B.SC. PHYSICS-ELECTIVE - : EC-3
ADVANCED MATHEMATICAL PHYSICS-I
(Credits: Theory-04, Practicals-01) Theory: 60 Lectures – Practical: 30 sessions

COURSE OBJECTIVES:

1. To get acquainted with the basic aspects of Linear Vector Spaces.
2. To get a basic understanding about Matrices.
3. To know and work out the problems involving the applications of the Matrices.
4. To learn some elementary aspects of Cartesian Tensors as well as that of tensorial formulation of Analytical Solid Geometry
5. To comprehend with the applications of General Tensors in physics.

LEARNING OUTCOMES:

1. To know about the basic aspects of Linear Vector Spaces.
2. To get acquainted with Matrices and their operations.
3. To know and work out the problems involving the applications of the Matrices.
4. To understand some basic aspects of Cartesian Tensors as well as that of tensorial
5. formulation of Analytical Solid Geometry.
6. To comprehend with the applications of General Tensors in physics.

The emphasis of the course is on applications in solving problems of interest to physicists. Students are to be examined on the basis of problems, seen and unseen.

UNIT -I

Chapter – I :

Linear Vector Spaces: Abstract Systems. Binary Operations and Relations. Introduct ion to Groups and Fields. Vector Spaces and Subspaces. Linear Independence and Dependence of Vectors. Basis and Dimensions of a Vector Space, Inner Product, Change of basis. Homomorphism and Isomorphism of Vector Spaces. Linear Transformations. Algebra of Linear Transformations. Non-singular Transformations. Representation of Linear Transformations by Matrices.

(10 Lectures)

UNIT-II

Chapter -II

Matrices: Addition and Multiplication of Matrices. Null Matrices. Diagonal, Scalar and Unit Matrices. Upper-Triangular and Lower-Triangular Matrices. Transpose of a Matrix , Rank of a Matrix, Linear Simultaneous equations, Symmetric and Skew-Symmetric Matrices. Conjugate of a Matrix. Hermitian and Skew-Hermitian Matrices. Singular and Non-Singular matrices. Orthogonal and Unitary Matrix. Trace of a Matrix, Determinant of a Matrix. (10 Lectures)

UNIT-III

Chapter- III

Matrix Applications : Eigen-values and Eigenvectors. Cayley- Hamilton Theorem. Diagonalization of Matrices. Solution of Coupled Linear Ordinary Differential Equations. Functions of a Matrix
(10 Lectures)

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UNIT-IV

Chapter -IV

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. Contravariant, Covariant and Mixed Tensors, Quotient Law of Tensors. Symmetric and Anti-symmetric

Tensors. Invariant Tensors: Kronecker and Alternating Tensors, Permutation 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.

(10 Lectures)

Chapter-V

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.

(10 lectures)

UNIT-V

Chapter-VI

Applications of Tensors & General Tensors in Physics: Four Vectors in Special theory of relativity:: Scalars and Vectors in four dimensional spacetime, Lorentz Transformation of coordinates, transformation of a Four-vector, Minkowski Space and its properties. Covariant formulation of Electro dynamics:: Lorentz Guage, Electromagnetic field strength Tensor, Maxwell equations, Transformation of Electromagnetic fields. Quotient Law of Tensors. Metric Tensor.

(10 Lectures)

Reference Books:

- Mathematical Tools for Physics, James Nearing, 2010, Dover Publications
- Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, and F.E. Harris, 1970, Elsevier.
- Modern Mathematical Methods for Physicists and Engineers, C.D. Cantrell, 2011, Cambridge University Press
- Introduction to Matrices and Linear Transformations, D.T. Finkbeiner, 1978, Dover Pub.
- Linear Algebra, W. Cheney, E.W. Cheney & D.R. Kincaid, 2012, Jones & Bartlett Learning • Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole
- Mathematical Methods for Physicists & Engineers, K.F. Riley, M.P. Hobson, S.J. Bence, 3rd Ed., 2006, Cambridge University Press