

DISCIPLINE SPECIFIC ELECTIVE COURSE – PHYSICS DSE 16a: MATHEMATICAL PHYSICS II

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Mathematical Physics II PHYSICS DSE 16a	4	3	1	0	Class XII pass with Physics and Mathematics as main subjects	Mathematics as DSC course containing linear algebra and calculus

LEARNING OBJECTIVES

The emphasis of course is to equip students with the mathematical tools required in solving problem of interest to physicists. The mathematical tools might be building blocks to understand the fundamental computational physics skills and hence enable them to solve a wide range of physics problems. Overall, to help students develop critical skills and knowledge that will prepare them not only for doing fundamental and applied research but also prepare them for a wide variety of careers.

LEARNING OUTCOMES

After completing this course, student will be able to,

- Understand Complex Analysis
- Understand algebraic structures in n-dimension and basic properties of the linear vector spaces.
- Apply vector spaces and matrices in the quantum world.
- Learn Fourier Transforms (FTs)

SYLLABUS OF PHYSICS DSE 16a

THEORY COMPONENT

Unit – I (20 Hours)

Complex Analysis: Introduction to complex variables, Functions of Complex variable, limit, continuity, Analytic functions, Cauchy-Riemann equations, singular points, Cauchy Integral Theorem, Cauchy's Integral Formula, Residues, Cauchy's residue theorem, application of contour integration in solving real integrals.

Unit – II (15 Hours)

Linear Algebra: Linear Vector Spaces, Inner Product of Vectors and Norm of a Vector, Euclidean spaces, unitary spaces and inner product spaces. Properties of inner product spaces, Cauchy-Schwartz inequality, concept of length and distance, metric spaces. Orthogonality of vectors, orthonormal basis. Eigenvalue and Eigenvector, Adjoint of a linear operator, Hermitian or Self adjoint operators and their properties and Unitary Operators. Hilbert Space (Definition only).

Unit – III

(10 Hours)

Fourier Transforms (FTs): Fourier Integral Theorem. Sine and Cosine Transforms. Properties of FTs: (1) FTs of Derivatives of Functions, (2) Change of Scale Theorem, (3) FTs of Complex Conjugates of Functions, (4) Shifting Theorem, (5) Modulation Theorem, (6) Convolution Theorems, and (7) Parseval's Identity.

References:

Essential Readings:

- 1) Complex Variables and Applications, J. W. Brown and R. V. Churchill, 9th edition, 2021, Tata McGraw-Hill
- 2) Mathematical Tools for Physics, J. Nearing, 2010, Dover Publications
- 3) Theory and Problems of Linear Algebra, S. Lipschutz, 1987, McGraw-Hill Inc.
- 4) Mathematical Methods for Physicists, H. J. Weber and G. B. Arfken, 2010, Elsevier.
- 5) Introduction to Matrices & Linear Transformations, D. T. Finkbeiner, 1978, Dover Pub.
- 6) Matrices and tensors in Physics: A.W. Joshi, 2017, New Age International Pvt.
- 7) Mathematical Methods in the Physical Sciences, M. L. Boas, 3rd edition, 2007, Wiley India.
- 8) Advanced Engineering Mathematics, E. Kreyszig, 2008, Wiley India.

Additional Readings:

- 1) Elementary Linear Algebra, Applications Version, H. Anton and C. Rorres, Wiley Student edition.
- 2) Mathematics for Physicists, S. M. Lea, 2004, Thomson Brooks/Cole
- 3) An Introduction to Linear Algebra and Tensors, M. A. Akivis, V. V. Goldberg, Richard and Silverman, 2012, Dover Publications