King Fahd University of Petroleum and Minerals

Department of Mathematics

MATH435 Syllabus, Term 241 (Fall 2024)

Instructor: Dr. Waled Al-Khulaifi (waled.alkhulaifi@kfupm.edu.sa)

Office Hours: Sunday, Tuesday, Thursday 01:15 PM – 02:15 PM **Office Location:** 5-411

Course Code and Title: MATH435, Ordinary Differential Equations

Course Credit Hours: 3-0-3

Textbook: "*The Qualitative Theory of Ordinary Differential Equations: An Introduction*" by F. Brauer and J. A. Nohel, Dover Publications, Inc. NY (1969).

Course Objective: The course aims to introduce basic concepts of existence, uniqueness, asymptotic behavior and stability of solutions to ordinary differential equations.

Course Description: First order scalar differential equations. Initial value problems. Existence, uniqueness, continuous dependence on initial data. Linear systems with constant coefficients. The exponential matrix. Asymptotic behavior of linear and almost linear systems. Two dimensional autonomous systems. Critical points and their classifications. Phase plane analysis. Introduction to the theory of Lyapunov stability.

Prerequisite: MATH202 and MATH225, or MATH208.

Course Learning Outcomes: Upon successful completion of the course, a student should be able to

1. Apply existence and uniqueness theory for initial value problems.
2. Discuss asymptotic behavior of linear and almost linear systems and the theory of Lyapunov stability.
3. Solve linear systems of differential equations, including higher order equations with constant coefficients.
4. Calculate and classify critical points of autonomous systems.

Grading Policy:

Major Exam 1	20%
Major Exam 2	20%
Homework Assignments	15%
Project	10%
Final Exam	35%

Attendance: All students are expected to attend all lectures. 9 unexcused absences will result in a DN grade.

Academic Integrity: All KFUPM policies regarding ethics apply to this course. See the Undergraduate Bulletin on the Registrar website.

Graduate Attributes: Check this link https://math.kfupm.edu.sa/bsinmathematics/graduate-attributes .

Coverage Plan

Week	Date (2024)	Section
1	Aug. 25-29	1.1 A Single Mass-Spring Systems
		1.2 Coupled Mass-Spring Systems
2	Sep. 1-5	1.3 Systems of First-Order Equations
		1.6 Existence, Uniqueness, and Continuity
3	Sep. 8-12	1.7 The Gronwall Inequality Exercise Session
4	Sep. 15-19	2.2 Existence and Uniqueness for Linear Systems
		2.3 Linear Homogeneous Systems
		2.4 Linear Nonhomogeneous Systems
National Day Holidays (Sunday and Monday 22-23 September 2024)		
5	Sep. 24-26	2.5 Linear Systems with Constant Coefficients
6	Sep. 29- Oct. 3	2.6 Similarity of Matrices and the Jordan Canonical Form
		2.7 Asymptotic Behavior of Solutions of Linear Systems with Constant Coefficients
7	Oct. 6-10	2.8 Autonomous Systems – Phase Space – Two dimensional Systems
		2.9 Linear Systems with Periodic Coefficients
Major Exam 1. Material: 1.1-2.5. Date: Saturday (October 12, 2024). Time: 6:30 – 8:30 PM		
8	Oct. 13-17	3.1 Existence in the Scalar Case Exercise Session
9	Oct. 20-24	3.2 Existence Theory of Systems of First-Order Equations
		3.3 Uniqueness of Solutions
10	Oct. 27-31	3.4 Continuation of Solutions
		3.5 Dependence on Initial Conditions and Parameters
11	Nov. 3-7	4.2 Definitions of Stability
		4.3 Linear Systems
Midterm Break (Sunday-Thursday, November 10-14, 2024)		
12	Nov. 17-21	4.4 Almost Linear Systems
		4.5 Conditional Stability
Major Exam 2. Material: 2.6-3.5. Date: Sunday (November 24, 2024). Time: 6:30 – 8:30 PM		
13	Nov. 24-28	4.6 Asymptotic Equivalence
		4.7 Stability of Periodic Solutions
14	Dec. 1-5	5.2 Lyapunov's Theorems
		5.3 Proofs of Lyapunov's Theorems
15	Dec. 8-12	5.4 Invariant Sets and Stability
		5.5 The Extent of Asymptotic Stability – Global Asymptotic Stability
16	Dec 15-16	Review and Catching Up
Final Exam: Comprehensive. Date: Check the Registrar Website		