हिमाचल प्रदेश केंद्रीय विश्वविद्यालय

Central University of Himachal Pradesh

(Established under Central Universities Act 2009)

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INTERDISCIPLINARY COURSES OFFERED BY THE SRINIVASA RAMANUJAN DEPARTMENT OF MATHEMATICS

Monsoon Semester, 2022

Sr. No.	Course Name	Course Code	Credits	
1	Linear Algebra and Tensors	MTH 351	04	**For PG**

Course Contents

Course Code: MTH 351

Course Name: Linear Algebra and Tensors

Course credit: 04

Course Instructor: Dr Meenakshi

Course Objectives:

To introduce student to the ideas and some fundamental concepts of Matrices

To give students a working knowledge of basic properties of Vector Spaces, Matrices and Cartesian Tensors and General Tensors

Course Outcomes: After completion of the course, a student will be able to

CO^1 Understand how linear transformations are used to preserve the structure of a vector space

CO^2 Understand how Matrices are extensively used in solving the simultaneous system of equations

CO^3 Understand the use of Cartesian Tensors

CO^4 Have the knowledge of central concepts of Algebra of Tensors

Credit Equivalent: 04 Credits (One credit is equivalent to 10 hours of lectures / organised classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual / group work; obligatory / optional work placement; literature survey / library work; data collection / field work; writing of papers / projects / dissertation / thesis; seminars, etc.)

Attendance Requirement:

Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must, failing which a student may not be permitted to appear in examination.

Evaluation Criteria:

1. Mid Term Examination: 25%
1. End Term Examination: 50%
2. Continuous Internal Assessment: 25%
3. Assignment 10%
4. Class participation 10%

5. Class tests 5%

Course Contents:

Unit I: Linear Vector Spaces: Abstract Systems, Binary Operations and Relations, Introduction to Groups and Fields, Vector Spaces and Subspaces, Linear Independence and Dependence of Vectors, Change of Basis, Homomorphism and Isomorphism of Vector Spaces, Linear Transformations, Representation of Linear Transformations by Matrices.

Unit II: Matrices: Addition and Multiplication of Matrices, Null Matrices, Diagonal, Scalar and Unit Matrices, Upper-Triangular and Lower- Triangular Matrices, Transpose of Matrix, Symmetric and Skew-Symmetric Matrices, Conjugate of a Matrix, Hermitian and Skew-Hermitian Matrices, Singular and Non-Singular matrices, Orthogonal and Unitary Matrices, Trace of a Matrix, Inner Product.

Eigen- values and Eigenvectors, Cayley- Hamilton Theorem, Diagonalization of Matrices, Solutions of Coupled Linear Ordinary Differential Equations, Functions of a Matrix.

Unit III : Cartesian Tensors: Transformation of Coordinates. 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 Antisymmetric Tensors, 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.

Unit IV: General Tensors: Transformation of Coordinates. Minkowski Space, Contravariant & Covariant Vectors. Contravariant, Covariant and Mixed Tensors. Kronecker Delta and Permutation Tensors. Algebra of Tensors. Sum, Difference & Product of Two Tensors. Contraction. Quotient Law of Tensors. Symmetric and Anti-symmetric Tensors. Metric Tensor.

Prescribed Text Books :

1. Mathematical Tools for Physics, James Nearing, 2010, Dover Publication.
2. Mathematical Methods for Physicists and Engineers, C.D, Cantrell, 2011, Cambridge University Press.
3. Introduction to Matrices and Linear Transformation, D.T. Finkbeiner, 1978, Dover Pub.
4. Linear Algebra, W. Cheney, E.W Cheney & D.R Kincaid, 2012, Jones & Bartlett Learning.
5. Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole
6. Mathematical Methods for Physics & Engineers, K.F.Riley, M.P.Hobson, S.J. Bence, 3rd Ed, 2006, Cambridge University Press.