComplement, Half and Full Adders, Half & Full Subtractors, 4-bitbinary Adder/Subtractor.
(b) Sequential Circuits: SR, D, and JK Flip-Flops, Clocked (Level and Edge Triggered) Flip-Flops, Preset and Clear operations. Race-around conditions in JK Flip-Flop, M/S JK Flip-Flop, Shift-Registers, Ring Counters.

7. Memory Organization: Volatile and Non-volatile memory, Idea of RAM and ROM, Computer memory, SRAM, DRAM, EPROM, EEPROM,Memory organization & addressing.

ELECTRICAL CIRCUITS AND NETWORK SKILLS

1. DC generator
(a) EMF generated in the armature for simplex lap and wave winding, concept of pole, Methods of Excita tion, Armature reaction, Dc motor : Torque equation of D.C motor, speed& torque Operating Characteristics of separately excited, Shunt, Series &Compound motors with emphasis on application areas. (b) Three phase generator, concept of stator and rotor, star and delta connections – their current voltage relationships (both line and phase current & voltage).

2. Transformer
Types of transformer, basic emf equation, no load current, leakage inductance, Magnetising current and equiva lent circuit of single phase transformer on no-load and on load, idea of star/star, star/delta, delta/star, and zig-zag connection of 3 phase transformer, 3 phase to 2 phase transformation, Scott T connection.

3. AC motor

(a) Single phase AC motor – double field revolving theory, slip-speed characteristics, (b) Construction of 3 phase induction motor and its action using rotating field theory, equivalent circuit of induction motor, Speed control by V/f control of induction motor (block diagram only).

4. Measurements and faults

(a) Measurement of three phase power by two and three wattmeter method,theory of induction type wattmeterand its use as energy meter in domestic house. Megger. (b) Unsymmetrical faults in distribution system, Common switchgear equipments like relay, circuit breakers and fuses, Simple oil circuit breaker and SF6 circuit breaker, Construction of protective relay in distribution bus-bar system, Block diagram of a utility distribution sub-station.

PHYSICS MAJOR PRACTICAL-3

1. Verification of Stefan's law using a torch bulb.
2. To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT).
3. Determination of the thermal conductivity of a bad conductor in the form of a disk by the Lees & Chorlton method.
4. Design of different logic gates and realization of truth table.
5. Construction of adder (Half and Full) and substractor
6. Design and study of the output waveform of an astable multivibrator using transistor/555 timer IC/OpAmp.
7. Design and verification of operation of RS, D & JK flipflop.

SEMESTER - IV

MATHEMATICAL METHODS III

1. Complex Analysis:

Brief Revision of Complex Numbers and their Graphical Representation. Euler's formula, Roots of Complex Numbers. Functions of Complex Variables. Analyticity and Cauchy-Riemann Conditions. Examples of analytic functions. Singular functions: poles and branch points, order of singularity, branch cuts. Integration of a function of a complex variable. Cauchy's Inequality. Cauchy's Integral formula. Simply and multiply connected region. Laurent and Taylor's expansion. Residues and Residue Theorem. Application in solving Definite Integrals. only single valued integrals; simple poles on and off the real axis.

2. Transform Calculus:

Laplace Transform: Definition of Laplace Transform, linearity property, conditions for existence of Laplace Transform. First and second shifting properties, Laplace Transform of derivatives and integrals, unit step functions, Dirac delta-function, error function. Differentiation and integration of transforms, convolution theorem, inversion, periodic functions. Evaluation of integrals by Laplace Transform. Solution of initial and boundary value problems.

Fourier Transform: Fourier Transform, Fourier sine and cosine transforms. Linearity, scaling, frequency shifting and time shifting properties. Self-reciprocity of Fourier Transform, convolution theorem. Applications to boundary value problems.

ANALOG ELECTRONICS

1. Semiconductor Diodes and application

(a) P and N type semiconductors. Energy Level Diagram. Conductivity and Mobility, Concept of Drift velocity. PN Junction Fabrication (Simple Idea). Barrier Formation in PN Junction Diode. Static and Dynamic Resistance. Current Flow Mechanism in Forward and Reverse Biased Diode. Drift Velocity. Derivation for Barrier Potential, Barrier Width and Current for Step Junction.

(b) Rectifier Diode: Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers, Calculation of Ripple Factor and Rectification Efficiency, L and C filter. Circuit and operation of clipping and clamping circuit.

(c) Principle and structure of • LEDs • Photodiode • Solar Cell • Varactor diode

2. Bipolar Junction transistors and biasing

(a) n-p-n and p-n-p Transistors. Characteristics of CB, CE and CC Configurations. Physical Mechanism of Current Flow. Current gains α and β, Relations between them. Active, Cut-off and saturation Regions. DC Load line and Q-point.

(b) Transistor Biasing and Stabilization Circuits; Fixed Bias, collector to base bias, emitter or self bias, voltage Divider Bias. Transistor as 2 port Network. h-parameter Equivalent Circuit. Analysis of a single-stage CE amplifier using Hybrid Model. Input and Output Impedance.

3. Field Effect transistors

JFET and MOSFET (both depletion and enhancement type) as a part of MISFET. Basic structure & principle of operations and their characteristics. Pinch off, threshold voltage and short channel effect.

4. Regulated power supply

Load regulation and line regulation. Zener diode as a voltage regulator. The problem with the zener regulator circuit. Requirement of feedback and error amplifier. Study of series regulated power supply using pass and error transistor assisted by zener diode as a reference voltage supplier.

5. Amplifiers

Transistor amplifier; CB, CE and emitter follower circuit and their uses. Load Line analysis of Transistor amplifier. Classification of Class A, B & C Amplifiers with respect to placement to Q point. Frequency response of a CE amplifier. The role of series and parallel capacitors for cut off frequencies. The idea about the value of coupling and bypass capacitor with respect to lower cut-off frequencies. Miller capacitance and its role in higher cut-off frequency.

