B.Sc. Physical Sciences with Physics as one of the Core Disciplines

DISCIPLINE SPECIFIC ELECTIVE COURSE – DSE 7-1 : ADVANCED MATHEMATICAL PHYSICS

Course Title and Code	Credits	Credit distribution of the course			Pre-requisite of the course
		Lecture	Tutorial	Practical	
Advanced Mathematical Physics DSE 7-1	4	3	1	0	

COURSE OBJECTIVES

The course is intended

- To impart the basic concepts of cartesian tensors to have in-depth analysis of physical system.
- To grasp the foundational principles of group theory so that students can apply it in theoretical and experimental physics.

LEARNING OUTCOMES

After completing the course the students will be able to

- Learn basic properties of cartesian tensors with physical examples such as moment of inertia tensor, stress tensor, strain tensor etc.
- Learn elementary group theory: definition and properties of groups, subgroups, Homomorphism, Isomorphism and Normal groups.

SYLLABUS OF DSE 7-1
THEORY COMPONENT
(Hours: 45)

Unit I **(10 hours)**

Cartesian Tensors

Transformation of Co-ordinates and fundamentals of Tensors. Einstein's Summation Convention. Relation between Direction Cosines. Algebra of Tensors: Sum, Difference and Product of Two Tensors. Contraction. Quotient Law of Tensors. Symmetric and Anti-symmetric Tensors. Invariant Tensors: Kronecker and Alternating Tensors. Association of Anti-symmetric Tensor of Order Two and Vectors.

Unit II **(8 Hours)**

Vector Calculus using Cartesian Tensors
Scalar and Vector Products of 2, 3, 4 vectors. Gradient, Divergence and Curl of Tensor Fields. Tensor notation of Laplacian operator. Proof of Vector Identities involving scalar and vector products and vector identities involving Del operator using Tensor notation.

Unit III **(7 Hours)**

Applications of Cartesian Tensors
Tensorial Character of Physical Quantities. Moment of Inertia Tensor. Stress and Strain Tensors: Symmetric Nature. Elasticity Tensor. Generalized Hooke's Law.

Unit IV **(20 Hours)**

Group Theory
Elementary properties of groups, Subgroup, Centre of a group, Co-sets of a subgroup, cyclic group. Permutation group. Homomorphism and Isomorphism of group. Normal and conjugate subgroups, Completeness and Kernel. Some special groups: SO(2), SO(3), SU(2), SU(3).

REFERENCES

Essential Readings

1) Vector Analysis and Cartesian Tensors, 3rd edition, D. E. Bourne, P. C. Kendall, 1992
2) Cartesian Tensors, H. Jeffreys, 1931, Cambridge University Press.
3) Mathematical Methods for Physicists, H. J. Weber and G. B. Arfken, 2010, Elsevier.
4) A Brief on Tensor Analysis, J. G. Simmonds, 1997, Springer.
5) Schaum's outlines series on Vector Analysis, M. Spiegel, 2nd edition, 2017.
6) Schaum's Outline Series on Tensor Calculus, D. Kay, Revised 1st edition, 2011.
7) An Introduction to Tensor Calculus and Relativity, D. F. Lawden, 2013, Literary Licensing
8) Matrices and tensors in physics by A. W. Joshi, 1995, New Age International Publications.
9) Group Theory and its Applications to Physical Problems, by Morton Hamermesh, Dover Publications (1989).
10) Elements of Group Theory for Physicists, by A. W. Joshi, John Wiley (1997).

Additional Readings

1) A Student's Guide to Vectors and Tensors, D. A. Fleisch, 2011, Cambridge Univ. Press.
2) The Feynman Lectures on Physics, Volume II, Feynman, Leighton and Sands, 2008, Narosa Publishing House.
3) A Primer in Tensor Analysis and Relativity, I. L. Shapiro, 1st edition, 2019, Springer.
4) Group Theory and Physics, S. Sternberg, Cambridge University Press (1994).
5) Group Theory and Quantum Mechanics, Michael Tinkham, Dover Publications (2003)