



COURSE OUTLINE

Course Number	Course Title	Credits
MAT252	Differential Equations	4
Hours: lecture/Lab/Other	Co- or Pre-requisite	Implementation sem/year
4 lecture hours	MAT152 or equivalent course with a minimum C grade or appropriate College Level Math placement test score and consultation with the mathematics chair or course coordinator.	Spring 2009

Catalog description (2006-2009 Catalog): Topics covered include solutions of ordinary differential equations including existence and uniqueness theorems, qualitative, numerical, and analytical methods of equations of first and second order, Cauchy-Euler equations, solutions by infinite series, systems of equations, and applications to modeling.

Is course New, Revised, or Modified? Modified Spring 2009

Required texts/other materials:

A First Course in Differential Equations: The Classic Fifth Edition
Dennis G. Zill
Brooks/Cole

Revision date:

Spring 2009

Course coordinators:

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Information resources: The Mercer County Community College Library has reference books available. There are many reference websites to which students may be referred. Students are also encouraged to utilize the Learning Centers for additional resources and/or tutoring. *MATLAB* is available for instructors to use for demonstration, or one class per week may be scheduled in AD234 if it is to be used more extensively throughout the course.

Course Competencies/Goals:

Students will demonstrate through quizzes, examinations, homework, and projects the ability to:

1. Identify and classify various types of differential equations.
2. Find general and particular solutions of first order linear differential equations by qualitative, numerical, and analytical methods, which include separation of variables, homogeneous equations, exact equations, integrating factor, and Bernoulli methods.
3. Determine whether unique solutions are guaranteed to exist.
4. Create and solve equations that model physical problems using appropriate methods.
5. Find general and particular solutions of second order linear differential equations by various methods, which include reduction of order, undetermined coefficients, variation of parameters, and solutions by series.
6. Define and use Laplace transforms to solve differential equations.
7. Solve systems of first order linear equations using differential operator, Laplace transform, and matrix methods including finding eigenvalues and eigenvectors and interpreting solutions of linear systems.
8. Use Euler's method to find numerical solutions of first order initial value problems.
9. Develop and interpret slope fields for differential equations.
10. Use technology to solve differential equations and systems numerically and visualize, interpret, and communicate the results.

Course-specific General Education Knowledge Goals and Core Skills:**General Education Knowledge Goals**

Goal 1. Communication. Students will communicate effectively in both speech and writing.

Goal 2. Mathematics. Students will use appropriate mathematical and statistical concepts and operations to interpret data and to solve problems.

Goal 4. Technology. Students will use computer systems or other appropriate forms of technology to achieve educational and personal goals.

MCCC Core Skills

Goal A. Written and Oral Communication in English. Students will communicate effectively in speech and writing, and demonstrate proficiency in reading.

Goal B. Critical Thinking and Problem-solving. Students will use critical thinking and problem solving skills in analyzing information.

Goal D. Information Literacy. Students will recognize when information is needed and have the knowledge and skills to locate, evaluate, and effectively use information for college level work.

Goal E. Computer Literacy. Students will use computers to access, analyze or present information, solve problems, and communicate with others.

Units of study in detail:**I. Introduction to Differential Equations****(1 week)**

At the end of Unit I, the student will be able to:

- Classify differential equations. (Course Goal 1; Gen Ed Goal 2; Core Skill B)
- Verify that a function is a solution to a differential equation or an initial value problem. (Course Goal 1; Gen Ed Goal 2; Core Skill B)
- Use phase line analysis to find equilibrium solutions of autonomous first-order differential equations, determine their stability, and determine the general behavior of other solutions. (Course Goals 1,2,10; Gen Ed Goals 1,2,4; Core Skills A,B,D,E)
- Create, both by hand and using software, and use slope fields to sketch solution curves for first order differential equations. (Course Goals 2,9,10; Gen Ed Goals 1,2,4; Core Skills A,B,E)
- Use Euler's method to find numerical solutions to differential equations and describe the change in error based on the change in step size. (Course Goals 1,2,8,10; Gen Ed Goals 1,2,4; Core Skills A,B,D,E)

II. First-Order Differential Equations**(3.5 weeks)**

At the end of Unit II, the student will be able to:

- State and use the existence and uniqueness theorem for first order initial value problems. (Course Goals 1,3; Gen Ed Goal 2; Core Skill B)
- Apply Picard's Theorem to determine if a first-order initial value problem has a unique solution. (Course Goals 1,3; Gen Ed Goal 2; Core Skill B)
- Use the techniques of separation of variables, homogeneous equations, exact equations, integrating factor, and Bernoulli to solve differential equations. (Course Goals 1,2,3; Gen Ed Goals 1,2,4; Core Skills A,B,E)
- Derive and solve differential equations that model motion in one direction, mixtures, and population growth. (Course Goals 2,4; Gen Ed 1,2,4; Core Skills A,B,D,E)
- Determine if two families of curves are orthogonal trajectories of one another and find the orthogonal trajectory of a given family of curves. (Course Goals 2,10; Gen Ed Goals 1,2,4; Core Skills B,E)

