PT – 101 METHODS IN MATHEMATICAL PHYSICS

Max. Marks: 85 Pass Marks: 29

Note: This paper has been divided into FIVE units. The paper will be set as per existing examination norms covering uniformly all the units and providing to the examinee sufficient choice in each unit.

Unit – I Tensor Analysis

Definition of Tensor and its rank, Transformation laws of covariant, contravariant and mixed tensors, Fundamental Operations with tensors (addition, subtraction and multiplication), Inner and outer product, Contraction of tensors, Associated tensors, Christoffel symbols, covariant differentiation of tensor

Unit – II Elements of Complex Variable

Functions of a complex variable, the derivative and the Cauchy-Riemann differential equations, line integrals of complex functions, Cauchy's integral theorem, Cauchy's integral formula, Taylor's series, Laurent's series, residues; Cauchy's residue theorem, singular points of an analytic function, evaluation of residues, Jordon-Lemma, evaluation of definite integrals,.

Unit – III Theory of Fourier and Laplace Transforms

Fourier series analysis, evaluation of constants, Fourier sine, cosine and complex transforms, transforms of derivatives, Convolution theorem, Parseval's relation, Momentum representation: Examples from optics, Electromagnetism and quantum mechanics, Laplace transforms(LT) of simple function and derivatives, LT and solution of simple differential equations, convolution theorem.

Unit – IV Special Functions

Singularity structure of a general second order homogeneous differential equation : ordinary points, regular and irregular points, indicial equation, The point at infinity, Series expansion method for solving differential equations, series solutions, Generating functions and recurrence relations and orthogonality of Legendre and Hermite polynomials

Unit – V Partial Differential Equations

Laplace equation, 2-D study flow of heat, circular harmonics, conducting cylinder in a uniform field, The potential of a ring, The potential about a spherical surface, the equation of heat, conduction or diffusion, variable linear flow, two-dimensional heat conduction, temperature inside a circular plate.

BOOKS RECOMMENDED

1) Applied Mathematics for Engineers and Physicist: Pipes
2) Mathematical Physics: Harper
3) Advanced Engineering Mathematics: Kreyszig
4) Schaum Series for Transforms, Complex Variables and Tensors
5) Mathematical Methods: Arfken
6) Elements of Complex variables: Churchill

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PT – 102 CLASSICAL MECHANICS

Max. Marks: 85 Pass Marks: 29

Note: This paper has been divided into FIVE units. The paper will be set as per existing examination norms covering uniformly all the units and providing to the examinee sufficient choice in each unit.

Unit – I Lagrangian Mechanics

Mechanics of a particle, Mechanics of a system of particles, Constraints, Generalised coordinates, De Alembert's principle and Lagrangian equations, Lagrangian for a charged partcle in an electromagnetic field, application of Lagrangian formulation to (a) single particle in space, (b) Atwood's machine.

Unit – II Variational Principle

Hamilton's principle, some techniques of the calculus of variation, application to (a) geodesics in a plane (b) minimum surface of revolution, Derivation of Lagrange's equation from Hamilton's principle, Conservation laws and corresponding symmetry principles

Unit – III Two body central force problem and scattering

Reduction of two body central force problem to the equivalent one body problem, The equation of motion and the first integrals, Classification of orbits, the virial theorem, the Kepler problem, scattering in a central force field, Rutherford scattering, transformation of the scattering problem to laboratory coordinates.

Unit – IV Small oscillations

Formulation of the problem, the eigen value equation, frequencies of free vibration, free vibration of a linear tri atomic molecule, transition from a discrete to a continuous system, the Lagrangian formulation for continuous system.

Unit – V Transformation and equation of motion

Lagendre transformations and the Hamilton equations of motion, cyclic coordinates and conservation theorem, Hamilton's equation from variational principle, equation of canonical transformation, Poisson brackets: Definition and identity relation, equation of motion and conservation theorem in the Poisson bracket formulation, the Hamilton-Jacobi equation for Hamilton's principal function, the Harmonic oscillator problem as an example of Hamilton-Jacobi method.

BOOKS RECOMMENDED

1. Classical Mechanics: Goldstein.
2. Classical Mechanics: Takwale

PT – 103 ELECTROMAGNETISM AND LASER OPTICS

Max. Marks: 85 Pass Marks: 29

Note: This paper has been divided into FIVE units. The paper will be set as per existing examination norms covering uniformly all the units and providing to the examinee sufficient choice in each unit.

Unit – I Application of Maxwell Equations

Maxwell's equation, Field energy, Poynting theorem, plane wave solution of Maxwell's equations, Reflection and Refraction at a plane boundary of dielectrics, Polarization by reflection and total internal reflection, Waves in a conducting medium, Reflection and refraction by the ionosphere.

Unit – II Electromagnetic Waves in Anisotropic Medium

The dielectric tensor of an anisotropic medium, structure of a monochromatic plane wave in an anisotropic medium: The phase velocity and the ray velocity, Fresnel's formulae for the propagation of E.M. wave in crystals, Geometrical constructions for determining the velocities of propagation and directions of vibrations, optical properties of uniaxial and biaxial crystals: The optical classification of crystals, E.M. wave propagation in uniaxial crystals.

Unit - III Electromagnetic Wave Interactions

E.M. wave propagation in biaxial crystals Refraction in crystals: double refraction, internal and external conical refraction, experimental demonstration of double refraction and conical refraction, Acoustic-optic interaction: Raman-Nath theory of ultrasonic diffraction of E.M. waves, magneto-optic interaction: Faraday effect, Electro-optic interaction: Kerr effect, interaction with matter: (a) normal and anomalous dispersion (b) Rayleigh scattering.

Unit - IV Elements of Laser Physics

The Laser amplifier: Amplifier gain, amplifier phase shift, Amplifier power source: Rate equation, four and three level pumping schemes, Examples of laser amplifiers, Characteristics of the laser output: Power, spectral distribution, Spatial distribution and polarization, Mode selection, Characteristics of common lasers.

Unit -V Nonlinear Optics

Nonlinear optical media, Second order nonlinear optics Second harmonic and rectification, The electro-optics effect, Three-wave mixing, Third order nonlinear optics, Third harmonic generation and self pulse modulation, four wave mixing, optical pulse conjugation.

Books Recommended

1. Introduction of electrodynamics: Griffith
2. Foundation of electromagnetic Theory: Reitz, Millford and Christy.
3. Plasma physics by F.F. Chen
4. Electromagnetic waves and radiation systems: Jordan and ball man
5. Classical electrodynamics: Jackson