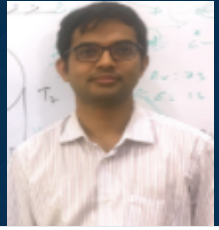

MATHEMATICAL METHODS IN PHYSICS 1

PROF.AUDITYA SHARMA

Department of Physics

IISER Bhopal

PRE-REQUISITES : We try to make this self-contained. However, some familiarity with the basic mathematical tools used in say, the first courses on Mechanics, Electromagnetism, would help.

INDUSTRIES APPLICABLE TO : Quantitative Finance and Scientific consulting companies

COURSE OUTLINE :

This would be the first of a two-part series on Mathematical Methods in Physics. The aim here is to provide a solid mathematical foundation for the budding Physicist eager to climb the ladder of self-learning. This course is designed to cater to an undergraduate student who excitedly embarks on a study of Physics, but is obstructed by the mathematics which appears so forbidding. The approach we will follow is one of showing many examples, and weaving the theory around examples. When possible, we will show how Mathematica can be used to offer extra insight.

ABOUT INSTRUCTOR :

Prof.Auditya Sharma: Got a B.Tech in Engineering Physics from IIT Madras in 2006, followed by a PhD in Physics with specialization in Statistical Physics from the University of California at Santa Cruz in 2011. He followed this with two postdoctoral stints: one at the International Institute of Physics, Natal, Brazil from 2011-2013, and another at Tel Aviv University, Israel from 2014-2015. He has been on the faculty in the Department of Physics at IISER Bhopal since 2015.

COURSE PLAN :

Week 1: Linear Algebra 1 : vectors, linear vector spaces, inner product, C-S inequality, linear independence, row-reduction

Week 2: Linear Algebra 2 : Matrices, determinants, span, basis, orthonormal basis, subspaces, linear operators.

Week 3: Linear Algebra 3: Direct sum, eigenvalues and eigenvectors, unitary, Hermitian, normal operators, transformations, defective matrices, diagonalization.

Week 4: Fourier Series and Transforms: periodic functions, series expansion, Fourier coefficients, Completeness relation, Fourier transforms.

Week 5: Ordinary Differential Equations 1: Introduction, Separable variables, orthogonal trajectories, linear first-order ODEs, Wronksian, exact ODEs, auxiliary equation.

Week 6: Ordinary Differential Equations 2: Inhomogeneous second order ODEs, method of undetermined coefficients, vibrations in mechanical systems, forced vibrations, resonance, linear superposition.

Week 7: Ordinary Differential Equations 3: Laplace transforms, Solving ODEs using Laplace transforms, Dirac Delta function.

Week 8: Ordinary Differential Equations 4: Green's function method, power series method, Frobenius method.