THEORY **Marks: 100**

Integral Transforms

Fourier Transforms (FTs):- Fourier Integral Theorem. Sine and Cosine Transforms. Properties of FTs: (1) FTs of Derivatives of Functions, (2) Change of Scale Theorem, (3) FTs of Complex Conjugates of Functions, (4) Shifting Theorem, (5) Modulation Theorem, (6) Convolution Theorems, and (7) Parseval's Identity.

(6 Lectures)

Laplace Transforms (LTs) :- Existence Theorem. LTs of Elementary Functions. Properties of LTs : (1) Change of Scale Theorem, (2) Shifting Theorem, (3) LTs of Derivatives and Integrals of Functions, (4) Derivatives and Integrals of LTs, (5) LT of Unit Step function, (6) LTs of Periodic Functions, and (6) Convolution Theorem. Inverse LT (Bromwich Integral).

(9 Lectures)

Applications of Laplace Transforms :- (1) Solution of First and Second Order ODEs, (2) Solution of Simultaneous First Order ODEs, (3) Solution of One-Dimensional PDEs : Wave and Diffusion Equations, (4) Evaluation of Definite Integrals.

(6 Lectures)

Dirac Delta Function

Definition, Representation and Properties of Dirac Delta Function. Fourier and Laplace Transforms. **(3 Lectures)**

Cartesian Tensors

Transformation of Co-ordinates. Einstein's Summation Convention. Relation between Direction Cosines. Tensors. Algebra of Tensors. Sum, Difference and Product of Two Tensors. Contraction. Quotient Law of Tensors. Symmetric and Anti-symmetric Tensors. Pseudotensors. Invariant Tensors : Kronecker and Alternating Tensors. Association of Antisymmetric Tensor of Order Two and Vectors. Vector Algebra and Calculus using Cartesian Tensors : Scalar and Vector Products, Scalar and Vector Triple Products. Differentiation. Gradient, Divergence and Curl of Tensor Fields. Vector Identities. Tensorial Formulation of Analytical Solid Geometry : Equation of a Line. Angle Between Lines. Projection of a Line on another Line. Condition for Two Lines to be Coplanar. Foot of the Perpendicular from a Point on a Line. Rotation Tensor (No Derivation). Isotropic Tensors. Tensorial Character of Physical Quantities. Moment of Inertia Tensor. Stress and Strain Tensors : Symmetric Nature. Elasticity Tensor. Generalized Hooke's Law.

(14 Lectures)

General Tensors

Transformation of Co-ordinates. Contravariant and Covariant Vectors. Contravariant, Covariant and Mixed Tensors. Kronecker Delta and Permutation Tensors. Algebra of Tensors. Sum, Difference and Product of Two Tensors. Contraction. Quotient Law of Tensors. Symmetric and Anti-symmetric Tensors. Metric Tensor. Reciprocal Tensors. Associated Tensors. Christoffel Symbols of First and Second Kind and their Transformation Laws. Covariant Derivative. Tensor Form of Gradient, Divergence and Curl.

(10 Lectures)

Suggested Books:

1. Vector Analysis and Cartesian Tensors, 3ed By D. E. Bourne, P C Kendall (Chapman & Hall, 1992)
2. Matrices and tensors in physics by A.W.Joshi.(New Age International Publications, 1995).
3. Vector Analysis and Cartesian Tensors, 3ed By D. E. Bourne, P C Kendall (Chapman & Hall, 1992)

Paper-18-PHHT-516: Quantum Mechanics

THEORY **Marks: 100**

Particles and Waves

Inadequacies in Classical Physics. Blackbody Radiation : Quantum Theory of Light. Photoelectric Effect. Compton Effect. Franck-Hertz experiment. Wave Nature of Matter : De Broglie Hypothesis. Wave-Particle Duality. Davisson-Germer Experiment. Wave description of Particles by Wave Packets. Group and Phase Velocities and Relation between them. Two-Slit Experiment with Electrons. Probability. Wave Amplitude and Wave Functions.

Heisenberg's Uncertainty Principle (Uncertainty Relations involving Canonical Pair of Variables) : Derivation from Wave Packets. γ-ray Microscope.

