Spring 2024

MATH 302
INTRODUCTION TO DIFFERENTIAL EQUATIONS (3)

Catalog description. First order ordinary differential equations, constant coefficient linear equations, oscillations, Laplace transform, convolution, Green's function.

Prerequisites. Math 216 or 243 (or concurrent) or 253A (or concurrent) or consent.

Recent choices of textbook. 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.

(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.

Course Objectives and Student Learning Outcomes. Upon successful completion of these courses the student will:

(1) Have an understanding of the basic methods of solving ordinary differential equations.
(2) 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.

Sample week-by-week plan.

Week 1	Definition of solutions to and classification of differential equations
Week 2	Method of integrating factors and separable differential equations
Week 3	First order differential equations and autonomous differential equations with applications to population dynamics modelling
Week 4	Exact differential equations and integrating factors for non-exact differential equations; euler's method; existence and uniqueness theorem
Week 5	Homogeneous differential equations with constant coefficients
Week 6	Solutions of linear homogeneous equations; the Wronskian; complex roots of the characteristic equation; repeated roots; reduction of order
Week 7	Nonhomogeneous equations; method of undetermined coefficients
Week 8	Variation of parameters;mechanical and electrical vibrations; general theory of higher order linear differential equations
Week 9	Homogeneous differential equations with constant coefficients;the method of undetermined coefficients
Week 10	Definition of the Laplace transform; solution of initial value problems; step functions
Week 11	Differential equations with discontinuous forcing functions
Week 12	Impulse functions; the convolution integral
Week 13	Review of power series
Week 14-15	Series solutions near an ordinary point