 North South University

Department of Mathematics and Physics

**MAT350: Engineering Mathematics**

**Course Name**: **Engineering Mathematics**

**Course Code**: MAT 350

**Credit Hours** : 3 Credits

**Pre-requisite** : MAT 130

**Term** : **SUMMER 2023**

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| **Instructor** | :Prof. Dr. Md. Mamun Molla |
| **Office** | :SAC1040 |
| **Email:** | :mamun.molla@northsouth.edu |
| **Office Time**  **Course Short Description:** | : MW: 11:00AM -12:0 AM, any other time upon request through email.  This course is intended for Engineering students who require a working knowledge of differential equations; included are techniques and applications of ordinary differential equations in engineering problems with some elements of scientific computing. |
| **Course**  **Objectives**  **Course Learning Outcomes:**  **Course**  **Contents:** | 1. To classify the different types of differential equations and find the appropriate analytical tools and techniques for finding the solutions of the first order and the second order ordinary differential equations. 2. To create and analyze mathematical models using the first order and the second order ordinary differential equations. 3. To demonstrate students’ understanding of how physical phenomena are modeled by system of differential equations and investigate the solution methods. 4. To develop the ability to apply Fourier series and Fourier Integrals to significant applied problems.   Upon successful completion of this course, students will be able to:  **(CO-1)** Classify the type of a given differential equation and find the appropriate analytical techniques for finding the solutions of the first order and the second order ordinary differential equations.  **(CO-2)** Formulate and analyze mathematical models using the first order and the second order ordinary differential equations.  **(CO-3)** Solve linear differential equations using different tools, like the Laplace transform technique, power series method; and identify their applications.  **(CO-4)**Demonstrate their understanding of how physical phenomena are modeled by system of differential equations and investigate the solution methods.  **(CO-5)**Develop the ability to apply Fourier series and Fourier Integrals to significant applied problems.  1. **First Order Ordinary Differential Equations:**  Introduction to Ordinary Differential Equations (ODEs), mathematical modeling with ODEs, Separable and Exact ODE, Linear ODE, Bernoulli equation.  2. **Second-Order Linear ODEs:**  Homogeneous Linear ODEs of Second Order, Homogeneous Linear ODEs with Constant Coefficients, Euler–Cauchy Equations, Existence and Uniqueness of Solutions. Wronskian, Non-homogeneous ODEs, Modeling: Mass–Spring System, Electric Circuits, Resonance, Solution by Variation of Parameters.  3. **Systems of ODE:**  System of ODEs, Phase plane method, Nonhomogeneous Linear Systems of ODEs.  4. **Series Solutions of ODEs:**  Power series method, Extended Power Series Method, Bessel’s Equation. Bessel Functions and general solution.  5. **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.  6. **Fourier Series and Fourier Functions**  Periodic function and Fourier Series, Fourier coefficients and applications. Even and odd functions, Half range expression, Fourier integrals and transforms.  **Mapping of Course Outcomes** |

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| **#** | **Course Outcomes (CO)** | **Bloom’s taxonomy**  **domain/level**  *(***C***: Cognitive*  **P***: Psychomotor*  **A***:* *Affective)* | **Delivery methods**  **and activities** | **Assessment**  **tools** |
| **CO-1** | Classify the type of a given differential equation and find the appropriate analytical techniques for finding the solutions of the first order and the second order ordinary differential equations. | **C2** | |  | | --- | | Lecture, Video  Discussion | | |  | | --- | | Quiz, Assignment | |
| **CO-2** | Apply and analyze mathematical models using the first order and the second order ordinary differential equations. | **C3, C4, P2** | |  | | --- | | Lecture, in-class group discussion,  Videos | | In class assessment,   |  | | --- | | Midterm exam, Assignment | |
| **CO-3** | Solve linear differential equations using different tools, like the Laplace transform technique, power series method; and identify their applications. | **C2, C3, P2** | Lecture,  Discussion   |  | | --- | |  | | Class work,  Quiz, Assignment, Midterm Exam,  Final Exam |
| **CO-4** | Demonstrate their understanding of how physical phenomena are modeled by system of differential equations and investigate the solution methods. | **C4, P2** | Lecture,  Video,  Discussion | Demonstration,  Quiz, Assignment, Final Exam |
| **CO-5** | Develop the ability to apply Fourier series and Fourier Integrals to significant applied problems. | **C2, C3, P2** | Lecture  Video  Demonstration | Assignment, Final Exam |

Note: C2, C3, C4, and P2 indicate different subdomains of Bloom’s Taxonomy. Please visit departmental website for details.

