CLEVELAND STATE UNIVERSITY
Mechanical Engineering Department

ESC 250: Differential Equations for Engineers (3 credit hours)

Instructor : Dr. Asuquo B. Ebiana, Associate Professor, Mechanical Engineering

Course Description: Differential Equations for Engineers:
- Mathematical models
- Linear 1st.- and 2nd.-order differential equations (ODEs.)
- Systems of differential equations
- Laplace transform techniques
- Numerical methods

Course Objectives : This course is intended to:
1. Introduce engineering students to the fundamentals of ODE
2. Teach students traditional analytical solution techniques
3. Enable students to be able to mathematically model and solve real-world problems
4. Introduce students to the use of symbolic software tools (MATLAB, Maple, Mathematica, etc.) for solving and interpreting differential equations.

Expected Outcomes : Upon satisfactory completion of this course, students should be able to:
1. Identify and formulate elementary level ODE models of real world problems
2. Acquire mastery of traditional analytical techniques to the analysis of ODE models
3. Use symbolic software tools (Maple, Mathematica, MATLAB, etc.) to solve/interpret ODEs
4. Apply acquired analysis skills to simple engineering problems.

Program Outcomes This course satisfies the following programmatic outcomes:
a) Ability to apply math, science and engineering knowledge to problem solving
e) Identification, formulation and solution of engineering problems
g) Ability to communicate effectively
k) Use the techniques, skills, and modern engineering tools necessary for engineering practice

Required Text : Differential Equations: Computing and Modeling, by C.H. Edwards Jr. & David E. Penny 5th. (or latest) edition, Pearson Education, Inc., Boston, MA, 2015.

Prerequisite : MTH 182 - Calculus II
[Helpful but not required to have basic knowledge of symbolic software tools (Maple, MATLAB, etc.)]

Grading Policy :

8 Problem Sets + 8 Pop Quizzes (**PS**+**PQ**)	10%
Test 1 (**T1**)	25%
Test 2 (**T2**)	25%
Computer Project (**Proj.**: 60 pts.; **Demo.**: 40 pts.)	10%
Final Exam (**FE**)	30%

Total Score = 0.0625 (**PS**+**PQ**) + 0.25 (**T1** + **T2**) + 0.10(**CP**) + 0.30(**FE**)

Grading Scale : **A**: ≥ 90, **A-**: 85-89, **B+**: 80-84, **B**: 75-79, **B-**: 70-74, **C+**:65-69, **C**: 60-64, **D**: 55-59, **F**: < 55

Prerequisites by Topic:
1. Differential, integral and multivariable calculus
2. Trigonometric functions and identities
3. Solutions of systems of linear equations
4. Graphing techniques
5. Basic algebra techniques
6. Analysis and solution of word problems
7. Familiarity with symbolic software tools helpful (Maple, Mathematica, Mathlab, etc.)

Topics Covered **Lecture Hours**

INTRODUCTION **3.0**
- Process of Mathematical Modeling
- Math Models and Differential Equations
- Slope Fields and Solution Curves
- Problem Solving

Topics Covered	Lecture Hours
1ST-ORDER ORDINARY DIFFERENTIAL EQUATIONS	**7.0**
• Exact Equations • Linear/Separable Equations • Right-Hand-Side Polynomial Equations • Homogeneous/Bernoulli Equations • Problem Solving	
MATHEMATICAL MODELS	**3.0**
• Population models • Acceleration-Velocity Models • Mixture Models	
EQUILIBRIUM SOLUTIONS AND STABILITY	**2.0**
• Autonomous Equations • Stable/Unstable Critical Points • Problem Solving	
TEST 1	**1.0**
2ND-ORDER ORDINARY DIFFERENTIAL EQUATIONS	**7.0**
• Homogeneous Equations • Non-Homogeneous Equations • Problem Solving	
END-POINT PROBLEMS AND EIGENVALUES	**3.0**
• The Whirling String • The Buckled Rod • The Deflection of a Uniform Beam • Problem Solving	
SYSTEMS OF DIFFERENTIAL EQUATIONS	**6.0**
• Linear & Non-linear Systems of Equations (1st. & 2nd. Order) • Transformation to 1st. Order. • The Method of Elimination (Ad hoc/Systematic) • The Eigenvalue Method for Homogenous Systems • Problem Solving	
TEST 2	**1.0**
LAPLACE TRANSFORM METHODS	**6.0**
• Laplace/Inverse-Laplace Transforms • Partial Fractions and Translations • Problem Solving	
NUMERICAL METHODS	**3.0**
• Euler's Method • Problem Solving • Computer Project (work done outside of class over entire semester)	
REVIEW	**1.0**
FINAL EXAM	**2.0**
TOTAL CONTACT HOURS	**45.0**

COMPUTER USAGE

- Consistent use of computational software tools (Maple, Mathematica, Mathlab, MathCad, etc.) for problem solving.

ABET Content

ABET category content as estimated by faculty member who prepared this course description: Engineering science: 3 credits or 100%

Prepared by: Asuquo B. Ebiana Date: January 20, 2020