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 2024**

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Office Time : ST 11:00am – 12:00pm and 3:00pm-4:00pm

RA 12:00pm – 3:00pm, and by appointment.

Course Short Description: 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

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.

Course Learning Outcomes: 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.

Course Contents:

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

#	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:

Attendance and class participations	**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%** (3 assignments)
Total Marks	**100%**

Grading Policies: As per NSU Grading Policy

Important Dates:

Midterm exam TBA

Final Exam According to NSU Schedule.

Reference Books:

1. A First Course in Differential Equations with Modelling and Applications, (10th Edition), Author-Dennis G. Zill.
2. Advanced Engineering Mathematics (10^{th} Edition)- Author: Erwin Kreyszig

Special Instructions:

(a) Submit the assignments in recommended date. **No late submission will be accepted**. Make a photocopy of your assignment before submission.

(b) Exam and Makeup policy is given in the last page of this course outline

(c) 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.

(d) 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:

Lesson	Topics	Learning Activities	Assessment tools	Learning Outcome
I	**First Order Ordinary Differential Equations:** Introduction to Ordinary Differential Equations (ODEs), mathematical modeling with ODEs, **Chapter 1**	Lecture	Discussions	CO-1
II	**First Order ODEs- Separable ODEs** Separable ODEs with modeling and applications. **Section 2.2**	Individual Assignment	Midterm Quiz 1	CO-1
III	**First Order ODEs- Exact ODEs** Separable and Exact ODEs with modeling and applications. **Section 2.4**	Lecture, Group Discussion	Discussions Mid term Quiz 1	CO-1

IV	**First Order Linear ODE:** Linear ODE with modeling and applications. **Section 2.3**	Lecture, Discussion,	Quiz 1 Mid term	CO-1
V	**First Order Linear ODE:** Linear ODE with modeling and Bernoulli's equation (By substitutions) **Section 2.5**	Lecture, Discussion,	Midterm Assignment 1	CO-1
VI	**Second-Order Linear ODEs: Homogeneous** Intro, Types and Solution methods., Homogeneous Linear ODEs of Second order and Solution methods. **Sections 4.1 & 4.2**	Lecture	Midterm Quiz 2	CO-1
VII	**Second-Order Linear ODEs: Non-Homogeneous** Non-Homogeneous Linear ODEs with Constant Coefficients: Superposition principle and inverse operator method. **Sections 4.3 & 4.4**	Lecture	Midterm Quiz 2	CO-1
VIII	**Second-Order Linear ODEs: Non-Homogeneous** Non-Homogeneous Linear ODEs with Constant Coefficients: inverse operator method. **Sections 4.4 & 4.5**	Lecture Assignment	Midterm Quiz 2	CO-1
IX	**Second-Order Linear ODEs: Non-Homogeneous** Non-Homogeneous Linear ODEs with Constant Coefficients: Shift exponents method **Sections 4.4 & 4.5**	Lecture	Midterm	CO-1
X	**Second-Order Linear ODEs: Non-Homogeneous** Non-Homogeneous Linear ODEs with Constant Coefficients: variation of parameters method **Section 4.6**	Lecture	Midterm Assignment 1	CO-1
XI	**Second-Order Linear ODEs: Modelling** Modelling of Mass–Spring System without damper **Section 5.1**	Discussion Lecture Assignment Videos,	Midterm Assignment 1	CO-2
XII	**Second-Order Linear ODEs: Modelling** Modelling: Mass–Spring System with damper **Section 5.1**	Lecture, Videos,	Midterm Assignment 1	CO-2
XIII	**MIDTERM EXAM**			
XIV	**Non-homogeneous ODEs:** Cauchy Euler Equation and Variation of parameters **Section 4.7**	Lecture,	Assignment 2 Final Exam	CO-1
XV	**Systems of ODEs** System of ODEs: Homogeneous system **Section 8.2**	Lecture, assignment	Final Exam	CO-4
XVI	**Systems of ODEs** System of ODEs: Homogeneous system, different types of solutions with initial conditions **Section 8.2**	Lecture, assignment	Assignment 2 Final Exam	CO-4

XVII	**Systems of ODEs** Nonhomogeneous Linear Systems of ODEs. **Section 8.3**	Lecture, assignment	Assignment 2 Final Exam	CO-4
XVIII	**Laplace Transformation** Laplace Transformation: Intro, derivations of L.T of functions **Section 7.1**	Lecture, assignment	Quiz 3 Final Exam	CO-3
XIX	**Laplace Transformation** Laplace Transformation: Inverse L.T, derivatives of L.T of functions, Application to solve ODEs **Section 7.2**	Lecture, assignment	Quiz 3 Final Exam	CO-3
XX	**Laplace Transformation** linearity and s-shifting of L.V and solutions of ODEs **Section 7.3**	Lecture,	Quiz 3 Final Exam	CO-3
XXI	**Laplace Transformation** Initial Value Problems, unit step function, delta function and t-shifting. **Section 7.3**	Lecture, class discussion, Problem solving	Quiz 3 Final Exam	CO-3 CO-2
XXII	**Fourier Series and Fourier Functions** Periodic function and Fourier Series, Fourier coefficients and applications. **Section 11.1**	Lecture, class discussion, Problem solving	Final Exam Assignment 3	CO-5
XXIII	**Fourier Series and Fourier Functions** Fourier series of arbitrary period, Fourier Even and odd functions, problem solutions **Sections 11.1 & 11.2**	Lecture, class discussion, Problem solving	Final Exam	CO-5
XXIV	**Fourier Series and Fourier Functions** Half range expression, problem solutions **Section 11.2**	Lecture, class discussion, Problem solving	Final Exam Assignment 3	CO-5
XXV	**Fourier Series and Fourier Functions** Fourier integrals and transforms	Lecture, class discussion, Problem solving	Final Exam Assignment 3 Quiz4	CO-5
XXVI	**Series Solutions of ODEs** Power series method-Intro, solution about ordinary point (1st order ODEs) **Section 6.1**	Lecture, class discussion, Problem solving	Final exam	CO-3
XXVII	**Series Solutions of ODEs** Power series method- solution about ordinary points (2nd order ODEs) **Section 6.2**	Lecture, Assignment	Final exam Assignment 3	CO-3
XXVIII	**Series Solutions of ODEs** Power series method-about singular point **Section 6.3**	Lecture, In class discussion, Problem solving	Final exam Assignment 3	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".

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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