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
- Euler method. A 2nd order Runge-Kutta method.
- 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**