6. Feedback amplifiers and OPAMP

(a) Effects of Positive and Negative Feedback. Voltage series, current series, voltage shunt and current shunt feedback and uses for specific amplifiers. Estimation of Input Impedance, Output Impedance, Gain, Stability, Distortion and Noise for voltage series feedback (b) Operational Amplifiers (Black Box approach): Characteristics of an Ideal and Practical Op-Amp. (IC 741) Open-loop and Closed-loop voltage Gain. Frequency Response. CMRR. Slew Rate and concept of Virtual ground. (c) Application of OPAMP: D.C. Application: • Inverting and non-inverting amplifiers • Inverting and non inverting Adder • Differentiator as Subtractor • Logarithmic & anti logarithmic amplifiers • Error amplifier – Comparator – Schmidt Trigger A.C. Application: • Differentiator • Integrator

7. Multivibrator:

Transistor as a switch, Explanation using CE output characteristics. Calculation of component values for a practical transistor switch. Transistor switching times, use of speed up capacitor (Physical explanation only) Construction and operation, using wave shapes of collector coupled Bistable, Monostable andAstable Multivibrator circuits, Expression for time period.

8.Oscillators

Sinusoidal Oscillators: Barkhausen's Criterion for self-sustained oscillations. RC Phase shift oscillator, Wein Bridge oscillator, determination of feedback factor and frequency of oscillation. Reactive network feedback oscillators: Hartley's & Colpitt's oscillators. Relaxation oscillator using OPAMP.

CLASSICAL MECHANICS II

Lagrangian and Hamiltonian formulation of Classical Mechanics

Generalised coordinates, Constraints and degrees of freedom, D'Alembert's principle, derivation of Lagrange's equation for conservative, holonomic systems from D'Alembert's principle and from the variational principle, Generalised momentum, cyclic coordinate and conservation principle, Definition of Hamiltonian, Hamilton's equation and its application to simple cases, Canonical transformations and Poisson brackets.

Special theory of Relativity

Basic Development & Principle of Relativity

Inertial frame, Galilean covariance of Newton's second law, inconsistency with electromagnetic theory, interpretation of null results of Michelson Morley experiment. Postulates of special theory of Relativity, definition of interval, Minkowski spacetime diagram, Lorentz transformation in (1+1) and (3+1) dimension for standard configuration, basic features: simultaneity, time dilation, space contraction. Transformation of velocity and acceleration. Fizeau's experiment.

4Vector formulism

Lorentz 4vector notation, invariance of metric, Boost and rotation, light cone, time-like, space-like & light-like interval. 4velocity, energy & momentum of a particle, 4momentum for massive & massless particle, aberration & Doppler Effect.

RENEWABLE ENERGY AND ENERGY HARVESTING

1. Fossil fuels and Alternate Sources of energy

Fossil fuels and nuclear energy, their limitation, need of renewable energy, non-conventional energy sources. An overview of developments in Ocean shore Wind Energy, Tidal Energy, Wave energy systems, Ocean Thermal Energy Conversion, solar energy, biomass, biochemical conversion, biogas generation, geothermal energy tidal energy, Hydroelectricity.

2. Solar energy

Solar energy, its importance, storage of solar energy, solar pond, non-convective solar pond, applications of solar pond and solar energy, solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, solar cell, absorption air conditioning. Need and characteristics of photovoltaic (PV) systems, PV models and equivalent circuits, role of maximum power point tracking for harvesting maximum energy and sun tracking systems.

3. Wind Energy harvesting

Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces, and grid interconnection topologies. (only idea of synchronisation, current injection, islanding etc with utility grid)

4. Ocean Energy

Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave energy Devices. Tide characteristics and Statistics, Tide Energy Technologies, Ocean Thermal Energy, Osmotic Power, Ocean Bio-mass.

5. Geothermal Energy

Geothermal Resources, Geothermal Technologies.

6. Hydro Energy

Hydropower resources, hydropower technologies, environmental impact of hydro power sources.

7. Piezoelectric Energy harvesting

Introduction, Physics and characteristics of piezoelectric effect, materials and mathematical description of piezoelectricity, Piezoelectric parameters and modeling piezoelectric generators, Piezoelectric energy harvesting applications.

8. Electromagnetic Energy Harvesting

(a) Linear generators, physics mathematical models, recent applications (b) Carbon captured technologies, cell, batteries, power consumption. (c) Environmental issues and Renewable sources of energy, sustainability.

9. Fuel cell

Introduction, Design principle and operation of fuel cell, Types of fuel cells, conversion efficiency of fuel cell, application of fuel cells

PHYSICS MAJOR PRACTICAL-4

1. Determination of the value of Planck's constant using visible photoelectric effect.
2. To determine (1) wavelength and (2) angular spread of He-Ne laser/ solid state laser using plane diffraction grating.

3. To study the reverse characteristics of Zener diode and study the load and line regulation.
4. Determination of band gap of a semiconductor by four probe method.
5. To study OPAMP - inverting amplifier, non-inverting amplifier, adder, substractor, comparator, integrator, differentiator.
6. (i) Determination of I/O characteristics of a transistor and determination of h-parameters (dc). (ii) Determination of h-parameters of a CE transistor with ac source.
7. Study the waveform of a Wien-Bridge oscillator and its calibration using CRO.

SEMESTER – V

QUANTUM MECHANICS AND APPLICATIONS

Historical development of Quantum Mechanics

Planck's formula of blackbody radiation. Compton effect, de Broglie hypothesis. Electron double-slit experiment, DavissonGermer experiment, Heisenberg's uncertainty principle (statement) with illustrations, Photon polarization.

Basics of quantum mechanics

Concept of wave function as describing the dynamical state of a system, wave packets, Group and phase velocities, classical velocity of a particle and the group velocity of the wave representing the particle. Principle of superposition, Schrodinger equation. Probabilistic interpretation; equation of continuity, probability current density. Boundary conditions on the wave function, Properties of the solutions of Schrodinger equation, time dependent and time independent Schrodinger equation, stationary states, spreading of wave packet.