III. Linear Differential Equations of Higher Order**(3 weeks)**

At the end of Unit III, the student will be able to:

- State and interpret the existence and uniqueness theorem for linear higher order initial value problems. (Course Goals 1,3; Gen Ed Goals 1,2,4; Core Skills B)
- Find the Wronskian of a list of functions and use it to determine if the functions are linearly independent. (Course Goals 1,3; Gen Ed Goals 1,2; Core Skills A,B)
- Verify that a two-parameter family of functions is a general solution to a nonhomogeneous differential equation. (Course Goals 1,5; Gen Ed Goals 1,2; Core Skills A,B)
- Construct a second solution to a differential equation from a given solution. (Course Goals 1,5; Gen Ed Goals 1,2; Core Skills A,B)

- Use the characteristic equation to determine the complimentary solution to a homogeneous linear differential equation with constant coefficients. (Course Goals 1,5; Gen Ed Goals 1,2; Core Skills A,B)
- Find the general solution to a homogeneous linear differential equation with constant coefficients. (Course Goals 1,5; Gen Ed Goals 1,2; Core Skills A,B)
- Solve a second order differential equation by the method of undetermined coefficients. (Course Goals 1,5; Gen Ed Goals 1,2; Core Skills A,B)
- Apply the method of variation of parameters to solve linear non-homogeneous differential equations with variable coefficients. (Course Goals 1,5; Gen Ed Goals 1,2; Core Skills A,B)

IV. Laplace Transforms

(2 weeks)

At the end of Unit IV, the student will be able to:

- Define the Laplace transform. (Course Goals 1,6; Gen Ed Goals 1,2; Core Skills A,B)
- Calculate the Laplace transform and inverse transform of given functions. (Course Goals 1,6; Gen Ed Goals 1,2; Core Skills A,B)
- Use the Laplace translation theorems and Laplace transforms of derivatives to solve n th order linear differential equations with constant coefficients which have initial conditions. (Course Goals 1,6; Gen Ed Goals 1,2; Core Skills A,B)
- Use Laplace transforms to solve integral equations. (Course Goals 1,6; Gen Ed Goals 1,2; Core Skills A,B)
- Apply appropriate methods to problems involving step functions, discontinuous forcing functions, and impulse functions and other applied problems (Course Goals 1,4,6; Gen Ed Goals 1,2,4; Core Skills A,B,D,E)

V. Differential Equations with Variable Coefficients and Applications (extent of coverage determined by instructor)

(2.5 weeks)

At the end of Unit V, the student will be able to:

- Recognize and solve Cauchy-Euler differential equations. (Course Goals 1,5; Gen Ed Goals 1,2; Core Skills A,B)
- Use power series techniques to solve differential equations around ordinary points and regular singular points. (Course Goals 1,5,10; Gen Ed Goals 1,2,4; Core Skill A,B,D,E)
- Integrate theory, skills and technology to solve problems involving harmonic oscillators, electric circuits, and other applications. (Course Goals 1,4,10; Gen Ed Goals 1,2,4; Core Skills A,B,D,E)

VI. Systems of Linear Differential Equations

(3 weeks)

At the end of Unit VI, the student will be able to:

- Create the matrix form of a corresponding system of differential equations. (Course Goals 1,4; Gen Ed Goals 1,2; Core Skills A,B)
- Calculate solutions to systems of differential equations by the differential operator and Laplace transform methods. (Course Goals 1,7; Gen Ed Goals 1,2; Core Skills A,B)

- Calculate eigenvalues and eigenvectors of a matrix. (Course Goals 1,7,10; Gen Ed Goals 1,2,4; Core Skills A,B,E)
- Solve systems of differential equations using eigenvalues and eigenvectors and the method of variations of parameters. (Course Goals 1,7,10; Gen Ed Goals 1,2,4; Core Skills A,B,D,E)
- Describe the matrix exponential. (Course Goals 1,7; Gen Ed Goals 1,2; Core Skill A,B)

Evaluation of student learning:

Students will receive regular feedback on their work through graded assignments, examinations, and projects. The syllabus for this course should describe the schedule for these assessment tools and how they will be used to calculate grades. Learning activities will consist of a combination of lectures, graded assignments, demonstrations and examinations. The specific choices for assessment will rest with the instructor. Outside of class, students are expected to do a significant amount of work to achieve learning goals for this course. A typical grading scheme for this course follows:

Midterm Exam	20%	Graded Assignments, Projects	50%
Final Exam	30%		

Academic Integrity Statement:

Under no circumstance should students knowingly represent the work of another as one's own. Students may not use any unauthorized assistance to complete assignments or exams, including but not limited to cheat-sheets, cell phones, text messaging and copying from another student. Violations should be reported to the Academic Integrity Committee and will be penalized. Please refer to the Student Handbook for more details.