MAT 285
DIFFERENTIAL EQUATIONS

COURSE DESCRIPTION:

Prerequisite: MAT 272
Corequisite: None

This course provides an introduction to ordinary differential equations with an emphasis on applications. Topics include first-order, linear higher-order, and systems of differential equations; numerical methods; series solutions; eigenvalues and eigenvectors; Laplace transforms; and Fourier series. Upon completion, students should be able to use differential equations to model physical phenomena, solve the equations, and use the solutions to analyze the phenomena. *This course is approved to satisfy the Comprehensive Articulation Agreement for transferability as a pre-major and/or elective course requirement*. Course Hours Per Week: Class, 3. Semester Hours Credit, 3.

LEARNING OUTCOMES:

1. Students will be able to model physical phenomena with first- and second-order differential equations, to solve such equations using analytic, graphical, or numerical methods, and to analyze and communicate the results. Students will display proficiency by demonstrating the following competencies.

a. Identify the order of an ordinary differential equation and determine whether it is linear or nonlinear.
b. Sketch a direction (slope) field for a first-order differential equation.
c. Apply the Existence-Uniqueness Theorem.
d. Use Euler's Method to approximate numerical solutions to first-order equations.
e. Identify a separable first-order equation and find general solutions of such equations using the method of separation of variables.
f. Identify first-order linear equations and find general solutions of such equations using integrating factors.
g. Solve first-order initial value problems involving separable or linear equations.
h. Solve selected applications involving first-order equations.
i. Identify second-order linear homogeneous differential equations and state the general form of solutions involving linearly independent functions.
j. Solve second-order linear homogeneous equations with constant coefficients by using characteristic equations.
k. Solve second-order linear nonhomogeneous equations with constant coefficients, using the method of undetermined coefficients.
l. Solve selected applications involving second-order equations.
m. Analyze solutions in terms of steady-state and transitory parts. Identify solutions demonstrating resonance.
n. Use the definition to compute the Laplace transform of a function.
o. Use a table and known properties of Laplace transforms to compute the Laplace transform of a function (including periodic and discontinuous functions).
p. Use appropriate methods (including the convolution theorem) to determine the inverse Laplace transform of a function.
q. Evaluate integrals, determine Laplace transforms, and solve differential equations involving the Dirac delta function.

2. Students will be able to model physical phenomena with first-order systems of differential equations, to solve such systems using analytic or graphical methods, and to analyze and communicate the results. Students will display proficiency by demonstrating the following competencies.

a. Identify a system of linear first-order differential equations in normal form.
b. Use the method of elimination to solve selected linear first-order systems.
c. Determine whether a degenerate system has no solutions or infinitely many linearly independent solutions.
d. Sketch a phase-plane diagram for a system of two linear differential equations.
e. Use Laplace transforms to solve initial value problems, including systems.
f. Use matrices to solve linear systems in normal form.
g. Find the eigenvalues and eigenvectors of a matrix.
h. Solve selected applications involving autonomous systems.

3. Students will be able to utilize power series to solve differential equations and will be able to utilize Fourier series to model periodic functions. Students will display proficiency by demonstrating the following competencies.

a. Compute power series solutions to selected linear differential equations and determine singular points.
b. Compute the Fourier series for a given function on a specified interval.

OUTLINE OF INSTRUCTION:

I. Introduction to Differential Equations
   A. Definitions and Terminology
   B. Initial-Value Problems
   C. Differential Equations as Mathematical Models

II. First-Order Differential Equations
   A. Solution Curves without a Solution
   B. Separable Variables
   C. Linear Equations
   D. A Numerical Method

III. Modeling with First-Order Differential Equations
   A. Linear Models

IV. Higher-Order Differential Equations
   A. Preliminary Theory – Linear Equations
   B. Homogeneous Linear Equations with Constant Coefficients
   C. Undetermined Coefficients – Superposition Approach
   D. Undetermined Coefficients – Annihilator Approach
   E. Solving Systems of Linear Equations by Elimination

V. Modeling with Higher-Order Differential Equations
   A. Linear Models: Initial-Value Problems
   B. Linear Models: Boundary-Value Problems

VI. Series Solutions of Linear Equations
   A. Solutions about Ordinary Points

VII. The Laplace Transform
   A. Definition of the Laplace Transform
   B. Inverse Transforms and Transforms of Derivatives
   C. Operational Properties I
   D. Operational Properties II
   E. Dirac Delta Function
   F. Systems of Linear Differential Equations

VIII. Systems of Linear First-Order Differential Equations
   A. Preliminary Theory
   B. Homogeneous Linear Systems

IX. Plane Autonomous Systems
   A. Autonomous Systems
   B. Stability of Linear Systems

X. Orthogonal Functions and Fourier Series
   A. Orthogonal Functions
   B. Fourier Series and Orthogonal Functions

REQUIRED TEXTBOOK AND MATERIALS:

Zill, Dennis G. and Michael R. Cullen. Differential Equations with Boundary-Value Problems. 7th edition. Cengage, 2009.

CALCULATOR:

TI-83/84 Graphing Calculator.

STATEMENT FOR STUDENTS WITH DISABILITIES:

Students who require academic accommodations due to any physical, psychological, or learning disability are encouraged to request assistance from a disability services counselor within the first two weeks of class. Likewise, students who potentially require emergency medical attention due to any chronic health condition are encouraged to disclose this information to a disability services counselor within the first two weeks of class. Counselors can be contacted by calling 536-7207, ext. 1413 or by visiting the Student Development Office in the Phail Wynn Jr. Student Services Center, room 1309.