Postulates of quantum mechanics

Dynamical variables as linear hermitian operators, properties of hermitian operators, ei genvalue equations, Momentum, energy and angular momentum operators. Measurement of observables, expectation values. Ehrenfest theorem, Commutation relations between operators. Compatible observables and simultaneous measurements, Eigenfunction expansion, free particle & Infinite sq uare well potential problem.

Simple Applications of Quantum Mechanics

Finite potential well, potential step, Delta function potential, rectangular barrier.

Linear Harmonic Oscillator

Quantised states, Quantisation by operator method.

Hydrogen Atom Problem

Central force problem in quantum mechanics, reduction to one dimensional problem. Angular momentum Eigen values and Eigen functions, Concept of spin, bound states of hydrogen atom, concept of scattering states.

SOLID STATE PHYSICS

Crystal Structure of Solids

Crystalline periodicity, crystal symmetry, Bravais lattices, position, directions and planes in crystals. Simple lattice, Closepacked structures & Reciprocal lattice. The Bragg diffraction law, Laue condition of Xray diffraction, determination of crystal structure with Xrays.

Bonding in Solids

Different types of bonding – ionic, covalent, metallic, van der Waals & hydrogen type.

Energy band Structure

Periodic potential in a crystalline solid, Bloch theorem, KroningPenny model and the formation of energy allowed and forbidden energy gaps, number of electrons in a band, reciprocal effective mass tensor of electrons. Electrons and holes. Metals, insulators and semiconductors.

Free Electron Theory of Metals

Relaxation time, mean free path, mobility and thermal conductivity. Drude model – electrical conductivity. WiedemannFranzLorentz relation. Hall effect in metals.

Dielectric Properties of Solids:

Static dielectric constant of solids, dipole moment and polarization, types of polarization – electronic, ionic and orientational polarizations. Internal fields of solids. ClausiusMosotti relation.

Magnetic Properties of Solids

Magnetic susceptibility, Diamagnetism of core electrons. Paramagnetism. Langevin equations for dia & paramagnetism. Curie's law. Quantum theory of paramagnetism (for S=1/2 system). Spontaneous magnetization and ferromagnetic properties of solids. Temperature variation of spontaneous magnetization, CurieWeiss law. Domain structure & hysteresis in ferromagnets.

Lattice Vibration & Specific heat of solids

Onedimensional monatomic lattice, periodic boundary condition & vibrational modes of the 1D lattice, Classical calculation of lattice specific heat Einstein's and Debye's theories of specific heat.

ADVANCED MATHEMATICAL METHODS

1. Linear Algebra and Vector Space

(a) Abstract systems. Binary operations and relations. Introduction to Groups and Fields. Vector spaces over real and complex fields. Subspaces. Homomorphism and isomorphism of Vector Spaces. Linear independence and dependence of vectors. Completeness of a set of vectors. Basis and dimension of a vector space.

(b) Inner product space. Norm (defined in terms of inner product). Orthogonality. Orthonormal basis. Gram Schmidt orthogonalisation - proof that an orthonormal basis always exists. Schwarz inequality. Linear functionals on a vector space. Addition and multiplication by scalars on linear functionals.

(c) Linear operators. Consequences of linearity: Action of an operator on the whole space in terms of it's action on the basis vectors. Representation of linear operators by matrices. Transformation of representations under change of basis. Algebra of linear operators. Singular and non-singular operators (with examples). The adjoint or hermitian conjugate of an operator. Hermitian, orthogonal and unitary operators with examples. Projection operators.

(d) Eigenvalues and eigenvectors of an operator - non-degenerate and degenerate cases. Hermitian and unitary operators; reality and unimodularity of eigenvalues. Condition of diagonalizability. Normal operators. Commuting operators and simultaneous eigenstates for non-degenerate and degenerate eigenvalues.

2. Tensors

(a) Introduction of the Levi-Civita symbol and its uses in deriving the vector identities. The summation convention.

(b) Cartesian tensors in 3-d: Definition of a tensor, tensor algebra, sum, difference, and outer product of two tensors. Contraction, quotient law, symmetric and antisymmetric tensors. Krönecker tensor. Isotropic tensors. Tensorial Character of Physical Quantities. Examples of index contraction: triple products of vectors, divergence of tensors. Construction of the moment of inertia tensor Iij , its properties, principal moments and axes of inertia, parallel and perpendicular axis theorem, relation of Iij with scalar moment of inertia. Metric tensor in cartesian and curvilinear coordinates. Introduction to stress tensor.

LASER AND FIBER OPTICS

1. Einstein coefficients and Rate equations

Historical background of laser, Einstein coefficients and stimulated light amplification: population inversion. Three level & four level lasers: Rate equation, condition for population inversion and threshold condition. minimum amount of pump power

2. Basic properties of laser
Coherence, directionality, monochromaticity, brightness.

3. Resonantors
Optical resonators. Different configurations of optical resonators. stability condition (no derivation required) and stability diagram for optical resonators. Cavity lifetime. The Quality factor.

4. Transient effect
Transverse and Longitudinal mode selection. Principle of Q-switching and Mode locking. Different methods of Q-switching : electro-optic Q-switching, Pockels cell .

5. Basic Laser Systems
(i) Gas Laser • He-Ne laser • CO2 Laser (ii) Solid state laser • Ruby Laser • Nd:YAG laser • Semiconductor laser (iii) Liquid laser: Dye laser.

6. Practical properties and uses of laser
(a)The Line-shape function. Various Line broadening mechanisms: collisional broadening , Natural broadening, Doppler broadening. (b) Basic idea of Laser cooling and trapping.

7. Fiber optics
Optical fiber, coherent bundle, Numerical aperture. Attenuation of optical fibers. Ray paths , Ray paths in a homogeneous medium, in square law media. Pulse dispersion in parabolic index medium and in planar step index waveguide. Modes of a planar waveguide: TE and TM modes. Physical understanding of modes, Optical fibers: Guided modes of step-index and graded index fibers. Applications of optical fibers in Communication and Sensing.

