Course Type	Course Code	Name of Course	L	T	P	Credit
DE	NPHD509	Advanced Mathematical Methods in Physics	3	0	0	3

Prerequisite: Mathematical Physics

Course Objective
1. To familiarize the scholars with some of the sophisticated methods of mathematics to deal with problems and applications in physics;
2. To specialize and equip them with some mathematical tools ready to plan and confront challenges in advanced physical fields of research.
Learning Outcomes
After completing the course the scholars will be more comfortable with extra knowledge to treat theoretical and experimental problems in physics; they will be able to employ the mathematical tools like vector operators, polynomials, boundary value problems, differential equations, special functions, integral transforms, complex variable analysis, group theory and tensor analysis.

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	Vector spaces - Discrete and continuous: orthogonality, operator algebra, Hermitian and unitary operators, projection operators, Matrices , eigenvalue problems and applications in Physics. Differential equations. Boundary value problems, Orthogonal polynomials, Spherical harmonics.	9	Students will learn about vector space, operator algebra, matrix representation etc., and how to apply the knowledge in various areas of physics.
2	Addition theorem and multipole expansions, Integral transforms (e.g. Fourier, Laplace, etc.), Green's functions and applications to physics. Method of residues, poles and cuts in complex variables.	9	In this unit the learning of integral transformation and Green's function and complex analysis will help students to solve problems on Electrodynamics, Quantum Mechanics, etc.
3	Introduction, Generators of the continuous groups and discreet groups, Group representation: reducibility, equivalence, Schur's lemma. Lie groups and Lie algebras, SU(2) and SU(3).	9	Students will learn Group theory and how to apply this in Classical Mechanics, Quantum Mechanics, condensed matter and particle physics etc.
4	Representations of simple Lie algebras, SO(n), Lorentz group, applications to spectroscopy, condensed matter and particle physics etc.	6	Students will learn the Lie algebra, Lorentz group and their applications.
5	Introduction, tensor algebra (linear combinations, direct products, contraction, Raising and lowering indices) Tensor densities, Covariant differentiation, Invariant equations and applications to physics	9	Students will learn about tensors and its algebra to apply in physics problems.
Total		**42**	

Text Books:

1. Mathematical Methods for Physicists; Arfken, Weber (Academic Press)
2. Complex Variables; A. K. Kapoor (World Scientific)
3. Matrices and Tensors in Physics; A. W. Joshi (New age international)

Reference Books:

1. Mathematical Physics: A modern introduction to its foundations; Sadri Hassani (Springer)
2. Mathematical Methods in Classical and Quantum Physics; Tulsi Dass and S. K. Sharma (University Press)
3. Mathematical Methods of Physics; Mathews-Walker (Addison-Wesley)
4. Schaum's Outlines of Vector Analysis, 2ed; Murray R. Spiegel, Seymour Lipschutz and Dennis Spellman; McGraw Hill, 2017
5. Schaum's Outlines of Theory and Problems of Vector Analysis and an Introduction to Tensor Analysis; M. R. Spiegel (McGraw Hill)
6. Green Function and Boundary Value Problems; Stakgold, Wiley