

# MATH 2A: DIFFERENTIAL EQUATIONS

## Foothill College Course Outline of Record

Heading	Value
<b>Units:</b>	5
<b>Hours:</b>	5 lecture per week (60 total per quarter)
<b>Prerequisite:</b>	MATH 1C.
<b>Advisory:</b>	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.
<b>Degree &amp; Credit Status:</b>	Degree-Applicable Credit Course
<b>Foothill GE:</b>	Non-GE
<b>Transferable:</b>	CSU/UC
<b>Grade Type:</b>	Letter Grade (Request for Pass/No Pass)
<b>Repeatability:</b>	Not Repeatable

## Student Learning Outcomes

- Students will model continuous processes using differential equations and use the model to answer related questions.
- 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 demonstrate the ability to solve differential equations and verify their solutions analytically, numerically, graphically, and qualitatively.

## Description

Differential equations and selected topics of mathematical analysis.

## Course Objectives

The student will be able to:

- Classify differential equations by order, linearity, separability, exactness, coefficient functions, homogeneity, type of any nonhomogeneities, and other qualities.
- 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.
- Solve differential equations with appropriate analytic techniques.
- Approximate solutions to differential equations with appropriate numeric techniques.
- Investigate solutions to differential equations with appropriate graphical techniques.
- Verify solutions to differential equations analytically, numerically, graphically, and qualitatively.

- Write differential equations and initial value problems to model phenomena in the physical, life, and social sciences.
- Interpret solutions to differential equations and initial value problems in context.
- Discuss differential equations and their solutions in accurate mathematical language and notation.
- Investigate solutions to differential equations using at least one numerical or graphing utility.

## Course Content

- Classes of differential equations
  - First order
    - Separable
    - Linear
    - Exact
  - Second order
    - Linear
    - Constant coefficient
    - Polynomial coefficient
  - Higher-order linear
  - Autonomous
  - Homogeneous
  - Nonhomogeneous
    - Polynomial
    - Exponential
    - Sinusoid
    - Other continuous functions
    - Discontinuous functions
    - Impulses
- Initial value problems
  - Existence and uniqueness theorem
    - Applications
- Classes of solutions
  - General solution
  - n-parameter family of solutions
  - Particular solution
  - Unique solution
  - Equilibrium solution
  - Linearly independent solutions with Wronskian
- Systems of linear differential equations
- Techniques for solving differential equations
  - Separation of variables
  - Integrating factor
  - Total differential
  - Characteristic equations
    - Distinct real roots
    - Repeated real roots
    - Complex roots
    - Fundamental solutions
    - Superposition principle
    - Undetermined coefficients
    - Variation of parameters
    - Annihilator method
    - Reduction of order
    - Laplace transforms
    - Power series
    - Method of Frobenius
    - Matrix methods
- Approximation of solution
  - Numerical approximation
    - Euler's method

- b. Improved Euler's method
- 2. Graphical approximation
  - a. Direction field
  - b. Phase line
  - c. Phase plane
- G. Applications selected from the following topics:
  - 1. Population models
    - a. Predator-prey models
    - b. Thresholds and carrying capacities
  - 2. Growth and decay
  - 3. Mixing problems
  - 4. Spring-mass systems
    - a. Undamped
    - b. Damped
  - 5. Electrical circuits
    - a. Inductor-capacitor
    - b. Resistor-inductor-capacitor
  - 6. Newton's laws
    - a. Falling bodies
    - b. Pendulums
    - c. Cooling
  - 7. Orthogonal trajectories
  - 8. Torricelli's law
  - 9. Financial applications
    - a. Compound interest
    - b. Time value of money
    - c. Annuities
  - 10. Communication models
    - a. Spread of a rumor
    - b. Mass marketing
  - 11. Public health models
    - a. Epidemics
    - b. Health care utilization

## Lab Content

Not applicable.

## Special Facilities and/or Equipment

Access to graphing technology, such as a graphing calculator or graphing software.

## Method(s) of Evaluation

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

- A. Homework
- B. Class Participation
- C. Term Paper(s)
- D. Presentation(s)
- E. Computer Lab Assignment(s)
- F. Term Project
- G. Quizzes
- H. Unit Exam(s)
- I. Proctored Comprehensive Final Examination

## Method(s) of Instruction

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

- A. Lecture

- B. Discussion
- C. Cooperative learning exercises

## Representative Text(s) and Other Materials

Nagle R., E. Saff, and D. Snyder. Fundamentals of Differential Equations. 9th ed. Pearson, 2017.

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

- A. 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.
- B. Five hours per week of lecture covering subject matter from text and related material. Reading and study of the textbook, related materials and notes.
- C. 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.
- D. 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