8. Holography
Principle of Holography. Recording and Reconstruction Method. Theory of Holography between two plane waves. Point source holograms

9. Introductory Nonlinear Optics
Origin of nonlinearity, susceptibility tensor, phase matching, second harmonic generation, Sum frequency gener ation, Difference frequency generation, Sum and Difference Frequency generation, for second-order nonlinear optical medium. Nonlinear susceptibility of a classical anharmonic oscillator in case of noncentrosymmetric medium.

ASTRONOMY AND ASTROPHYSICS

(a) Contents of our Universe: basic introduction of stars, galaxies, clusters, interstellar medium, black holes, our own galaxy Milky Way. Mass, length, time and magnitude scales in astronomy. Interaction of light and matter fundamentals of radiative transfer (emission, absorption, radiative trans fer equation, mean free path, optical depth), thermal radiation and thermodynamic equilibrium (Kirchhoff's law of thermal emission, Boltzmann and Saha equation, thermodynamics of black body radiation, concept of local thermodynamic equilibrium.

(b) Properties of stars (distance, brightness, size, mass, temperature, luminosity). Measurement of stellar parameters: distance parallax, Cepheid variables, nova and supernovae, red shift), stellar spectra, spectral lines, the Hertzsprung-Russell diagram, luminosity and radius, binary system and mass determination, scaling relation on the Main Sequence. Basic equation of stellar structure hydrostatic equilibrium and the virial theorem, radiative and convective energy transport inside stars, nuclear energy production. Equation of state, opacity, Derivation of scaling relations. Formation and evolution of stars star formation, pre-main-sequence collapse (gravitational instability and mass scales, collapse of spherical cloud, contraction onto the Main Sequence, Brown Dwarfs), evolution of high-mass and low-mass stars (core and shell hydrogen burning, helium ignition), late-stage evolution of stars, evolution of Sun-like stars and solar system.

(c) Milky Way galaxy: components, morphology and kinematics of the Milky way, the galactic center, spiral arms. Classification and morphology of galaxies - quiet and active galaxies, types of active galaxies, Active Galactic Nuclei (AGN) and Quasars, accretion by supermassive black holes.

(d) Newtonian cosmology, Olber's paradox, Hubble's law and the expanding Universe, scale factor and comoving coordinate.

NUCLEAR AND PARTICLE PHYSICS

Nuclear Structure & Properties

Nuclear mass, charge, size, shape, binding energy, spin and electric/magnetic moment. Neutron and proton rich nuclei. N-Z chart of nuclei, Nature of forces between nucleons, nuclear stability and nuclear binding, the liquid drop model and the BetheWeizsacker mass formula, application to stability considerations, extreme single particle shell model (qualitative discussion with emphasis on phenomenology with examples), Magic numbers. Prediction of spin-parity.

Unstable Nuclei: α, β & γ decay

(a) Rutherford Scattering, GeigerNuttal law, alpha particle spectra – fine structure, long range alpha particle, straggling, alpha decay problem.
(b) Nature of beta ray spectra, the neutrino, energy levels and decay schemes, positron emission and electron capture, Qvalues, selection rules (Fermi & Gamow –Teller), Kurie plot.
(c) Gamma ray spectra and nuclear energy levels, isomeric states. Gamma absorption in matter.

Nuclear Reactions
Conservation principles in nuclear reactions. Qvalues and thresholds (relativistic formulation preferred), nuclear reaction crosssections, examples of different types of reactions and their characteristics. Direct reactions, Bohr's postulate of compound nuclear reaction, Ghoshal's experiment.

Nuclear Fission
Discovery and characteristics of nuclear fission, Energy and Mass distribution of fission fragments, explanation in terms of liquid drop model, spontaneous and induced fission. Chain reaction and basic principle of nuclear reactors.

Nuclear Fusion
Energetics in terms of liquid drop model, Fusion as a source of energy production in Stars. Synthesis of nuclei under primordial and explosive condition (qualitative discussion).

Elementary particles
Four basic interactions in nature and their relative strengths, Quantum numbers – mass, charge, spin, isotopic spin, strangeness, intrinsic parity, hypercharge. Charge conjugation. Conservation laws. Classifications of elementary particles – hadrons and leptons, baryons and mesons, elementary ideas about quark structure of hadrons.

Particle Accelerators
Cyclotron–basic theory, synchrotron, linear accelerator.

Physics Major Practical-5:

1. Determination of the concentration of majority carriers of a semiconductor using Hall effect experiment.
2. Study of polarization with laser source, polarizer, analyzer, half & quarter wave plate.
3. Determination of band gap of a semiconductor by fourprobe method.
4. BH loop.
5. Tracing of the characteristics of a JFET, determination of transconductance & studying the performance of a JFET amplifier.
6. Design and construction of a regulated power supply using OPAMP, Zener Diode & transistor.
7. Determination of thermoelectric power using thermocouples.

Physics Major Practical-6:

Computer Programming

Programming related to the solution of algebraic equation, curve fitting, sorting, numerical differentiation & integration.

SEMESTER – VI

STATISTICAL MECHANICS

1. Classical Statistical Mechanics

(a) Macrostate & Microstate, Elementary Concept of Ensemble and Ergodic Hypothesis (statement only). Phase Space. (b) Microcanonical ensemble, Postulate of Equal a-priori probabilities. Boltzmann hypothesis: Entropy and Thermodynamic Probability. (c) Canonical ensemble, Partition Function, Thermodynamic Functions of an Ideal Gas, Classical Entropy Expression, Gibbs Paradox. Equivalence of microcanonical and canonical ensemble. (d) Sackur Tetrode equation, Law of Equipartition of Energy (with proof) Applications to Specific Heat and its Limitations. Thermodynamic Functions of a Two-Energy Level System. Negative Temperature. (e) Grand canonical ensemble. Application of ideal gas using grand canonical ensemble. chemical potential.

2. Systems of Identical particles

Collection of non-interacting identical particles. Classical approach and quantum approach: distinguishability and indistinguishability. Occupation number and MB distribution, emergence of Boltzmann factor. Composite system postulate and symmetry postulate of quantum mechanics (for a pair of particles only). Bosons and Fermions. Symmetric and Antisymmetric wave functions. state counting for bosons and fermions.

