MATH 316 – GENERAL SYLLABUS

Texts:  Boyce and DiPrima (BD) Differential Equations (required)
        Polking and Arnold(PA) Ordinary Differential Equations using Matlab (optional)

Course Outline:

Beginning Week 1: Introduction.
- Classification of DEs.
- Mathematical models, dimensions and units, solutions to ODEs.
  See Sections 1.1,1.3 in BD

Weeks 1-3: First order equations $\frac{dy}{dx} = f(x,y)$. Here the emphasis is on geometry,
solution techniques and numerical approximations.
- Direction fields, solution curves, integral curves, some theory (do solution curves
touch?), long time behaviour.
- Autonomous equations $\frac{dy}{dx} = f(y)$, phase line, equilibria and stability.
- Separable equations $\frac{dy}{dx} = f(x)g(y)$
- Linear equations $y' + p(x)y = g(x)$: integrating factors, variation of parameter
- Theory: existence and uniqueness of solutions, linear vs nonlinear.
  See Sections 1.2, 2.1-2.5,2.7-2.8 in BD

Week 4: EXAM 1

Weeks 4-5: Homogeneous Second Order Equations $ay'' + by' + cy = 0$.
- Constant coefficient homogeneous
- Enough theory to argue that the general solution in the homogeneous case is a
  linear combination of two LI solutions
  See Sections 3.1-3.4 in BD.

Weeks 6-7: Nonhomogeneous Second Order Equations $ay'' + by' + cy = g(t)$.
- General solution = G.S. of homogeneous plus any particular solution
- Method of Undetermined Coefficients
- Variation of Parameters - Main point it always works, but more complicated
  than UC
- Harmonic and forced harmonic motion
  See Sections 3.5-3.8 in BD

Week 8: EXAM 2
**Weeks 8-9: Laplace Transform**

See Chapter 5 in BD

**Weeks 10-11: Linear autonomous systems (2x2 case):** $x' = ax + by; y' = cx + dy.$
- Matrix formulation and elementary matrix manipulations
- Eigenproblem and general solution
- Enough theory to argue that the general solution (i.e., the set of all solutions) is a linear combination of two linearly independent solutions
- Phase Plane

Most of Chapter 7 in BD.

**Week 12: EXAM 3**

**Weeks 13-14: Nonlinear autonomous systems:** $x' = f(x, y); y' = g(x, y)$.
- Equilibrium solutions and stability
- Linearization about equilibria
- Phase plane portraits
- Examples: predator prey models, competing species, pendulum.
- Conservative systems $x'' + g(x) = 0$ and the energy method

See Sections 9.1-9.5 in BD. Handout on conservative systems.

**Week 15: Catch-up and Review**

**Finals Week: FINAL EXAM**