

Introduction to Vectors and Tensor Analysis

Credit Hours:	3	Course Code:	MATH-4101	Prerequisites:	MATH-2101
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Course Introduction: This course provides an in-depth understanding of vector calculus and tensor analysis, essential for mathematical physics and engineering applications. It covers vector operations, integral theorems, coordinate systems, and the fundamental properties of tensors. Applications include physical tensors, isotropic systems, and the diagonalization of the inertia tensor for system symmetries.

Course Learning Outcomes: Upon successful completion of this course, a students should be able to:

CLO1: Prove continuity and establish limit functions in Vectors and Tensors

CLO2: define Divergence, Gradient of Scalar Functions, and Curl of Vectors

CLO3: establish Green's Theorem, Stokes's Theorems and Divergence Theorem

CLO4: work out answers to simple problems in Tensor Analysis.

PLO/CLO Mapping:

	PLO1	PLO2	PLO3
CLO1	✓	✓	✓
CLO2	✓	✓	✓
CLO3	✓	✓	
CLO4	✓	✓	

Course Contents: 3-D vectors, summation convention, kronecker delta, Levi- Civita symbol, vectors as quantities transforming under rotations with ijk notation, scalar- and vector-triple products, scalar- and vector point functions, differentiation and integration of vectors, line integrals, path independence, surface integrals, volume integrals, gradient, divergence and curl with physical significance and applications, vector identities, Green's theorem in a plane, divergence theorem, Stokes theorem, coordinate systems and their bases: the spherical, cylindrical and curvilinear coordinate meshes, alternating symbol, relation between alternating symbol and Kronecker delta, tensors of first, second and higher orders, algebra of tensors, contraction of tensor, quotient theorem, symmetric and skew symmetric tensors, Covariant and Contravariant tensors, invariance property, isotropic tensors, differentiation of tensors, application of tensors in modeling an isotropic systems, study of physical

tensors (moment of inertia, index of refraction, etc.), diagonalization of inertia tensor as aligning coordinate frame with natural symmetries of the system.

Recommended Books: Following are the recommended books.

1. Bourne D. E., Kendall P. C., Vector Analysis and Cartesian Tensors, 2nd edition, Thomas Nelson UK, 1977.
2. Shah N. A., Vector and Tensor Analysis, A-One Publishers, Lahore, 2005.
3. Smith G. D., Vector Analysis, Oxford University Press, Oxford.
3. Spiegel M. R., Vector Analysis, McGraw Hill, New York, 1974.