3. Bose-Einstein Statistics

B-E distribution law. Thermodynamic functions of a strongly degenerate Bose Gas, Bose Einstein condensation and properties of liquid He IV (qualitative description only).

4. Radiation: classical and quantum aspects

(a) Spectral Distribution of Black Body Radiation. Rayleigh-jeans law, UV catastrophe, Planck's Quantum Postulates. Planck's Law of Blackbody Radiation: Experimental Verification. Deduction of Rayleigh- Jeans Law, Stefan-Boltzmann Law, Wien's Displacement law from Planck's law. (b) Bose derivation of Planck's law. Radiation as a photon gas and Thermodynamic functions of photon gas. chemical potential of photon gas.

5. Fermi-Dirac Statistics

Fermi-Dirac Distribution Law. Thermodynamic functions of strongly Degenerate Fermi Gas, Fermi Energy, Electron gas in a Metal, Specific Heat of Metals due to electrons.

ELECTROMAGNETIC THEORY

1.Maxwell Equations

Review of Maxwell's equations. Vector and Scalar Potentials. Gauge Transformations: Lorentz and Coulomb Gauge. Boundary Conditions at Interface between Different Media. Wave Equations. Plane Waves in Dielectric Media. Poynting Theorem and Poynting Vector. Electromagnetic (EM) Energy Density. Physical Concept of Electromagnetic Field Energy Density, Momentum Density and Angular Momentum Density

2. EM Wave Propagation in Unbounded Media

Plane EM waves through vacuum and isotropic dielectric medium, transverse nature of plane EM waves, refrac tive index and dielectric constant, wave impedance. Propagation through conducting media, relaxation time, skin depth.

3. EM Wave in Bounded Media

Boundary conditions at a plane interface between two media. Reflection & Refraction of plane waves at plane interface between two dielectric media. Laws of Reflection & Refraction. Fresnel's formulae for perpendicular & parallel polarization cases, Reflection & Transmission coefficients, Brewster's law. Total internal reflection, evanescent waves. Metallic reflection (normal Incidence).

4. Polarization

Description of Linear, Circular and Elliptical Polarization. Propagation of E.M. Waves in birefringent medium.

5. Polarization in uniaxial crystals

Uniaxial and Biaxial Crystals. Light Propagation in Uniaxial Crystal. Double Refraction. Polarization by Double Refraction. Nicol Prism. Ordinary & extraordinary refractive indices. Phase Retardation Plates: Quarter Wave and Half-Wave Plates. Production & analysis of polarized light. Babinet Compensator and its Us

6. Rotatory polarization

Optical Rotation. Biot's Laws for Rotatory Polarization. Fresnel's Theory of optical rotation. Calculation of angle of rotation. Experimental verification of Fresnel's theory. Specific rotation. Laurent's half-shade and biquartz polarimeters.

NANO MATERIALS AND APPLICATIONS

1. Nanoscale Systems

Length scales in physics, Nanostructures: 1D, 2D and 3D nanostructures (nanodots, thin films, nanowires, nanorods), Band structure and density of states of materials at nanoscale, Size Effects in nano systems, Quantum connement: Applications of Schrodinger equation: Infinite potential well, potential step, potential box, quantum confinnement of carriers in 3D, 2D, 1D nanostructures and its consequences.

2. Synthesis of Nanostructure Materials

(a) Top down and Bottom up approach, Photolithography. Ball milling. Gas phase condensation. (b) Vacuum deposition • Physical vapor deposition (PVD) • Thermal evaporation – Electron beam evaporation – Pulsed Laser deposition • Chemical vapor deposition (CVD) • MBE growth of quantum dots (c) Chemical Synthesis • Chemical bath deposition • Electro deposition • Spray pyrolysis • Hydrothermal synthesis • Sol-Gel synthesis• Preparation through colloidal methods

3. Characterization

(a) X-Ray Diffraction. Optical Microscopy. Scanning Electron Microscopy (SEM). Transmission Electron Mi croscopy (TEM). Atomic Force Microscopy (AFM). Scanning Tunneling Microscopy (STM).

4. Optical Properties

(a) Coulomb interaction in nanostructures. Concept of dielectric constant for nanostructures and charging of nanostructure. Quasi-particles and excitons. Excitons in direct and indirect band gap semiconductor nanocrystals. Quantitative treatment of quasi-particles and excitons, charging effects. Radiative processes: General formalization, absorption, emission and luminescence. Optical properties of heterostructures and nanostructures.

5. Electron Transport

(a) Carrier transport in nanostrucutures. Coulomb blockade effect, thermionic emission, tunneling and hoping conductivity. Defects and impurities: Deep level and surface defects.

6. Applications

(a) Applications of nanoparticles, quantum dots, nanowires and thin films for photonic devices (LED, solar cells). Single electron transfer devices (no derivation). CNT based transistors. Nanomaterial Devices: Quantum dots heterostructure lasers, optical switching and optical data storage. Magnetic quantum well; magnetic dots -magnetic data storage. Micro Electromechanical Systems (MEMS), Nano Electromechanical Systems (NEMS).

ADVANCED STATISTICAL MECHANICS

1. Review of classical statistical mechanics

(a) Idea of phase space, classical Liouville theorem, different enseembles. Evaluation of thermodynamic param eters using microcanonical ensemble for (i) harmonic oscillator, (ii) classical ideal gas (Sackur Tetrode Equation), (iii) paramagnets. Partition function and thermodynamic parameters evaluation for other simple examples. An harmonic oscillator: mean energy ,mean position, specific heat using canonical ensemble, idea of thermal expansion of solids. Virial theorem and equipartion theorem . Energy fluctuatiuon in canonical ensemble. (b) Grand canonical ensemble, various thermodynamic parametrs in grand canonical ensemble. Chemical po tential for classical ideal gas. Saha ionization equation.Density and energy fluctuation in grand canonical ensemble. Equivalence of different ensembles.

