SEMESTER - I

Paper - I : Classical Mechanics

Max. Marks : 55
Time : 3 Hrs

Note : Nine questions will be set and students will attempt 5 questions. Question No. 1 will be compulsory consisting of 4 parts based on the conceptual aspects of the whole syllabus. The answers should not be in yes/no. In addition to Question No. 1 there will be four Units in the question-paper each containing two questions belonging to four Units in the syllabus. Students will select one question from each unit.

UNIT - I

Hamilton's variational principle - Derivation of Lagrange's equations from this principle, extension of the non-holonomic systems - method of undetermined multiplier, velocity dependent forces and dissipation function, conservation laws - some illustrative applications (like simple pendulum, coplanar double pendulum, pendulum with moving support).

UNIT - II

Two-body central forces problems - Classification of orbits, differential equations for orbits, Virial theorem, Kepler’s laws of planetary motion and their derivation. Scattering : scattering in laboratory and centre of mass frames, scattering cross sections, Rutherford scattering (derivation of differential and total cross section).

UNIT - III

Kinematics and dynamics of rigid body - Orthogonal transformations, Euler angles, Euler theorem, angular momentum, rotational K.E., principle axis transformations, Euler equations, force free motion of a rigid body, symmetric top.

UNIT - IV

Legendre transformations and Hamilton's equations, cyclic coordinates and conservation theorems, Ruth's Procedure, canonical transformations, Poisson brackets (with illustrative evaluations), Poincare invariants,

Hamilton-Jacobi method and example of harmonic oscillator problem, action angle variables and its applications to harmonic oscillator problem.

References

1. Classical Mechanics - H. Goldstein, Addison - Wesley
2. Classical Mechanics - N.C. Rana and P.S. Jog, Tata - McGraw Hill
3. Classical Mechanics - T.L. Chow, John - Wiley.
4. Classical Mechanics - Sankara Rao, Prantice Hall
5. Mechanics - L.D. Landau and E.M. Lifshitz, Pergamon

SEMESTER - I

Paper - II : Applied Mathematics

Max. Marks : 55
Time : 3 Hrs

Note : Nine questions will be set and students will attempt 5 questions. Question No. 1 will be compulsory consisting of 4 parts based on the conceptual aspects of the whole syllabus. The answers should not be in yes/no. In addition to Question No. 1 there will be four Units in the question-paper each containing two questions belonging to four Units in the syllabus. Students will select one question from each unit.

UNIT - I

Bessel Functions : Baessel's functions of the first kind : Generating function, recurrence relations, Jn(x) as solution of Bessel's differential equation, expansion of Jn(x) when n is half and odd integer, orthogonality of Jn(x) (Statement only).
Legendre Polynomials : Generating functions for Pn(x) ($n \geq 0$), recurrence relations and special properties, Pn(x) as solution of Legendre differential equation, Rodrigues formula, orthogonality of Pn(x), associated Legendre polynomials (Introduction only).

UNIT - II

Laguerre Polynomials : Generating function and recurrence relations.
Hermite Polynomials : Generating function, recurrence relations, orthogonality of Hn(x).
Complex Variables : Function of complex variable, Analytic functions, Cauchy-Riemann conditions for the function to be analytic, Cauchy's integral theorem, Cauchy's integral formula, Taylor's and Laurent's series, definite Integrals, Jordan's Lemma.

UNIT - III

Laplace Transform : Definition, important properties of Laplace transforms, Inverse Laplace transforms and its important properties.

Error Analysis : Types of experimental errors, statistical analysis of random errors, the normal or Gaussian law of error, Propagation of

Errors, method of least squares, applications of method of least squares solution of linear equations, curve fitting.

UNIT - IV

Group Theory : Definition of a group with illustrative examples, group multiplication table, rearrangement theorem, cyclic groups, subgroups and cosets, conjugate elements and class structure, normal division and factor groups, isomorphy and homomorphy, class multiplications, group representation, reducible and irreducible representation, the great orthogonality theorem (statement only) and geometrical interpretation, character of a representation and construction of character of character table with illustrative example of symmetry groups of equilateral triangle, rectangle and square.

References

1. Mathematical Methods for Physicists - G. Arfken
2. Mathematical Physics for Physicists and Engineers - L. Pipes.
3. Theory and Problem of Complex Variables - M.R. Speigel, Schaum's Outlines
4. Theory and Problems of Laplace Transform - M.R. Speigel, Schaum's Outlines.
5. Group Theory and Quantum Mechanics - M. Tinkam
6. Theory of Errors - J. Topping
7. Numericals Methods - J.H. Mathews Prentice Hall of India.

