Middlesex Community College
COURSE OUTLINE

MAT	285	Differential Equations	3
Dept. Abbr.	**Course No.**	**Course Title**	**Credits**

Course Description

MAT*285 is an introductory course in differential equations, particularly intended for students in engineering. Topics include: Solution methods for differential equations including selected first order equations, nth-order equations, and systems of linear equations using matrix techniques, Laplace transforms, and numerical methods. Series techniques for selected linear differential equations including Bessel's equation will be considered. Computer software and/or graphing calculators will be integrated as appropriate throughout the course.

Prerequisite: Eligibility for ENG*101 (or ENG*101E) and MAT*256 with "C" or better

General Objectives of the Course

In this course, emphasis is placed on analyzing differential equations and systems of differential equations from several points of view: finding exact solutions when possible, using eigenvalues to predict local and global behavior, using Laplace transforms to handle otherwise awkward conditions, and using numerical techniques when appropriate. Numerous topics from trigonometry, algebra and calculus are used throughout the course, reinforcing the student's background and providing the student with a broader understanding of the applications of ideas encountered in earlier courses. By consolidating and expanding upon all previous work in these areas, this course provides a solid base to the student for further work in mathematics and related disciplines.

After completing this course, the student will be able to:

- Represent and solve real-life models using differential equations
- Solve differential equations using different techniques
- Determine how solutions change as a parameter is varied
- Use vector notation to provide a geometric approach to solutions of differential equations
- Determine the overall behavior of several types of differential equations by analyzing the phase plane or slope field
- Solve, with the assistance of the computer, selected differential equations using numerical techniques

This course will satisfy the Quantitative Reasoning requirement of the TAP, as Students will: interpret mathematical and quantitative information, and draw logical inferences from representations such as formulas, equations, graphs, and schematics. Students will also engage in Critical Analysis and Logical Thinking, as they will solve problems, and make decisions, based upon analytical processes.

TAP Learning Outcomes (Competencies) of the Course

Written Communication in English ((E)

3. Craft Logical Arguments
   - Generate a controlling idea or thesis.
   - Provide clear and logical evidence, support, or illustration for their assertions.
   - Choose appropriate and effective organizing methods, employing effective transitions and signposts.

Critical Analysis and Logical Thinking (E)

2. Formulating arguments: Formulates good arguments, including a significant focus on inductive reasoning.
3. Analysis: Break subject matter into components and identify their interrelations to ascertain the defining features of the work and their contributions to the whole.
5. Synthesis: Draw together disparate claims into a coherent whole in order to arrive at well-reasoned and well - supported inferences that can be justified as a conclusion.

Quantitative Reasoning (D)

1. Represent mathematical and quantitative information symbolically, graphically, numerically, and verbally.
2. Apply quantitative methods to investigate routine and novel problems. This includes calculations/procedures, mathematical and/or statistical modeling, prediction, and evaluation.
3. Interpret mathematical and quantitative information and draw logical inferences from representations such as formulas, equations, graphs, tables, and schematics.
4. Evaluate the results obtained from quantitative methods for accuracy and/or reasonableness.

(D) Designated (E) Embedded

Number indicates the numbered item in the TAP Competency Report

Unit #	Instructional Unit	Specific Objectives of Unit (The specific objectives reflect the behavioral outcomes, which include what the student will be able to do at the completion of the unit. Evaluation is then to be based on the student's accomplishment of these objectives. Assume that each statement is prefixed with "The student will be able to".)
1	Unit 1: First-Order Differential Equations	Topics covered: Modeling, Separation of Variables, Slope Fields, Euler’s Method, Existence and Uniqueness, Equilibria and the Phase Line, Bifurcations, Linear Equations and Integrating Factors 1. Classify differential equations according to type, order, and degree 2. Solve separable differential equations analytically 3. Use geometric techniques to represent solutions (Slope Fields) 4. Use numerical method to approximate solutions to initial value problems (Euler’s Method) 5. Identify the existence and uniqueness of solutions 6. Solve autonomous equations 7. Determine how solutions change as a parameter is varied 8. Solve higher order linear equations using the following techniques: a) method of undetermined coefficients, and b) method of integrating factors
2	Unit 2: First-Order Systems and Linear Systems	Topics covered: Modeling with Systems, System Geometry, Analytic Methods, Euler’s Method, the Linearity Principle, Straight-Line Solutions, Real and Complex Eigenvalues, Second Order Linear Equations, the Trace-Determinant Plane 1. Represent and solve two models, namely, evolution of the two populations in a predator-prey system and the motion of a mass-spring system using systems of differential equations 2. Introduce vector notation to provide a geometric approach 3. Use analytic techniques to find explicit formulas for solutions in somewhat specialized situations 4. Use vector notation to generalize Euler’s method 5. Apply the Linearity Principle to manufacture infinitely many new solutions 6. Find special solutions of linear systems using the geometry of the vector field 7. Solve systems of linear differential equations using matrix techniques 8. Determine the overall behavior of several types of differential equations by analyzing the phase plane or slope field
3	Unit 3: Applications to Oscillators and	Topics covered: Harmonic Oscillators, Forcing, Resonance, Equilibrium Point Analysis and Null-clines, Hamiltonian Systems (optional)

	Non-Linear Systems	1. Apply method of undetermined coefficients to solve differential equations representing damped / undamped harmonic oscillators 2. Approximate the nonlinear systems near an equilibrium point using the process of linearization 3. Analyze systems of differential equations employing analytical, qualitative, and numerical techniques 4. Determine whether a system is Hamiltonian and if it is, find the Hamiltonian function
4	Unit 4: Laplace Transforms	Topics Covered: Laplace Transforms, Discontinuities, Second Order Equations, Delta Functions and Impulses, Convolution 1. Solve linear differential equations using Laplace transforms 2. Solve differential equations containing discontinuous functions using Laplace Transforms 3. Solve second order, constant coefficient, forced linear equations using Laplace Transforms 4. Compute the inverse Laplace Transform of a product 5. Solve, with the assistance of the computer, selected differential equations using numerical techniques