2. Quantum statistical mechanics

Density matrix formulation. Random phase approximattion. Ensemble average for micro, canonical and grand canonical ensemble. Density matrix Examples: electron in magnetic field, free particle, harmonic oscillator. Distri bution function of identical particles: bosons and fermions

3. Ideal Bose systems and Fermi systems

Ideal bose gas. Thermodynamic relations, equation of state. bose-einstein condensation,: evaluation of various thermodynamic parameters . chemical potential for bose gas. Ideal fermi gas: thermodynamic relations.equatio of state. Pauli paramagnetism, degenerate and non-degenerate fermi gas. Relativistic fermi gas. White dwarf and chandrasekhar mass limit.

4. Ising model

Ising model : Bragg-Williams theory and relation with binary alloy.

5.Non-equilibrium statistical mechanics

Equilibrium time scales, irreversibility and role of fluctuation; coarse grained description. Random walk : calculation of occupation probability.

COMMUNICATION ELECTRONICS

1. Electronic communication

Introduction to communication means and modes. Need for modulation. Block diagram of an electronic com munication system. Brief idea of frequency allocation for radio communication system in India (TRAI). Electro magnetic communication spectrum, band designations and usage. Channels and base-band signals. Concept of Noise, signal-to-noise (S/N) ratio

2. Analog modulation

(a) Amplitude Modulation, mathematical analysis for modulation index, frequency spectrum and power in AM Generation of AM (Emitter Modulation), Diode/square law modulator, Amplitude Demodulation (diode detector), Balanced modulator for DSB, Concept of Single side band generation and detection, concept of vestigial side band. (b) Frequency Modulation (FM) and Phase Modulation (PM), modulation index and frequency spectrum, Transistor/FET reactance modulator, equivalence between FM and PM, Generation of FM using VCO, FM detector : slope detector, Balanced slope detector, Idea of Phase discriminator and ratio detector, Qualitative idea of IF and Super heterodyne receiver.

3. Analog pulse modulation

Channel capacity, Sampling theorem, Basic Principles- PAM, PWM, PPM, modulation and detection technique for PAM only, Multiplexing – FDM and TDM and its application in communication.

4. Digital pulse modulation

Need for digital transmission, Sampling and Shanon's criteria, Quantization and Encoding, Quantisation error, non-uniform quantisation, Impulse sampling, Natural sampling and flat top sampling, Pulse Code Modulation (PCM), Differential PCM , Digital Carrier Modulation Techniques, Concept of Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK). (b) Idea of 8-PSK, QPSK, BPSK, use of Constellation diagram (idea only), Delta modulation. Concept of companding- A law and μ law. Line Coder: Unipolar and bipolar RZ & NRZ, Manchester format.

5. Introduction to communication and navigation systems

(a) Satellite Communication: Introduction, need, Geosynchronous satellite orbits geostationary satellite advan tages of geostationary satellites. Satellite visibility, transponders (C - Band), path loss, ground station, simplified block diagram of earth station. Uplink and downlink. (b) Mobile Telephony System _ Basic concept of mobile communication, frequency bands used in mobile com munication, concept of cell sectoring and cell splitting, SIM number, IMEI number, need for data encryption, architecture (block diagram) of mobile communication network, idea of GSM, CDMA, TDMA and FDMA tech nologies, simplified block diagram of mobile phone handset, 2G, 3G and 4G concepts (qualitative only). GPS navigation system (qualitative idea only)

ATOMIC & MOLECULAR PHYSICS

Atomic Spectra

Spectrum of light, Bohr model for hydrogen like ions, experimental evidences, Rydberg atoms, FranckHertz experiment and its improvements, BohrSommerfeld quantization, spectra of alkali atoms.

Vector Atom Model

Magnetic moment of an electron for orbital motion, space quantization, SternGerlach experiment, electron spin, vector model, Lande g factor, interpretation of SternGerlach experiment, doublet lines of alkali spectra, spinorbit interaction, Zeeman effect (normal & anomalous), Paschen-Back effect.

Many Electron Atoms

Helium spectra, LS and JJ coupling, Pauli exclusion principle, Hund's rules, equivalent and non-equivalent electrons.

Molecular spectra

Diatomic moleculesrotational and vibrational levels, basic ideas about molecular spectra, Raman Spectra.

Laser Physics

Population inversion, Einstein's A, B coefficients, feedback of energy in a resonator, three level and four level systems.

PHYSICS MAJOR PRACTICAL-7

1. Synthesis of nanomaterials by chemical methods
2. Study of I-V characteristics of nanomaterials.
3. Studies on dye sentisized solar cell.
4. Examine the main parameters of amplitude modulation and frequency modulation
5. Modeling and simulation of MESFET.
6. Scientific visit equivalent to two experiments with report submission by each students.

PHYSICS MAJOR PRACTICAL-8:

Microprocessor (Intel8085)

Software experiments with microprocessor related to the storing/ transferring/clearing of data in the memory addresses, increment of stored data, addition of binary numbers, finding of the largest/ negative/ positive numbers in a given series of data, sorting etc.

RECOMMENDED BOOKS

MATHEMATICAL METHODS

Reference Books

1. Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris, 2013, 7th Edn., Elsevier.
2. An introduction to ordinary differential equations, E.A. Coddington, 2009,PHI learning
3. Differential Equations, George F. Simmons, 2007, McGraw Hill.
4. Mathematical Tools for Physics, James Nearing, 2010, Dover Publications.
5. Mathematical methods for Scientists and Engineers, D.A. McQuarrie, 2003, Viva Book.
6. Advanced Engineering Mathematics, D.G. Zill and W.S. Wright, 5 Ed.,2012, Jones and Bartlett Learning.
7. Mathematical Physics, Goswami, 1st edition, Cengage Learning
8. Engineering Mathematics, S.Pal and S.C. Bhunia, 2015, Oxford UniversityPress
9. Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.
10. Linear Algebra and Its Applications, G. Strang, 2005, Cengage Learning
11. Introduction to Mathematical Physics: Methods & Concepts: Chun Wa Wong, 2012, Oxford University Press
12. Introduction to Matrices and Linear Transformations, D.T. Finkbeiner, 1978, Dover Pub
13. Schaums Outline of Tensor Calculus , D. Kay, 2011, McGraw-Hill Education
14. Introduction to Tensor Calculus and Continuum Mechanics, J.H. Heinbockel, 2001, Trafford Publishing

CLASSICAL MECHANICS

Reference Books

1. An introduction to mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw-Hill.
2. Mechanics, Berkeley Physics, vol.1, C.Kittel, W.Knight, et.al. 2007, Tata McGraw-Hill.
3. Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley. Analytical Mechanics, G.R. Fowles and G.L. Cassiday. 2005, Cengage Learning.
4. Feynman Lectures, Vol. I, R.P.Feynman, R.B.Leighton, M.Sands, 2008, Pearson Education
5. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole. Additional Books for Reference
6. Mechanics, D.S. Mathur, S. Chand and Company Limited, 2000 University Physics.

