

## Differential Equations PhD Qualifying Exam Syllabus

### References:

*Elementary Differential Equations* by Boyce and DiPrima.

*Nonlinear Dynamics and Chaos* (5th edition) by Steve Strogatz.

*Partial Differential Equations—Theory and Technique* by Carrier and Pearson.

*Applied Partial Differential Equations* by Richard Haberman.

### 230/330 Topics:

- General solution of first-order equations
- Second-order linear equations. Wronskian. Linear independence of solutions. Basis for the solution space.
- Systems of linear differential equations. Convert a higher-order equation to a system of first-order equations in vector form.
- Inhomogeneous equations. Variation of parameters.
- Classification of singularities. Critical points.
- Phase plane analysis of dynamical systems. Classification of fixed (critical points)
- Bifurcation theory. One and two dimensional bifurcations. Hopf bifurcations.
- Multiple-scale perturbation theory. Applications to weakly nonlinear oscillators.

### 339 Topics:

- Elliptic, parabolic, and hyperbolic partial differential equations.
- The classical equations: heat equation, wave equation, Laplace equation. Harmonic functions.
- Separation of variables. Fourier series expansions. Sturm-Liouville theory. Eigenfunction expansion.
- D'Alembert's solution. Method of characteristics.
- The Dirichlet, Cauchy, and Neumann problems. Well-posedness.
- Laplace transform. Fourier transform. Green's functions.