Indian Institute of Technology Kanpur

Department of Physics

Academic Year: 2021–22-I Semester

PHY 605A: Reviews of Mathematical Methods

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This course is *solely* intended for first-year PhD students joining IIT Kanpur from other Universities/Institutes. This course aims to develop problem-solving skills.

Broad topics that will be covered in this course are as follows:

- ♢ Eigenfunction methods for differential equations: Hermitian operators, Sturm-Liouville equations, eigenvalue problems, variation methods.
- ♢ Partial differential equations: general and particular solutions, Laplace and Poisson equations, wave equation, heat-flow or diffusion equation.
- ♢ Green's functions: definition and properties of Green's function, construction and uniqueness, generalized Green's function, problems in two- and three-dimensional systems, scattering problems.
- ♢ Complex analysis: Cauchy-Riemann conditions, conformal transformations, Cauchy integral theorem and formula, Taylor and Laurent series, calculus of residues, approximating integrals, saddle-point method, applications to physics problems.
- ♢ Elements of group theory: definition and examples of groups, group representations, finite groups, physical applications.
- ♢ Elements of probability and statistics: random variables and distributions, generating functions, discrete and continuous distributions, joint distributions, estimators and sampling distributions, maximum-likelihood method[†], method of least squares[†], hypothesis testing[†], applications to physics problems.

References: No textbook will be strictly followed. Below-listed books will be useful for the contents of the course:

1. Mathematical Methods for Physicists, G. B. Arfken, H. J. Weber and F. E. Harris, Academic Press.
2. Complex Variables and Applications, J. W. Brown and R. V. Churchill, McGraw-Hill.
3. Group Theory in a Nutshell for Physicists, A. Zee, Princeton University Press.

[†]time permitting.