**Marks Distribution:**

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| **Attendance** | **10%** |
| **Regular Quizzes** | **20%** (3 quizzes & best 2 quizzes will count for marks |
| **Mid-term** | **25%** (Duration of the mid-term exam will be 70 minutes). |
| **Final Exam** | **35%** (Duration of the final exam will be 01 hour & 30 minutes). |
| **Assignment** | **10%** (02 assignments) |
| **Total Marks** | **100%** |

**Grading**

**Policies:** As per NSU Grading Policy

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| **Important**  **Dates:** | Midterm exam TBA |

FinalExam According to NSU Schedule.

Reference Books:

**1**. A First Course in Differential Equations with Modeling and Applications, (10th Edition), Author-Dennis G. Zill.

**2**. Advanced Engineering Mathematics (10th Edition)- Author: Erwin Kreyszig

**Special Instructions:**

1. Submit the assignments in recommended date. **No late submission will be accepted**. Make a photocopy of your assignment before submission.
2. Exam and Makeup policy is given in the last page of this course outline
3. A late present means you come to the class within 15 minutes the class starts. You are automatically **absent after 15 minutes delay** and not allowed to the class room.
4. If you are a **probation student/retake student**, I would like to have you in 29 classes (presents in minimum **24 classes are must)**

**Lesson Plan:**

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| **Lesson** | **Topics** | **Learning Activities** | **Assessment tools** | **Learning Outcome** |
| **I** | First Order Ordinary Differential Equations: Introduction to Ordinary Differential Equations (ODEs), mathematical modeling with ODEs, | Lecture | Discussions | CO-1 |
| **II** | **First Order ODEs- Separable ODEs**  Separable ODEs with modeling and applications. | Individual Assignment | Mid term  Quiz 1 | CO-1 |
| **III** | **First Order ODEs- Exact ODEs**  Separable and Exact ODEs with modeling and applications. | Lecture,  Group Discussion | Discussions  Mid term  Assignment 1 | CO-1 |
| **IV** | **First Order Linear ODE:**  Linear ODE with modeling and applications. | Lecture,  Discussion, | Quiz 1  Mid term  Assignment 1 | CO-1 |
| **V** | **First Order Linear ODE:**  Linear ODE with modeling and Bernoulli’s equation | Lecture,  Discussion, | Quiz 1  Mid term | CO-1 |
| VI | **Second-Order Linear ODEs: Homogeneous**  Intro, Types and Solution methods., Homogeneous Linear ODEs of Second order and Solution methods. | Lecture | Mid term | CO-1 |
| **VII** | **Second-Order Linear ODEs: Non-Homogeneous**  Non-Homogeneous Linear ODEs with Constant Coefficients: Superposition principle and inverse operator method. | Lecture | Mid term  Assignment 2  Quiz 1 | CO-1 |
| **VIII** | **Second-Order Linear ODEs: Non-Homogeneous**  Non-Homogeneous Linear ODEs with Constant Coefficients: inverse operator method. | Lecture  Assignment | Mid term Assignment 1 | CO-1 |
| **IX** | **Second-Order Linear ODEs: Non-Homogeneous**  Non-Homogeneous Linear ODEs with Constant Coefficients: Shift exponents method | Lecture | Mid term | CO-1 |
| **X** | **Second-Order Linear ODEs: Non-Homogeneous**  Non-Homogeneous Linear ODEs with Constant Coefficients: variation of parameters method | Lecture | Mid term  Assignment 1 | CO-1 |
| **XI** | **Second-Order Linear ODEs: Modelling**  Modelling of Mass–Spring System without damper | Discussion  Lecture  Assignment  Videos, | **Mid term** Assignment 1 | CO-2 |
| **XII** | **Second-Order Linear ODEs: Modelling**  Modelling: Mass–Spring System with damper | Lecture,  Videos, | **Mid term** Assignment 1 | CO-2 |
