MATH 2A: DIFFERENTIAL EQUATIONS

Foothill College Course Outline of Record

Heading	Value
Effective Term:	Summer 2024
Units:	5
Hours:	5 lecture per week (60 total per quarter)
Prerequisite:	MATH 1C.
Advisory:	Demonstrated proficiency in English by placement via multiple measures OR through an equivalent placement process OR completion of ESLL 125 & ESLL 249; not open to students with credit in MATH 12A.
Degree & Credit Status:	Degree-Applicable Credit Course
Foothill GE:	Non-GE
Transferable:	CSU/UC
Grade Type:	Letter Grade (Request for Pass/No Pass)
Repeatability:	Not Repeatable

Student Learning Outcomes

- Students will demonstrate the ability to solve differential equations and verify their solutions analytically, numerically, graphically, and qualitatively.
- Students will develop conceptual understanding of mathematical modeling of continuous processes and their rates of change. They will learn to demonstrate and communicate this understanding in a variety of ways, such as: reasoning with definitions and theorems, connecting concepts, and connecting multiple representations, as appropriate.
- Students will model continuous processes using differential equations and use the model to answer related questions.

Description

Differential equations and selected topics of mathematical analysis.

Course Objectives

The student will be able to:

1. Classify differential equations by order, linearity, separability, exactness, coefficient functions, homogeneity, type of any nonhomogeneities, and other qualities.
2. Identify appropriate analytic, numerical, and graphical techniques for solving or approximating solutions to differential equations of the particular classes specified in the expanded description of course content.
3. Solve differential equations with appropriate analytic techniques.
4. Approximate solutions to differential equations with appropriate numeric techniques.
5. Investigate solutions to differential equations with appropriate graphical techniques.
6. Verify solutions to differential equations analytically, numerically, graphically, and qualitatively.
7. Write differential equations and initial value problems to model phenomena in the physical, life, and social sciences.
8. Interpret solutions to differential equations and initial value problems in context.
9. Discuss differential equations and their solutions in accurate mathematical language and notation.
10. Investigate solutions to differential equations using at least one numerical or graphing utility.

Course Content

1. Classes of differential equations
    a. First order
        i. Separable
        ii. Linear
        iii. Exact
    b. Second order
        i. Linear
        ii. Constant coefficient
        iii. Polynomial coefficient
    c. Higher-order linear
    d. Autonomous
    e. Homogeneous
    f. Nonhomogeneous
        i. Polynomial
        ii. Exponential
        iii. Sinusoid
        iv. Other continuous functions
        v. Discontinuous functions
        vi. Impulses
2. Initial value problems
    a. Existence and uniqueness theorem
        i. Applications
3. Classes of solutions
    a. General solution
    b. n-parameter family of solutions
    c. Particular solution
    d. Unique solution
    e. Equilibrium solution
    f. Linearly independent solutions with Wronskian
4. Systems of linear differential equations
5. Techniques for solving differential equations
    a. Separation of variables
    b. Integrating factor
    c. Total differential
    d. Characteristic equations
        i. Distinct real roots
        ii. Repeated real roots
        iii. Complex roots
        iv. Fundamental solutions
    e. Superposition principle
    f. Undetermined coefficients
    g. Variation of parameters

   h. Annihilator method
   i. Reduction of order
   j. Laplace transforms
   k. Power series
   l. Method of Frobenius
   m. Matrix methods
6. Approximation of solution
   a. Numerical approximation
      i. Euler's method
      ii. Improved Euler's method
   b. Graphical approximation
      i. Direction field
      ii. Phase line
      iii. Phase plane
7. Applications selected from the following topics:
   a. Population models
      i. Predator-prey models
      ii. Thresholds and carrying capacities
   b. Growth and decay
   c. Mixing problems
   d. Spring-mass systems
      i. Undamped
      ii. Damped
   e. Electrical circuits
      i. Inductor-capacitor
      ii. Resistor-inductor-capacitor
   f. Newton's laws
      i. Falling bodies
      ii. Pendulums
      iii. Cooling
   g. Orthogonal trajectories
   h. Torricelli's law
   i. Financial applications
      i. Compound interest
      ii. Time value of money
      iii. Annuities
   j. Communication models
      i. Spread of a rumor
      ii. Mass marketing
   k. Public health models
      i. Epidemics
      ii. Health care utilization

Lab Content

Not applicable.

Special Facilities and/or Equipment

1. Access to graphing technology, such as a graphing calculator or graphing software.
2. When taught online/hybrid: students need internet access and access to course management system and specific software related to the course.

Method(s) of Evaluation

Methods of Evaluation may include but are not limited to the following:

Homework
Class participation
Term paper(s)
Presentation(s)
Computer lab assignment(s)
Term project
Quizzes
Unit exam(s)
Proctored comprehensive final examination

Method(s) of Instruction

Methods of Instruction may include but are not limited to the following:

Lecture
Discussion
Cooperative learning exercises

Representative Text(s) and Other Materials

Nagle R., E. Saff, and D. Snyder. Fundamentals of Differential Equations, 9th ed.. 2018.

Boyce W., R. DiPrima, and D. Meade. Elementary Differential Equations, 11th ed.. 2017.

These texts are the most recent editions available; we will adopt the next edition of each as it becomes available.

Types and/or Examples of Required Reading, Writing, and Outside of Class Assignments

1. Homework problems covering subject matter from text and related material ranging from 15-30 problems per week. Students will need to employ critical thinking in order to complete assignments
2. Five hours per week of lecture covering subject matter from text and related material. Reading and study of the textbook, related materials, and notes
3. Student projects covering subject matter from textbook and related materials. Projects will require students to discuss mathematical problems, write solutions in accurate mathematical language and notation, and interpret mathematical solutions. Projects may require the use of a computer algebra system such as Mathematica or MATLAB
4. Worksheets: Problems and activities covering the subject matter. Such problems and activities will require students to think critically. Such worksheets may be completed inside and/or outside of class

Discipline(s)

Mathematics