SEMESTER - I

Paper - III : Applied Spectroscopy

Max. Marks : 55
Time : 3 Hrs

Note : Nine questions will be set and students will attempt 5 questions. Question No. 1 will be compulsory consisting of 4 parts based on the conceptual aspects of the whole syllabus. The answers should not be in yes/no. In addition to Question No. 1 there will be four Units in the question-paper each containing two questions belonging to four Units in the syllabus. Students will select one question from each unit.

UNIT - I

Molecular spectroscopy : Rotation of molecule, Rotational spectra, Rigid diatomic molecule, Intensities of spectral line, Effect of isotopic substitution, Non-rigid rotation. Spectrum of non-rigid rotator. Vibrating diatomic molecule, energy of a diatomic molecule, Harmonic oscillator. Anharmonic oscillator.

Diatomic vibrating rotator, Breakdown of the Born-Oppenheimer approximation, Interaction of rotation and vibration, Vibration of polyatomic molecules, Fundamental vibrations and their symmetry, overtones and combination frequencies, influence of rotation on the spectra of polyatomic molecules, influence of nuclear spin.

UNIT - II

Raman spectroscopy : Classical theory of Raman effect, Rayleigh scattering, stoke and antistoke lines, molecular polarizability, pure rotational Raman spectra of linear symmetric top molecules. Vibrational Raman spectra, Raman Activity of vibrations, Rule of mutual exclusion, Rotational fine structure, Advantages and limitations of Raman spectroscopy, Comparison between Raman sepctra and Infra red spectra.

UNIT - III

Electronic spectroscopy of molecules : Electronic spectra of diatomic molecules, The Born-Oppenheimer approximation Vibrational Coarse structure, Progression, Intensity of vibrational - Electronic spectra, Frank-Condon Principle.

Resonance spectroscopy : Spin and applied field, Interaction between spin and magnetic field, Larmor precession, Electron spin resonance, Position of electron spin resonance absorptions, 'g' factor, Factor affecting 'g' value Limitation of ESR, ESR spectrometer. Application of ESR.

UNIT - IV

Nuclear magnetic resonance spectroscopy : Nuclear spin, Magnetic moment, Nuclear magnetic resonance, magnetic moment and magnetic field, Theory of NMR spectra. Chemical shift, Spin-spin spliting, Shielding and deshielding of magnetic nuclei, NMR spectrometer Limitation of NMR spectroscopy, Application of NMR.
Mössbauer spectroscopy : Natural line width, Recoil energy loss, Resonance and resonance fluorescence, Mössbauer effect, Basic principle, Spectrometer, Lamb Mössbauer factor, Application of Mössbauer spectroscopy.

References

1. Fundamental of Molecular spectroscopy - Colin N. Banwell and Elaine M.McCash, McGraw - Hill.
2. Molecular spectra and molecular structure - Gerhard Herzberg.
3. Introduction to molecular spectroscopy, theory and experiment. E.F. Brittan, W.O. George and C.H. Wells, Academic Press.
4. Principles of Instrumental Analysis - Douglas A. Skoog, F. James Holler, Timothry A. Nieman Saundens Publishing
5. Basic Principles of Spectroscopy - R. Chang, Krieiger Publication.

SEMESTER - I

Paper - IV : Laser Physics

Max. Marks : 55
Time : 3 Hrs

Note : Nine questions will be set and students will attempt 5 questions. Question No. 1 will be compulsory consisting of 4 parts based on the conceptual aspects of the whole syllabus. The answers should not be in yes/no. In addition to Question No. 1 there will be four Units in the question-paper each containing two questions belonging to four Units in the syllabus. Students will select one question from each unit.

UNIT - I

Introduction to laser, Spontaneous transitions between atomic levels - Homogenous and Inhomogenous broadening, Induced transition, Absorption and Amplification. Einstein Coefficient, significance of Einstein coefficients. Active material, population inversion, Laser medium, Pumping. Properties of laser – Coherence, Spatial coherence, Temporal coherence, Directionality, Monochromaticity, Focusability. Origin of the line shape function, Shape and width of the spectral lines, Spiking behaviour of the lasers

UNIT - II

Laser rate equation, Fabry Perot Laser, Oscillations frequency, Three and Four levels Lasers, Power in laser Oscillation and Mode Locking. Q-switched lasers.
Curved Mirror Oscillator Theory : Optical Resonator with Spherical Mirrors, Mode stability criteria, Modes in generalised resonator, Resonance Frequencies of Optical resonators.

UNIT - III

Laser System and Applications : Ruby Laser, Nd^{3+} : YAG Laser. He-Ne Laser, N_2-Laser, CO_2 Laser, Ar^+ Laser, Excimer Laser, Semiconductor junction Laser and Organic-Dye Lasers, Free electron Laser and X-Ray Lasers.