| **XIII** | **MIDTERM EXAM** | | | |
| **XIV** | **Non-homogeneous ODEs:**  Cauchy Euler Equation and  Variation of parameters | Lecture, | Assignment 2  Final Exam | CO-1 |
| **XV** | **Systems of ODEs**  System of ODEs: Homogeneous system | Lecture,  assignment | Final Exam | CO-4 |
| **XVI** | **Systems of ODEs**  System of ODEs: Homogeneous system, different types of solutions with initial conditions | Lecture,  assignment | Assignment 2  Final Exam | CO-4 |
| **XVII** | **Systems of ODEs**  Nonhomogeneous Linear Systems of ODEs. | Lecture,  assignment | Assignment 2  Final Exam | CO-4 |
| **XVIII** | **Laplace Transformation**  Laplace Transformation: Intro, derivations of L.T of functions | Lecture,  assignment | Quiz 2  Final Exam | CO-3 |
| **XIX** | **Laplace Transformation**  Laplace Transformation: Inverse L.T, derivatives of L.T of functions, Application to solve ODEs | Lecture,  assignment | Assignment 2 Quiz 2  Final Exam | CO-3 |
| **XX** | **Laplace Transformation**  linearity and s-shifting of L.V and solutions of ODEs | Lecture, | Assignment 2  Quiz 2  Final Exam | CO-3 |
| **XXI** | **Laplace Transformation**  Initial Value Problems, unit step function, delta function and t-shifting. | Lecture,  class discussion,  Problem solving | Assignment 2  Quiz 2  Final Exam | CO-3  CO-2 |
| **XXII** | **Fourier Series and Fourier Functions**  Periodic function and Fourier Series, Fourier coefficients and applications. | Lecture,  class discussion,  Problem solving | Final Exam  Assignment 2  Quiz 3 | CO-5 |
| **XXIII** | **Fourier Series and Fourier Functions**  Fourier series of arbitrary period, Fourier Even and odd functions, problem solutions | Lecture,  class discussion,  Problem solving | Final Exam  Quiz 3 | CO-5 |
| **XXIV** | **Fourier Series and Fourier Functions**  Half range expression, problem solutions | Lecture,  class discussion,  Problem solving | Final Exam  Assignment 2  Quiz 3 | CO-5 |
| **XXV** | **Fourier Series and Fourier Functions**  Fourier integrals and transforms | Lecture,  class discussion,  Problem solving | Final Exam  Assignment 2  Quiz 3 | CO-5 |
| **XXVI** | **Series Solutions of ODEs**  Power series method-Intro, solution about ordinary point (1st order ODEs) | Lecture,  class discussion,  Problem solving | Final exam | CO-3 |
| **XXVII** | **Series Solutions of ODEs**  Power series method- solution about ordinary points (2nd order ODEs) | Lecture, Assignment | Final exam  Assignment 2 | CO-3 |
| **XXVIII** | **Series Solutions of ODEs**  Power series method-about singular point | Lecture,  In class discussion,  Problem solving | Final exam  Assignment 2 | CO-3 |
| **XXIX** | Preparation for final Exam: Review of selected topics | Explaining,  Demonstrating |  |  |
|  | **Final Exam** | | | |

**Classroom Rules of Conduct:** Please Refer to NSU Student Handbook, Sections: “Disciplinary Actions” and “Procedures and Guidelines”.

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| **Exams & Make Up Policy** |
| Minimum five quizzes will be taken (best three will be considered). NO makeup for quizzes and NO Formative assessment will be retaken under any circumstances.If a student misses the Midterm exam and/or Final exam due to the circumstances beyond their control (official valid documents are required) and informed beforehand (if possible), reasonable arrangement may be considered.. Please note the retake exam questions are generally a bit tricky and critical compare to the regular exam questions. **Students will get the opportunity to see/recheck their midterm and Final exam scripts.** |

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