Mathematical Physics - 1 - Web course

COURSE OUTLINE

The first course in Mathematical Physics generally introduces the basic mathematical tools that are commonly needed in different physics courses at the undergraduate (B. Tech and M. Sc) level.

Courses such as, Classical Mechanics, Electrodynamics, Quantum Mechanics, Statistical Mechanics, Solid State Physics, Nuclear physics require a certain amount of mathematical foundation to be able to understand the basic principles and carry the knowledge forward to be able to apply in different areas of research.

The course contains vector calculus in curvilinear coordinates, linear vector spaces, tensors and complex analysis. The topics will be complimented by many examples from different topics in Physics.

Contents:

Vectors:

Vector calculus, Gradient, Divergence and Curl in curvilinear coordinates applications to Classical mechanics and Electrodynamics.

Vector spaces:

Linear independence, bases, orthogonality and completeness, Gram- Schmidt orthogonalization, Hilbert space, linear operators, change of basis, similarity transformation, dual spaces, applications to quantum mechanics.

Matrices:

Matrix diagonalization, eigenvalues and eigenvectors, orthogonal and unitary matrices, Pauli matrices.

Delta function:

Dirac delta function, definitions and different representations of delta functions, applications to Electrodynamics.

Tensors:

Tensors in index notation, Kronecker and Levi Civita tensors, inner and outer products, contraction, symmetric and antisymmetric tensors, quotient law, metric tensors, covariant and contravariant tensors, simple applications to general theory of relativity and Klein-Gordon and Dirac equations in relativistic quantum mechanics.

Complex analysis:

Cauchy-Riemann conditions, analyticity, Cauchy-Goursat theorem, Cauchy's integral formula, branch points and branch cuts, multivalued functions, residue theorem, applications of residue theorem, Jordan's lemma, Taylor and Laurent series, singularities and convergence, Conformal mapping and applications.

COURSE DETAIL

Sl. No	Topic	No. of Hours
1.	Vector calculus, Gradient, Divergence and Curl in curvilinear coordinates applications to	06

NP-TEL

NPTEL

http://nptel.iitm.ac.in

Physics

Coordinators:

Dr. Saurabh Basu
Department of PhysicsIIT Guwahati

	Classical mechanics and Electrodynamics.	
2.	Linear independence, bases, orthogonality and completeness, Gram-Schmidt orthogonalization, Hilbert space, linear operators, change of basis, similarity transformation, dual spaces, applications to quantum mechanics.	08
3.	Matrix diagonalization, eigenvalues and eigenvectors, orthogonal and unitary matrices, Pauli matrices.	06
4.	Dirac delta function, definitions and different representations of delta functions, applications to Electrodynamics.	03
5.	Tensors in index notation, Kronecker and Levi Civita tensors, inner and outer products, contraction, symmetric and antisymmetric tensors, quotient law. Metric tensors, covariant and contravariant tensors, simple applications to general theory of relativity and Klein Gordon and Dirac equations in relativistic quantum mechanics	07
6.	Cauchy-Riemann conditions, analyticity, Cauchy-Goursat theorem Cauchy's integral formula, branch points and branch cuts, multivalued functions, residue theorem. Applications of residue theorem, Jordan's lemma, Taylor and Laurent series, singularities and convergence, Conformal mapping and applications.	10

References:

1. G.B. Arfken and H.J. Weber, *Mathematical methods for Physicists*, Academic Press (1995).
2. K.F. Riley, M.P. Hobson and S.J. Bence, *Mathematical Methods for Physics and Engineering*, Cambridge University Press (1998).
3. T. Lawson, *Linear Algebra*, John Wiley and Sons (1996).
4. R.V. Churchill. *Complex variables and applications*, Mcgraw Hill (1990).
5. A.W. Joshi, *Matrices and Tensors in Physics*, New Age (1995).