(20 Lectures)

Quantum Mechanics

Basic Postulates and Formalism :- Energy, Momentum and Hamiltonian Operators.
Time-independent Schrödinger Wave Equation for Stationary States. Properties of Wave Function. Interpretation of Wave Function. Probability Density and Probability. Conditions for Physical Acceptability of Wave Functions. Normalization. Linearity and Superposition Principles. Eigenvalues and Eigenfunctions. Expectation Values. Wave Function of a Free Particle.

(8 Lectures)

Applications of Schrödinger Wave Equation:

Eigen Functions and Eigenvalues for a Particle in a One Dimensional Box.

(2 Lectures)

Bound State Problems :- General Features of a Bound Particle System, (1) One Dimensional Simple Harmonic Oscillator : Energy Levels and Wave Functions. Zero Point Energy, (2) Quantum Theory of Hydrogen Atom : Particle in a Spherically Symmetric Potential. Schrodinger Equation. Separation of Variables. Radial Solutions and Principal Quantum Number, Orbital and Magnetic Quantum Numbers. Quantization of Energy and Angular Momentum. Space Quantization. Electron Probability Density. Radiative Transitions. Selection Rules.

(12 Lectures)

Scattering Problems in One Dimension :- (1) Finite Potential Step : Reflection and Transmission. Stationary Solutions. Probability Current. Attractive and Repulsive Potential Barriers. (2) Quantum Phenomenon of Tunneling : Tunnel Effect. Tunnel Diode (Qualitative Description). (3) Finite Potential Well (Square Well).

(6 Lectures)

Suggested Books:

1. L. I. Schiff, Quantum Mechanics, 3rd edition, (McGraw Hill Book Co., New York 1968).
2. E. Merzbacher, Quantum Mechanics, 3rd edition, (John Wiley & Sons, Inc1997)
3. J.L. Powell & B. Crasemann, Quantum Mechanics, (Addison-Wesley Pubs.Co.,1965)
4. A. Ghatak & S. Lokanathan, Quantum Mechanics: Theory and Applications, 5th Edition, (Macmillan India , 2004)
5. E. M. Lifshitz and L. D. Landau, Quantum Mechanics: Non-Relativistic Theory (Course of Theoretical Physics, Vol 3), 3rd Edition, Butterworth-Heinemann (1981).
6. Quantum Mechanics: Foundations and Applications by Arno Bohm.--3rd ed.—(New York: Springer-Verlag, 2003).

Paper-19-PHHT-517: Atomic and Molecular Physics

THEORY **Marks: 100**

Determination of e/m of the Electron. Thermionic Emission. Isotopes and Isobars.

(5 Lectures)

X-rays :- Ionizing Power, X-ray Diffraction, Bragg's Law. Bohr Atomic Model, Critical Potentials, X-rays-Spectra: Continuous and Characteristic X-rays, Moseley Law.

(**7 Lectures)**

Atoms in Electric and Magnetic Fields :- Electron Angular Momentum. Space Quantization. Electron Spin and Spin Angular Momentum. Larmor's Theorem. Spin Magnetic Moment. Stern-Gerlach Experiment. Zeeman Effect: Electron Magnetic Moment and Magnetic Energy, Gyromagnetic Ratio and Bohr Magneton.

(5 Lectures)

Atoms in External Magnetic Fields :- Normal and Anomalous Zeeman Effect. Paschen Back and Stark Effect (Qualitative Discussion only).

(4 Lectures)

Many electron atoms :- Pauli's Exclusion Principle. Symmetric and Antisymmetric Wave Functions. Periodic table. Fine structure. Spin orbit coupling. Spectral Notations for Atomic States. Total Angular Momentum. Vector Model. L-S and J-J couplings. Hund's Rule. Term symbols. Spectra of Hydrogen and Alkali Atoms (Na etc.).

(10 Lectures)

Molecular Spectra :- Rotational Energy levels, Selection Rules and Pure Rotational Spectra of a Molecule. Vibrational Energy Levels, Selection Rules and Vibration Spectra. Rotation-Vibration Energy Levels, Selection Rules and Rotation-Vibration Spectra. Determination of Internuclear Distance.

(9 Lectures)

Raman Effect :- Quantum Theory of Raman Effect. Characteristics of Raman Lines. Stoke's and Anti-Stoke's Lines. Complimentary Character of Raman and infrared Spectra.

(4 Lectures)

Lasers :- Einstein's A and B coefficients. Metastable states. Spontaneous and Stimulated emissions. Optical Pumping and Population Inversion. Three-Level and Four-Level Lasers. Ruby Laser and He-Ne Laser.

