Announcement: Final Exam

- Monday 12/19 between 5:15pm and 7:45pm, Harriman Hall 116
- Final exam will be **accumulative** covering all the material from the semester
- About 50–60% will be on material after Test 2
- As usual, you can have a **single-sided, one-page, letter-size** (8.5inx11in) cheat sheet
Topics Covered in The Course

- Theory and analytical methods for linear ODEs
  - linear differential equations
    - homogeneous or inhomogeneous
    - constant coefficients or variable coefficients
  - systems of linear differential equations
  - existence and uniqueness of IVPs

- More advanced topics
  - Green’s functions; special classes of nonlinear ODEs
  - BVPs; eigenvalue problems, Sturm-Liouville theory
  - Singularities, power series methods, and approximate solutions
Basic Concepts and Techniques

- **Linear differential equations**
  - Linear dependence of functions; Wronskian; principle of superposition of homogeneous equations; general solutions
  - Separation of variables (separable equations)
  - Integrating factor for linear first-order equations
  - Characteristic equations for linear equations with constant coefficients
  - Inhomogeneous linear equations: method of undetermined coefficients; variation of parameters; Green’s functions

- **Systems of linear differential equations**
  - Fundamental matrix; matrix exponential
  - Systems of linear differential equations: eigenvalue method; generalized eigenvectors
  - Solutions of nonhomogeneous systems of linear differential equations: method of undetermined coefficients; variation of parameters
Nonlinear Differential Equations and Boundary Value Problems

- First-order nonlinear differential equations
  - Bernoulli equations and Riccati equations
  - Exact equations; autonomous equations

- Endpoint problems and eigenvalues
  - Boundary value problems; eigenvalue problem
  - Sturm-Liouville problems; Sturm-Liouville eigenvalues; eigenfunction expansions
Singularities and Approximate Methods

- Classification of singular points of linear equations (ordinary points, regular singular points, and irregular singular points)
- Taylor series solutions for local analysis near ordinary points
- Methods of Fuchs and Frobenius; exceptional cases with integral differences
- Bessel’s equations and Bessel’s functions
- Local behavior at irregular singular points; asymptotic series solution; method of dominant balance
- Local analysis of inhomogeneous linear equations