OUTLINE OF TOPICS PY501 (Fall 2012)

Instructor: Pankaj Mehta (323 SCI, pankajm@bu.edu)

I. Integration (12-14 lectures)

A) Elementary properties of complex functions

1) Cauchy-Riemann equations
2) Complex integration – Cauchy's theorem and formula
3) Laurent expansions
4) Singularities of complex functions
   –poles, branch points, and essential singularities

B) Calculus of Residues

1) Basic theoretical considerations
2) Applications
   –contour integration; rational and exponential integrals
   –summation of series
   –evaluation of power-series coefficients

C) Conformal Mapping

1) Basic theoretical considerations
   –bilinear, transcendental, and trigonometric maps
2) Applications to solutions of Laplace's equation
   –wedge, strip, rectangular, and circular geometries

D) Asymptotic Expansion of Integrals

1) Integration by parts
2) Saddle-point approximation & Gaussian integrals
3) Laplace's method
4) Stationary phase approximation
5) Method of steepest descent in the complex plane

II Dynamical Systems (10-12 lectures)

Chapters 1-8 of *Nonlinear Dynamics And Chaos* by Strogatz.

III . Partial Differential Equations (10-12 lectures)

A) Partial Differential Equations

1) Solution of first-order equations by method of characteristics
2) Classification of solutions for second-order equations
   –canonical forms of second-order equations
   –discrete equation analog and stability analysis
3) Separation of variables
   –solutions to the Helmholtz equation in various geometries
4) Green's functions for inhomogeneous equations
   (a) construction of Green's functions for initial value problems
   Green's function for the diffusion and wave equation

(b) Green's functions in bounded domains

(c) Green's functions by eigenfunction expansions

(d) Theory of Green's functions for arbitrary boundary conditions

B) Maxwell's equations in a vaccuum