(4 Lectures)

Suggested Books:

1. Concepts of Modern Physics by Arthur Beiser (McGraw-Hill Book Company, 1987)

2. Atomic physics by J.B.Rajam & foreword by Louis De Broglie.(S.Chand & Co., 2007).

3. Atomic Physics by J.H.Fewkes & John Yarwood. Vol. II (Oxford Univ. Press, 1991).

4. Physics of Atoms and Molecules, Bransden and Joachein.

5. Molecular Spectroscopy, Banwell.

6. Optoelectronics by Ghatak and Thyagarajan

7. Principles of Lasers by Svelto

Paper-20-PHHT-518: Electronic Devices

THEORY **Marks: 100**

Circuit Analysis :- Kirchhoff's Laws, Mesh and Node Analysis of dc and ac Circuits, Duality in Networks, Equivalent Star (T) and delta (π) Networks of a Given Network, Star to Delta and

Delta to Star Conversion. Wheatstone Bridge and its Applications to Wein Bridge and Anderson Bridge.

(6 Lectures)

Semiconductor Diodes :– p and n Type Semiconductors. Energy Level Diagram. Conductivity and Mobility. pn Junction Fabrication (Simple Idea). Barrier Formation in pn Junction Diode. Current Flow Mechanism in Forward and Reverse Biased Diode (Recombination, Drift and Saturation of Drift Velocity). Derivation of Mathematical Equations for Barrier Potential, Barrier Width and Current for Step Junction. pn junction and its characteristics. Static and Dynamic Resistance. Diode Equivalent Circuit. Ideal Diode. Load Line Analysis of Diodes. Load Line and Q-point.

(5 Lectures)

Two-terminal Devices and their Applications :- (1) Rectifier Diode. Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers Calculation of Ripple Factor and Rectification Efficiency. Qualitative idea of C, L and π - Filters. (2) Zener Diode and Voltage Regulation. (3) Photo Diode, (4) Tunnel Diode, (5) LED (6) Varactor Diode.

(4 Lectures)

Bipolar Junction transistors :- n-p-n and p-n-p Transistors. Characteristics of CB, CE and CC Configurations. Current gains α, β and γ and Relations between them. Load Line Analysis of Transistors. DC Load line and Q-point. Physical Mechanism of Current Flow. Active, Cutoff, and Saturation Regions. Transistor in Active Region and Equivalent Circuit.

(6 Lectures)

Amplifiers : – Transistor Biasing and Stabilization Circuits. Fixed Bias and 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. Current, Resistance, Voltage and Power Gains. Class A, B, and C Amplifiers.

(8 Lectures)

Coupled Amplifiers :- RC-Coupled Amplifier and its Frequency Response of Voltage Gain.

(2 Lectures)

Feedback in Amplifiers, Effects of Positive and Negative Feedback on Input Impedance, Output Impedance and Gain, Stability, Distortion and Noise.

(3 Lectures)

Sinusoidal Oscillators :- Barkhauson's Criterion for Self-sustained Oscillations. RC Phase Shift Oscillator, Determination of Frequency. Hartley Oscillator. Colpitts
Oscillator.

(3 Lectures)

Non-Sinusoidal Oscillators – Astable and Monostable Multivibrators.

(3 Lectures)

Three-terminal Devices (UJT and FETs) :- (1) UJT : Its Chararacteristics and Equivalent Circuit. Relaxation Oscillator, (2) JEFT : Its Characteristics and Equivalent Circuit. Advantages of JFET. MOSFET (Qualtiative Discussion only).

(4 Lectures)

Modulation and Demodulation:- Types of Modulation. Amplitude Modulation. Modulation Index. Analysis of Amplitude Modulated Wave. Sideband Frequencies in AM Wave. CE Amplitude Modulator. Demodulation of AM Wave using Diode Detector. Idea of Frequency, Phase, and Digital Modulation.

