MATHEMATICAL METHODS (2021)

Instructor: Ravi Venkatramani
Email: ravi.venkatramani@tifr.res.in
Phone: 2278 2064 (off), 9503233302 (cell)
TA: Krishnakant Vishwakarma
Email: krishnatifr@gmail.com or krishna.vishwakarma@tifr.res.in

Course start date: March 15 (Monday)
Hours: 9:30 am – 11:00 am (Mon/Wed/Fri)

Office Hours: 5:00-7:00 pm Mon/Wed

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, contour integration, applications
        iv. Rouche`s theorem, argument principle and applications
2. **Vectors, Matrices, and Tensors (13 Lectures)**
    a. Vectors
        i. Vector algebra, differentiation and integration, Vector operators
        ii. Line, surface, and volume integrals Integral theorems and applications
    b. Matrix representations and operators
        i. Notation, algebra and matrix operations, special square matrices
        ii. Change of basis, eigenvalues and eigenvectors and applications
    c. Tensors (Cartesian)
        i. Notation and algebra, quotient law, special tensors
3. **Orthogonal functions and Integral Transforms (6 Lectures)**
    a. Orthogonal functions
        i. Generalized vector spaces
        ii. Even, odd, orthogonal, and orthonormal functions and expansions
        iii. Sturm-Liouville equations and their solutions
    b. Fourier series and transforms
        i. Definitions, expansions, and properties
        ii. convolutions/deconvolutions, correlations functions, energy spectra
4. **Differential Equations (8 Lectures)**
    a. Ordinary differential equations (ODE) and elementary methods
        i. Classifications of equations, Solution methods for first order ODE
    b. Higher order ODE and solutions
        i. Linear equations with const and variable coefficients,
        ii. Solutions using Laplace transforms and Green`s functions
    c. Series solutions of ODE
        i. Solutions about ordinary and singular points, Fuch`s theorem, Frobenius Method
    d. 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 engineering,* 3rd edition, Cambridge University Press (2002)

Grading:
Two exams with equal weight: Part-I in April/May and Part-II in June
Assignments every two weeks (first assignment March 22) + in-class discussion
Grade distribution (50% for each part)**:**
Assignments (10%) + in-class discussion (6 presentation + 4 participation=10%) + written exam (30%)