ELECTROSTATICS & ELECTRODYNAMICS

Reference Books

1. Introduction to Electrodynamics – D. J. Griffith, (Prentice Hall, India Pvt. Ltd).
2. Berkeley Physics Vol II (Electricity and Magnetism) E.M. Purcell (Tata McGraw Hill).
3. The Feynman Lectures on Physics – Vol. II (Addison – Wesley).

4. Foundations of electromagnetic theory – Reitz, Milford & Christy (Narosa).
5. Introduction to Electrodynamics – V.Barger & M.G.Olsson (Little Brown).
6. Electromagnetic Theory – Corson & Lorraine (W.H.Freeman).

WAVES AND OPTICS

Reference Books

1. Berkeley Physics Vol III (Waves) J R Crawford (Tata McGraw Hill)
2. Fundamentals of Optics F. A. Jenkins and H. E. White (Mc Graw Hill, Kogakusha).
3. Geometrical and Physical Optics B. S. Longhurst (Orient Longman).
4. Optics – Klein & Furtak (J Willey).
5. Optics – Hecht and Zajac (AddisonWesley)
6. Optics – M.Born & E Wolf (Pergamon).

THERMAL PHYSICS

Reference Books

1. Heat and thermodynamics Zemansky and Dittman (5th/6th eds.)(Mc Graw Hill).
2. Thermodynamics & introduction to Thermostatistics– H.B.Callen (2nd eds.) (J.Willey).
3. Thermodynamics, Statistical Physics & Kinetics – Sears & Sallinger (TMH).
4. Thermodynamics – F. Fermi (Dover).
5. A Treatise on Heat Saha and Srivastava (The Indian Press Ltd).
6. An introduction to Thermal Physics – D.V.Schroeder (Pearson).
7. Kinetic theory of gases Loeb (Radha Publ. House).

DIGITAL SYSTEMS AND APPLICATIONS

Reference Books

1. Digital Principles and Applications, A.P. Malvino, D. P. Leach and Saha, 7th Ed., 2011, Tata McGraw
2. Digital Logic and Computer Design, M. Morris Mano, 2017, Pearson Edication India
3. Fundamentals of Digital Circuits, Anand Kumar, 2nd Edn, 2009, PHI Learning Pvt. Ltd.
4. Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
5. Digital Electronics G K Kharate ,2010, Oxford University Press

ANALOG ELECTRONICS

Reference Books

1. Circuits and Networks, Analysis and Synthesis, A Sudhakar, Shyammohan S Palli, Tata McGraw Hill Education Private Ltd.

2. Solid State Electronic Devices, B.G.Streetman & S.K.Banerjee, 6th Edn.,2009, PHI Private Ltd.
3. Fundamental Principles of Electronics, B Ghosh, 2nd ed, 2008, Books & Allied (P) Ltd.
4. Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata McGraw Hill Education Private Ltd.
5. Electronics: Fundamentals and Applications, J.D. Ryder,2004, Prentice Hall India Private Ltd.
6. Learning OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition,2000, Prentice Hall India Private Ltd.

RELATIVITY

Reference Books

1. Relativity - The Special and General Theory, A. Einstein, Methuen and Co. Ltd., 1920
2. Special Relativity (MIT Introductory Physics). A.P. French, 2018, CRC Press
3. Special Relativity: For the Enthusiastic Beginner, D. Morin, 2017, Createspace Independent Pub
4. The Special Theory of Relativity, Banerji and Banerjee 2nd Ed., PHI Learning Private Ltd.
5. Introduction to Special Relativity , J.H. Smith, 2003, Dover Publications Inc
6. The Special Theory of Relativity , D. Bohm, 2006, Routledge
7. It‘s About Time Understanding Einstein‘s Relativity, N.D. Mermin, Princeton University Press 8. Classical Electrodynamics, J.D. Jackson, 2007, Wiley

RENEWABLE ENERGY AND ENERGY HARVESTING

Reference Books

1. Non-conventional energy sources, G.D Rai, Khanna Publishers, New Delhi
2. Solar energy - M P Agarwal - S Chand and Co. Ltd
3. Solar energy - Suhas P Sukhative Tata McGraw - Hill Publishing Company Ltd
4. Renewable Energy, Power for a sustainable future, Godfrey Boyle, Oxford University Press, in association with The Open University
5. Solar Energy: Resource Assesment Handbook, Dr. P Jayakumar, 2009 6. Photovoltaics, J.Balfour, M.Shaw and S. Jarosek, Lawrence J Goodrich (USA)

QUANTUM MECHANICS AND APPLICATIONS

Reference Books

1. Introduction to Quantum Mechanics, D.J. Griffiths, 2nd Ed. 2005, Pearson Education

2. Quantum Mechanics, Robert Eisberg and Robert Resnick, 2nd Edn., 2002, Wiley.
3. A Text book of Quantum Mechanics, P.M.Mathews and K.Venkatesan, 2nd Ed., 2010, McGraw Hill Private Ltd
4. Quantum Mechanics, G. Aruldhas, 2nd Edn. 2002, PHI Learning of India

