Mathematical Methods (Second Year) MT 2008

I. Linear Algebra

Part I.A: Vector spaces

Euclidean Linear Vector Spaces; Real vs Complex Vector Spaces; Dual Vectors and Scalar Product; Linear Independence; Dimension; Bases; Different Bases and Orthogonality.

Part I.B: Linear operators

Linear Operators; Matrices; Commutator; Functions of Operators; Matrix Representations of Linear Operators; Operations on Square Matrices; Change of Basis; Unitary and OrthogonalTransformations; Eigenvalues and Eigenvectors; Hermitian Matrices; Diagonalization of Hermitian Matrices; Jordan Normal Form; Simultaneous Diagonalization of Hermitian Matrices; Tensor Product of Vector Spaces.

II. Differential Equations

Part II.A: Ordinary differential equations

Difference Equations; Differential Equations as limits of Matrix Equations; Boundary Conditions and Eigenvalues; Green's Functions; Second order ODEs of Sturm-Liouville Type; Orthogonality of Eigenfunctions; Legendre's Equation; Hermite's Equation; Eigenfunction Expansions.

Part II.B: Partial differential equations

Examples; Initial Conditions; Boundary Conditions; Separation of Variables; Use of Cartesian, Spherical Polar and Cylinder Coordinates.

Part II.C: Fourier methods

Fourier Series; Fourier Transforms as Limit of Fourier Series; Inverse Transform; Dirac Delta Function; Parseval's Theorem; Convolution.

Recommended reading list

Comprehensive textbooks:

[1] K. Riley et al.: Mathematical Methods for Physicists and Engineers, CUP
[2] G. Arfken and H.J. Weber: Mathematical Methods for Physicists, Elsevier
[3] P. Dennery and A. Krzywicki: Mathematics for Physicists, Dover
[4] R. Courant and D. Hilbert: Methods of Mathematical Physics, Interscience

Lecture notes:

[5] F. Essler, Lectures Notes on Mathematical Methods, Oxford 2006

Linear algebra:

[6] S. Lang: Linear Algebra, Springer

Differential equations:

[7] M. Boas: Mathematical Methods in the Physical Sciences
[8] G. Stephenson: Partial Differential Equations for Science Students