Math 302–303: Introduction to Differential Equations I & II (3–3)

Catalog descriptions:

Math 302: First order ordinary differential equations, constant coefficient linear equations, oscillations, Laplace transform, convolution, Green's function.

Pre: Math 216 or 243 (or concurrent) or 253A (or concurrent) or consent.

Math 303: Constant coefficient linear systems, variable coefficient ordinary differential equations, series solutions and special functions, Fourier series, partial differential equations.

Pre: 302, 311 (or concurrent), or consent.

Recent choices of textbooks:

W. E. Boyce and R. C. DiPrima, *Elementary Differential Equations and Boundary Value Problems*, Wiley Pub.

S. J. Farlow, *An Introduction to Differential Equations and their Applications*, Dover Pub.

E. A. Coddington, *An Introduction to Ordinary Differential Equations*, Dover Pub.

J. Lebl, *Notes on Diffy Qs: Differential Equations for Engineers*, free online book.

Topics for Math 302:

1. Introduction. Definitions of order and linearity. Basic examples, such as exponential growth and decay. Direction fields.
2. First order differential equations. Linear equations and integrating factors. Separable equations. Applications such as mixing problems, population growth, radioactive decay, etc. Existence and uniqueness theorems. Autonomous equations and stability of equilibrium solutions. Exact equations. Euler's Method.
3. Second order linear equations. Homogeneous equations with constant coefficients. General results on existence and uniqueness of solutions, linear independence and the Wronskian. Reduction of order. Finding particular solutions of nonhomogeneous equations by the method of undetermined coefficients and variation of parameters. Applications such as mechanical vibrations and R–L–C circuits.
4. A brief introduction to higher order linear equations.
5. The Laplace transform. Definition and basic properties. Solving initial value problems. Unit step functions, piecewise continuous functions, and impulses. Convolution.
6. Introduction to series solutions of second order linear equations. Review of power series. Series solutions near an ordinary point, with examples such as Airy's equation, Legendre's equation, etc.

Topics for Math 303:

1. Series solutions of second order linear equations, Euler equations, singular theory.
2. Systems of first order equations. Existence and uniqueness theorems. Relation to single higher order equations. Review of eigenvalues, eigenvectors, and inverse matrices. Solving linear systems with constant coefficients by matrix methods.
3. Non–linear equations. Equilibrium points and phase plane diagrams. Examples such as predator–pray equation.
4. Introduction to boundary value problems. Fourier series. The heat equation on a finite rod.
5. Introduction to Sturm Liouville boundary value problems.

Course Objectives and Student Learning Outcomes:

Upon successful completion of these courses the student will:
- Have an understanding of the basic methods of solving ordinary differential equations.
- Have an understanding of where and how differential equations are applied in other sciences.

Program objectives:

The need to solve differential equations motivated the development of calculus. The mathematical formulations of many problems in the sciences (Physics, Chemistry, Engineering, Life Sciences, and more) are as differential equations. In this junior level course sequence students learn this important mathematical subject, and they learn how to apply mathematics to other fields.