North South University
Department of Mathematics and Physics

MAT 480: Differential Equations

Course Name: **Differential Equations**
Module Type: **ONLINE**
Course Code: MAT 480
Credit Hours: 3 Credits
Pre-requisite : MAT 250
Term: **Spring 2021**

Course Short Description:
Differential equation models describe a wide range of complex problems in economics, finance, engineering, biology and physical sciences. This course is intended for students who require a solid understanding and working knowledge of ordinary differential equations (ODEs) both linear and nonlinear; included are techniques and applications of ordinary differential equations in different real life problems. The course will also deal with partial differential equations (PDEs) very briefly, with some elements of numerical computation.

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Course Learning Outcomes:

Upon successful completion of this course, students will be able to:

(a) Classify the type of a given differential equation and apply the appropriate analytical technique for finding the solution of first order differential equations.
(b) Create and analyze mathematical models using first order ordinary differential equations, for linear and nonlinear case.
(c) Demonstrate the type of second order ordinary differential equations and use analytic methods for constructing solutions to homogeneous and nonhomogeneous second-order ODEs.
(d) Apply Laplace transformations to find solutions of different ODEs related to real life problems.
(e) Apply and analyze mathematical methods for solution of second order nonlinear ODEs.
(f) Investigate different iterative solution techniques of ODEs.
(g) Recognize the PDEs, and develop skills to derive solutions of linear and nonlinear PDEs. Solve heat equation and wave equation.

Course Outline:

1. **First Order Ordinary Differential Equations:**
   Introduction to Ordinary Differential Equations (ODEs) and applications of ODEs in different fields of engineering, economics and civil background.
   Linear ODE of first order:
   Separable and Exact ODE, Linear ODE, Homogeneous Equations. Modelling with first order linear ODEs.
   Nonlinear ODE of first order:
   Bernoulli equation, Logistic differential equation. Modelling with first order nonlinear ODEs.
2. **Linear Second-Order ODEs:**
   - **Second order ODE of constant Coefficients:**
   - **Homogeneous from:**
     Homogeneous linear ODEs of Second Order, Existence and Uniqueness of Solutions Homogeneous linear ODEs with Constant Coefficients.
   - **Non-homogeneous from:**
     General form of second –order ODEs in non-homogeneous form. Solution methods: the inverse operator method (Annihilator method), shifting exponent method, variation of parameters method; Applications of non-homogeneous ODEs of second order.
   - **Second order ODE of Variable Coefficients:**
     Cauchy Euler Equations, Existence and Uniqueness of Solutions. Wronskian, Non-homogeneous ODEs.
3. **Nonlinear Differential equations of second order: (Zill- Chapters 4.10, and 5.3)**
   - Introduction, solution of nonlinear second order ODEs: order reduction method, Taylor series solution.
4. **Laplace Transformation**
   - Laplace Transformation and its inverse, linearity and shifting, Laplace transformations of derivatives and integrals, Initial Value Problems, unit step function, delta function and t-shifting. Convolution Theorem. Application in
5. **Numerical Solutions of Ordinary Differential Equations (Zill- Chapters 9.1, and 9.2)**
   - Introduction, Numerical solution of first order ODES: Euler method, Runge-Kutta method; Solution of second order ODES: Euler method. Error analysis in numerical solutions of ODEs.
6. **Partial Differential Equation**
   - Introduction to PDE, formation of PDEs, Order and degree, Linear and nonlinear PDE, Lagrange method, Charpit's method to solve PDEs.
   - Introduction to Diffusion-type problem, Separable of variables, One-dimensional wave equations, wave equations in two dimensions.

Marks Distribution:

Attendance-	10%
Regular Quizzes (minimum 4 quizzes)	15%
Mid-Term	30%
Assignment	10%
Continuous Assessment	5%
Final Exam-	30%
Total	**100%**

Text Books:

1. A First Course in Differential Equations with Modeling and Applications, (10th Edition), Author-Dennis G. Zill.
2. Advanced Mathematical Economics, Author-Rakesh V. Vohra, publisher-Routledge, Taylor and Francis.
3. Advanced Engineering Mathematics (10^{th} Edition)- Author: Erwin Kreyszig
4. Elementary Differential Equations and Boundary Value, Author-William E. Boyce and Richard C. DiPrima, Publisher-John Wiley & Sons.

Grading Policies: As per NSU Grading Policy

Important dates:

First midterm	TBA
Formative Assessment	TBA
Course Final	As per NSU Schedule

Rules and Restrictions:

(a) Submit the assignments in recommended date. **No late submission will be accepted**. Make a photocopy of your assignment before submission.
(b) There is **no scope to retake a quiz in any chance**. In case of Mid-term- or Final exam, exceptional cases*(unfortunate physical inability, accidents, serious illness) may be considered conditionally (with a **penalty of 20% reduced marks**) with proper justification.
(c) A late present means you come to the class within 10 minutes the class starts. You are automatically **absent after 10 minutes delay** and not allowed in the class.
(d) Three consecutive absents need an official clarification.
(e) If you are a **probation student/retake**, I would like to have you in 24 classes (**20 present is Must)**

********** **Thank You** **********