(4 Lectures)

Suggested Books:

1. Robert Boylestad, Louis Nashelsky, Electronic Devices and Circuit Theory, 8Th Edition, Pearson Education, India, 2004.
2. A. P. Malvino, Electronic Principals, Glencoe, 1993.
3. John Morris, Analog Electronics.
4. Allen Mottershead, Electronic Circuits and Devices, PHI, 1997.
5. Solid state electronic devices By Ben G. Streetman & Sanjay Banerjee, Pearson Prentice Hall, 2006.
6. Basic Electronics & Linear Circuits By N. N. Bhargava, D. C. Kulshreshtha & SC Gupta, Tata McGrawHill, 2006

Physics Lab V

PRACTICALS **Marks: 100**

1 : Determination of Fundamental Constants

1. To determine the value of Boltzmann Constant by studying Forward Characteristics of a Diode.
2. To determine the value of Planck's Constant by using a Photoelectric Cell.
3. To determine the value of Planck's Constant by using LEDs of at least 4 Different Wavelengths.

2 : Atomic & Molecular Physics

1. To determine the value of e/m by (a) Magnetic Focussing or (b) Bar Magnet.To determine the wavelengths of Hydrogen spectrum and hence to determine the value of Rydberg's Constant.
2. To determine the Wavelength of H-alpha Emission Line of Hydrogen Atom.
3. To determine the Absorption Lines in the Rotational Spectrum of Iodine Vapour.

3 : Miscellaneous

1. To determine the Wavelength and the Angular Spread of a He-Ne Laser.
2. To determine the value of Stefan's Constant.
3. To determine the Wavelength and the Velocity of Ultrasonic Waves in a liquid (Kerosene Oil, Xylene, etc.) by studying the Diffraction of light through an Ultrasonic Grating.

Note

1. Each College should set up all the Practicals from the above list.
2. Each Student is required to perform 6 Practicals by taking at least 1 Practical from each of the units 505.1 to 503.3.

Text and Reference Books

1. Geeta Sanon, BSc Practical Physics, 1st Edn. (2007), R. Chand & Co.
2. B. L. Worsnop and H. T. Flint, Advanced Practical Physics, Asia Publishing House, New Delhi.
3. Indu Prakash and Ramakrishna, A Text Book of Practical Physics, Kitab Mahal, New Delhi.
4. D. P. Khandelwal, A Laboratory Manual of Physics for Undergraduate Classes, Vani Publication House, New Delhi.
5. Nelson and Jon Ogborn, Practical Physics.

Physics Lab VI

PRACTICALS **Marks: 100**

1 : Networks

1. To verify the Thevenin, Norton, Superposition, and Maximum Power Transfer Theorem
2. To measure the Input and Output Impedance of an Unknown Network and to convert it into Equivalent T and Pi Circuits.

2 : Power supply

1. To study (a) Half-wave Rectifier and (b) Full-wave Bridge Rectifier and investigate the effect of C, L and π filters.
2. To design a Semiconductor Power Supply of given rating using (a) Half wave, (b) Full wave or (c) Bridge rectifier and investigate the effect of C-filter.
3. To study the Forward and Reverse characteristics of a Zener Diode and to study its use as a Voltage Regulator.
4. To investigate simple regulation and stabilization circuits using Voltage Regulator ICs.

3 : Transducers

1. To determine the Characteristics of p-n junction of a Solar Cell.
2. To study the Characteristics of a Photo-diode.
3. To determine the Coupling Coefficient of a Piezoelectric crystal.

4 : Transistor Applications

1. To study the CE Characteristics of a Transistor.
2. To study the various Transistor Biasing Configurations.
3. To design a CE Amplifier of a given gain (mid-gain) using Voltage Divider Bias.
4. To study the Frequency Response of Voltage Gain of a RC-Coupled Amplifier.
5. To design an Oscillator of given specifications using Transistors.
6. To study the Characteristics of a FET and design a common source amplifier.

Note

1. Each college should set up all the Practicals from the above list.
2. Each student is required to perform at least 8 Practicals by taking at least 2 Practicals from each of the units 506.1 to 506.3.
3. The students should be encouraged to do practicals by using Breadboard or softwares like PSpice wherever possible.

Text and Reference Books

1. Geeta Sanon, BSc Practical Physics, 1st Edn. (2007), R. Chand & Co.
2. Nelson and Jon Ogborn, Practical Physics.
3. Adrian C. Melissinos, Jim Napolitano, Experiments in Modern Physics.
4. Paul B. Zbar and Albert B. Malvino, Basic Electronics (A Text-Lab Manual), Tata McGraw Hill.
5. A. P. Malvino, Electronics.
6. John Morris, Analog Electronics.
7. A P Malvino and D P Leach, Digital Principles and Applications.