

MATHEMATICAL METHODS (2018)

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Course start date: August 6 (Monday)
Hours: 11:15 am – 12:30 pm (Monday)
9:30 am – 10:45 am (Thursday)
Office Hours: 10:30 am – 12:30 pm
(Tuesday and Friday)

Syllabus

1. Complex numbers and analysis (7 Lectures)

- a. Argand's diagram, complex algebra
- b. de Moivre's theorem and applications
- c. Functions of complex variables
 - i. Analytic functions, multi-valued functions, singularities and zeros
 - ii. Complex integration and series expansions
 - iii. Residue theorem and applications, Contour integration

2. Vectors, Matrices, and Tensors (8 Lectures)

- a. Vectors
 - i. Vector algebra, differentiation and integration
 - ii. Vector operators, gradient, divergence, curl
 - iii. Line, surface, and volume integrals
 - iv. Integral (Green's, Divergence, and Stokes) theorems and applications
- b. Matrix representations and operators
 - i. Notation, algebra and matrix operations, Special square matrices
 - ii. Change of basis, eigenvalues and eigenvectors
 - iii. Applications
- c. Tensors (Cartesian)
 - i. Notation and algebra, quotient law, Kronecker delta, Levi civita symbols

3. Orthogonal functions and Integral Transforms (8 Lectures)

- a. Orthogonal functions
 - i. Even, odd, orthogonal, and orthonormal functions
 - ii. Fourier series, expansion in terms of orthonormal functions
 - iii. Gram-Schmidt orthogonalization, Schwarz inequality
 - iv. Hermite, Legendre, and Laguerre polynomials and associate properties
- b. Fourier transforms
 - i. Definitions, Properties
 - ii. convolutions/deconvolutions
 - iii. Correlations functions, energy spectra
 - iv. Parseval's theorem
- c. Laplace transforms
 - i. Definitions and properties
 - ii. Transforms of derivatives and integrals

4. Differential Equations (13 Lectures)

- a. Ordinary differential equations (ODE) and elementary methods

- i. Classifications of equations, exact, inexact, linear, nonlinear, homogenous, nonhomogenous.
 - ii. Direct integration, separation of variables, integrating factors
- b. Higher order ODE and solutions
 - i. Linear equations with const coefficients,
 - ii. Linear equations with variable coefficients,
 - iii. Solutions using Laplace transforms
 - iv. Solutions using Greens functions
- c. Series solutions of ODE
 - i. Solutions about ordinary and singular points
 - ii. Wronskian and derivative methods
 - iii. Fuch`s theorem
- d. Eigenfunction methods
 - i. Operators:Adjoint, Hermitian and properties
 - ii. Sturm-Liouville equations
 - iii. Superposition of eigenfunctions
- e. Partial differential equations
 - i. Diffusion, Wave, Laplace, Poisson, and Schrodinger equations

Reference Books:

1. M. L. Boas, *Mathematical methods in physical sciences*, 3rd editions, Wiley-India (2006)
2. K. F. Riley, M. P. Hobson, S.J. Bence, *Mathematical methods for physics and gineering*, 3rd edition, Cambridge University Press (2002).

Grading:

Two exams with equal weight: Part-I in October and Part-II in December

Assignments every two weeks + in-class discussion

Grade distribution (50% for each part):

Assignments (10%) + in-class discussion (6 presentation + 4 participation=10%) + written exam (30%)