SOLID STATE PHYSICS

Reference Books

1. Introduction to Solid State Physics, Charles Kittel, 8th Edition, 2004, Wiley India Pvt. Ltd.
2. Solid-state Physics, H. Ibach and H. Luth, 2009, Springer Solid State Physics, Rita John, 2014, McGraw Hill
3. Elementary Solid State Physics, 1/e M. Ali Omar, 1999, Pearson India
4. Solid State Physics and Electronics, A.B.Gupta and N.Islam, Books and Allied (P) Ltd
5. Solid State Physics, M.A. Wahab, 2011, Narosa Publications

LASER AND FIBER OPTICS

Reference Books

1. Lasers: Theory and Applications , A. Ghatak & K. Thyagarajan
2. Principles of Lasers , O. Svelto, 2009, Springer
3. Laser Physics, M. Sargant, M. Scully & W. Lamb , 1974, Westview Press
4. Introduction to Fiber Optics, A. Ghatak, 1998, Cambridge University Press
5. Introduction to Modern Optics, G. Fowles, 1989, Dover Publications
6. Optics, E. Hecht & A. Ganesan, 2009, Pearson Prentice Hall 7. Nonlinear Optics, R. Boyd, 2008, Academic PresS

NUCLEAR AND PARTICLE PHYSICS

Reference Books

1. Introductory nuclear Physics by Kenneth S. Krane (Wiley India Pvt. Ltd., 2008)
2. Concepts of nuclear physics by Bernard L. Cohen. (Tata Mcgraw Hill, 1998)
3. Introduction to Elementary Particles, D. Griffiths, John Wiley & Sons
4. Basic ideas and concepts in Nuclear Physics - An Introductory Approach by K. Heyde (IOP- Institute of Physics Publishing, 2004)
5. Radiation detection and measurement, G.F. Knoll (John Wiley & Sons, 2000)
6. Nuclear Physics, Irving Kaplan, Oxford & IBH Publishing Co. Pvt. Ltd.

STATISTICAL PHYSICS

Reference Books

1. Statistical Mechanics K. Huang (Wiley Eastern).
2. Fundamentals of Statistical and Thermal Physics F. Reif (MGH).
3. Statistical Mechanics – F. Mandl (ELBS).
4. Statistical Mechanics – R.K.Pathria (Elsevier).
5. Statistical Mechanics – Palash Baran Pal (Narosa).
6. Intermediate Statistical Mechanics. J. Bhattacharjee and D. Banerjee, 2017, World Scientific (HBA)
7. A Modern Course in Statistical Physics, L. Reichl, 2016, Wiley-VCH
8. Equilibrium Statistical Mechanics , G.F. Mazenko, 2000, Wiley VCH
9. Elements of Nonequilibrium Statistical Mechanics , V. Balakrishnan, 2008, CRC Press
10. Principles of Condensed Matter Physics , P.M. Chaikin & T.C. Lubensky , 2000, Cambridge University Pres

ELECTROMAGNETIC THEORY

Reference Books

1. Introduction to Electrodynamics, D.J. Griffiths, 3rd Ed., Pearson Education
2. Optics, E. Hecht, 2016, Pearson Education
3. Elements of Electromagnetics, M.N.O. Sadiku, 2001, Oxford University Press
4. Introduction to Electromagnetic Theory, T.L. Chow, 2006, Jones & Bartlett Learning
5. Fundamentals of Electromagnetics, M.A.W. Miah, 1982, Tata McGraw Hill

NANO MATERIALS AND APPLICATIONS

Reference Books

1. Introduction to Nanotechnology (Wiley India Pvt. Ltd.), C.P. Poole, Jr. Frank J. Owens
2. Nanotechnology: Principles & Practices, S.K. Kulkarni, (Capital Publishing Company)
3. Introduction to Nanoscience and Technology, K.K. Chattopadhyay and A. N. Banerjee, (PHI Learning Private Limited)
4. Nanotechnology, Richard Booker, Earl Boysen, (John Wiley and Sons)
5. Nanoparticle Technology Handbook (Elsevier, 2007), M. Hosokawa, K. Nogi, M. Naita, T. Yokoyama
6. Introduction to Nanoelectronics, V.V. Mitin, V.A. Kochelap and M.A. Stroscio, 2011, Cambridge University Press

COMMUNICATION ELECTRONICS

Reference Books

1. Electronic Communications, D. Roddy and J. Coolen, Pearson Education India
2. Advanced Electronics Communication Systems, Tomasi, 6th edition, Prentice Hall
3. Electronic Communication systems, G. Kennedy, 3rd Edn, 1999, Tata McGraw Hill
4. Principles of Electronic communication systems, Frenzel, 3rd edition, McGraw Hill
5. Communication Systems, S. Haykin, 2006, Wiley India
6. Electronic Communication system, Blake, Cengage, 5th edition
7. Wireless communications, Andrea Goldsmith, 2015, Cambridge University Press
8. Communication System by Sanjay Sharma, S.K. Kataria and Sons

ASTRONOMY AND ASTROPHYSICS

Reference Books

1. An Introduction to Modern Astrophysics, B.W. Carroll & D.A. Ostlie, Addison-Wesley Publishing Co
2. 2. Introductory Astronomy and Astrophysics, M. Zeilik and S.A. Gregory, 4 th Edition, Saunders College Pub lishing
3. 3. Astrophysics in a Nutshell (Basic Astrophysics), Dan Maoz, Princeton University Press
4. 4. Theoretical Astrophysics, Volume III: Galaxies and Cosmology, T. Padmanabhan, Cambridge University Pres

ATOMIC & MOLECULAR PHYSICS

Reference Books

1. Laser Principles and Applications – A. K. Ghatak and K. Tyagrajan (TMH).
2. Introduction to Atomic & Nuclear Physics – H.Semat and J.R.Albright (RW).
3. Atomic & Nuclear Physics – Yang and Hamilton (McGraw Hill).
4. Atomic & Nuclear Physics – S. K. Sharma (Pearson Education).
5. Atomic & Nuclear Physics (vol.I) – S.N.Ghoshal (S.Chand).
6. Quantum Physics – Eisberg & Resnick (J.Wiley).