DEPT. MATHEMATICS COURSE NO. 2206

NUMBER OF CREDITS: 4 COURSE TITLE Ordinary Differential Equations

CATALOG DESCRIPTION

This course presents the theory, computations and applications of first and second order ordinary differential equations and two-dimensional systems.

AUDIENCE For engineering and science and math majors.

FULFILLS MN TRANSFER CURRICULUM AREA(S) (Leave blank if not applicable)

Area 4: by meeting the following competencies: all Note: Area 4 has already been satisfied by the prerequisites.

PREREQUISITES OR NECESSARY ENTRY SKILLS/KNOWLEDGE: Math 1122 (Calculus 2)

LENGTH OF COURSE one semester

THIS COURSE IS USUALLY OFFERED:

Every other year ☐ fall ☒ spring ☐ summer ☐ undetermined ☐

Four goals are emphasized in course at Minnesota West Community & Technical College:

1) ACADEMIC CONTENT:
   The academic objectives of this course are:
   (a) to study the existence and uniqueness of solutions of ordinary differential equations.
   (b) to provide introductory experiences in solving application problems using differential equations and modeling.
   (c) to study the geometry of solutions as trajectories in the phase plane.
   (d) to compute solutions algebraically and to be able to apply Laplace transforms.

2) THINKING SKILLS:
   This course will help students improve the effectiveness of their thinking skills by:
   (a) using mathematical modeling to solve problems and understand patterns.
   (b) developing problem-solving strategies.
   (c) focusing on logical, observational, insightful, and evaluative thinking.

3) COMMUNICATIONS SKILLS:
   This course will help students improve their oral and written communication skills through:
   (a) oral interpretation of problems.
   (b) writing concise solution papers to mathematical problems.
4. **HUMAN DIVERSITY:**

This course will help students recognize, understand and appreciate human diversity by:

(a) working with others to solve problems so as to experience ways diverse persons interpret and solve mathematical problems.
(b) Comparing basic assumptions before tackling a complicated problem.

**TOPICS TO BE COVERED:**

1. First Order differential equations— separable, homogeneous, exact, linear integrating factors, substitutions, Picard’s iteration, the existence and uniqueness theorem, and applications to modeling (linear and non-linear).
2. Second order differential equations—linear independence and the Wronskian, linear homogeneous and nonhomogeneous with constant coefficients, characteristic values, undetermined coefficients, variation of parameters, and applications to modeling of harmonic motion —linear oscillators (simple, damped, and forced), and electric circuits.
4. Laplace and Inverse Transforms — solutions of initial value problems, step functions, Dirac delta function, and convolution.
5. Two-dimensional first order linear differential equation systems — eigenvalues, eigenvectors, independence, fundamental matrix, classification of equilibrium and phase-plane diagrams.
7. An introduction to two-dimensional first order nonlinear autonomous systems and the applications to chaotic dynamical systems.

**LIST OF EXPECTED COURSE OUTCOMES:**

1. Set up differential equation models for a variety of situations.
2. Separate variables as a means of solving certain first order equations.
3. Sketch and interpret slope fields of first order equations.
4. Settle certain questions of existence and uniqueness of solutions.
5. Use integrating factors to solve first order linear differential equations.
6. Use phase plane methods (direction field, solution curves, equilibria) to analyze and interpret systems of differential equations— example: predator-prey problems.
7. Represent and analyze second order differential equations as systems, such as harmonic oscillators.
9. Use linear methods to represent and analyze linear differential systems.
10. Analyze phase plane portraits for systems with real and complex eigenvalues, including special cases of repeated and zero eigenvalues.
11. Describe effect of varying parameter has on phase plane portrait (bifurcation).
12. Linearize non-linear systems near equilibrium.
13. Solve second order non-homogenous linear equations, such as a driven oscillator.
14. Analyze resonant behavior for second order sinusoidally driven systems.
15. Compute Laplace transforms of various elementary functions.
16. Utilize Laplace transform to solve initial value problems including those with discontinuous and impulse forcing (delta dirac function).
LEARNING/TEACHING TECHNIQUES used in the course are:
- Collaborative Learning
- Problem Solving
- Student Presentations
- Interactive Lectures
- Creative Projects
- Individual Coaching
- Lecture
- Films/Videos/Slides
- Demonstrations
- Other (describe below)
- Lab-Computer

ASSIGNMENTS AND ASSESSMENTS FOR THIS CLASS INCLUDE:
- Reading
- Tests
- Oral Presentations
- Individual Projects
- Textbook Problems
- Collaborative Projects
- Group Problems
- Workbooks
- Other (describe below)
- Term Paper
- Papers
- Portfolio
- Group Projects
- Term Paper

EXPECTED STUDENT LEARNING OUTCOMES:

The student will be able to:

1. solve and check differential equations of the first-order using a variety of methods: analytically, graphically (direction fields), and numerically.
2. solve a selection of application problems involving linear first order differential equations.
3. solve and check a variety of second-order differential equations using several methods as in (1) above.
4. solve a selection of second-order differential equations in physics related to harmonic motion and electrical circuits.
5. solve a selection of differential equations using power series techniques.
6. solve a selected variety of differential equations using Laplace Transforms.
7. solve a selection of a set of two-dimensions differential equations (systems) by using matrices (linear algebra methods).
8. solve a selection of linear and non-linear differential equations by numerical methods such as the methods of Euler and Runge-Kutta.

The information in this course outline is subject to revision

To receive reasonable accommodations for a documented disability, please contact the campus Student Services Advisor or campus Disability Coordinator as arrangements must be made in advance. In addition, students are encouraged to notify their instructor.

Veteran Services: Minnesota West is dedicated to assisting veterans and eligible family members in achieving their educational goals efficiently. Active duty and reserve/guard military members should advise their instructor of all regularly scheduled military appointments and duties that
conflict with scheduled course requirements. Instructors will make every effort to work with the student to identify adjusted timelines. If you are a veteran, please contact the Minnesota West Veterans Service Office.

This document is available in alternative formats to individuals with disabilities by contacting the Student Services Advisor or by calling 800-658-2330 or Minnesota Relay Service at 800-627-3529 or by using your preferred relay service.

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