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Differential Equations for Chemists

Dr. Josephine Shamash

Syllabus

Fall 2022

1. Complex numbers, convergence of complex sequences and series, complex analytic functions, in particular the exponential function.

Ordinary Differential Equations

2. First order ordinary differential equations: Approximating solutions with direction fields. Linear equations, separable equations, autonomous equations, integration factors. Modelling with first order equations, equilibrium solutions. Existence and uniqueness theorem for first order ODEs.
   Special cases of second order ODEs.

3. Homogeneous linear differential equations of order *n* with constant coefficients. Non-homogeneous linear differential equations: solving by the method of undetermined coefficients. Applications of results on second order linear homogeneous ODEs to mechanical and electrical vibrations.

4. Introduction to systems of first order linear differential equations.
   Review of linear algebra: Systems of linear algebraic equations, Gaussian elimination, Gauss-Seidel method for inverting matrices, Vector spaces. Eigenvalues and eigenvectors. Approximating solutions to first order linear differential equations with the phase plane.

5. Homogenous systems of first order linear differential equations with constant coefficients. Applications to models: concentration of solutions etc. Two-point boundary value problems, eigenvalue problems.

Partial Differential Equations

6. Fourier series. Series solutions to differential equations.

7. Solution to the heat equation on a finite rod by separation of variables. Other heat conduction problems with non-homogeneous boundary conditions. Green's functions solutions for PDEs: the heat equation on an infinite rod.

8. The wave equation: vibrations of an elastic string and other models. Series solutions using separation of variables. The D'Alembert solution to the wave equation.

9. The 2-dimensional heat equation (the Laplace equation) on a rectangle.

Bibliography:

Arfken: Mathematical Methods for Physicists
Boas: Mathematical Methods in the Physical Sciences
Boyce and di Prima: Elementary differential equations and Boundary value problems, 7th edition.
Edwards and Penney: Elementary differential equations with Boundary value problems.
Mathews and Walker: Mathematical Methods of Physics
Riley, Hobson and Bence: Mathematical Methods for Physics and Engineering

Assignments: 20% of final grade. (Most assignments taken from Boyce and di Prima)
Final exam: 80% of final grade.