UNIT - IV

Spatial Frequency Filtering, Holography, Laser induced Fusion, Light wave communications, Lasers in Isotope Separation. Fundamental Characteristics of High energy density beams in materials processing. An oscillating Laser Beam. Hardfacing using a CW Laser. Applications of Laser Technology : Drilling, Cutting, Welding, Engraving, Stimulated Raman's Scattering and Self Focussing of Optical beams. Harmonic Generation, Second harmonic generation, Phase matching.

References

1. Laser and Optical Engineering - P.Das, Narosa Publication.
2. Lasers and Nonlinear Optics - B.B. Land.
3. Optical Electronics - A Ghatak and K. Thyagarayan.
4. Introduction to Optical Electronics - A. Yariv, Holt, Rinehart and Winston.

SEMESTER - I

Paper - V : Electronics - I

Max. Marks : 55
Time : 3 Hrs

Note : Nine questions will be set and students will attempt 5 questions. Question No. 1 will be compulsory consisting of 4 parts based on the conceptual aspects of the whole syllabus. The answers should not be in yes/no. In addition to Question No. 1 there will be four Units in the question-paper each containing two questions belonging to four Units in the syllabus. Students will select one question from each unit.

UNIT - I

Network Theorems : Kirchoff's Current and Voltage Law, Maximum Power Transfer Theorem, Node Method, Mesh Method, Millman Theorem, Thevenin's Theorem, Norton's Theorem, Superposition Theorem, Two-Port Networks, Equivalent Circuits, Integration, Differentiation using RC Circuits, Clipping, Clamping, Phase and Phasor diagrams of R-C, L-C, R-L, R-L-C Circuits.

Junction Diodes : Rectifying Diode, Forward and Reverse Bias Characteristics, Varactor Diode, Light Emitting Diode, Zener Diode, Tunnel Diode.

Bipolar Junction Transistor : Basic working Principle (Qualitative), Characteristics, Basic Configurations and Biasing, Operating Point, Load Line, Biasing for stabilization of Operating Point.

UNIT - II

JFET and MOSFET : Basic working Principle (Qualitative), Characteristics, Pinchoff Voltage.

Unijunction Transistor : Basic Working Principle (Qualitative), Characteristics.

Power Control Devices : Four Layer Diode (PNPN), Silicon Controlled Rectifier (SCR), Triac, Diac, Principles and Characteristics and Applications i.e. SCR as rectifier and Triac as Power Controller in Single Phase.

Transducers : Commonly used Transducers like LDR, Thermistors. Thermocouples, Photodiodes, Photo Transistors, IR Detectors, MVDT, Strain Gauge, Application of Transducers in Temperature, Pressure, Light Intensity, Humidity Measurements.

UNIT - III

Power Supplies : Regulated Power Supply, Zener Regulated Power Supply, Series and Shunt Regulated Power Supply, Three Terminal ICs Power Supply. Load Regulation and Line Regulation. Switched Mode Power Supply : Design Principle and Application.

Amplifiers : Different Terms used in Amplifiers, such as Signal, Source, Input, Output, Voltage and Current Gain, Power Gain, Decibel, Input and Output Impedance. Classification according to the Frequency Response, RC Coupled Class A Common Emitter Amplifier, Introduction to the Class B Operation.

Feed back in Amplifier : Effect of Negative Feedback on Amplifier Performance, Push-Pull Amplifiers : Phase Splitter circuits, Complementary Push-Pull, Thermal runway, Heat sinks.

UNIT - IV

Oscillators : Positive Feedback, Barkhausen Criteria, Phase Shift Oscillators, Wien Bridge Oscillator, Tuned Oscillator, Hartley, Colpits-Oscillators, Crystal Oscillator.

Operational Amplifier : Differential Amplifier, OPAMP inverting and Non-inverting Inputs, Virtual Ground, Parameters such as Input Impedance, Output Impedance, Open Loop Gain, CMRR, Measurements of Parameters.

Operational Amplifier : OPAMP as Inverting and Non-inverting Amplifier, Summing and Difference Amplifier, Comparator, Differentiator and Integrator, Instrumentation Amplifier, PLL (Phase Lock Loop). Non-linear Applications of OPAMP.

References

1. Electrical Engineering - V. Del. Toro
2. Integrated Electronics - Millman Halkias
3. Basic Electronics - B.L. Theraja
4. Instrumentation - A.K. Shahni
5. Fundamental of Electronics - J.D. Ryder
6. Network Analysis - Van Valkenburg
7. Measurement and Instrumentation - W.D. Cooper.