# College of Computing and Mathematics
## Department of Mathematics

**MATH435** – Ordinary Differential Equations
**SYLLABUS**
AY 2021-2022 **(Term 212)**

**Instructor: Dr. Khairul Saleh**

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| **Course #:** | MATH 435 |
| **Course Title:** | Ordinary Differential Equations |
| **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. |
| **Prerequisites:** | MATH 202 and MATH 225, or MATH 208. |
| **Course Learning outcomes:** | Upon successful completion of this 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.

| Week | Date | Section |
|------|------|---------|
| 1 | 16-20 Jan | 1.1 A single Mass-Spring Systems |
| | | 1.2 Coupled Mass-Spring Systems |
| 2 | 23-27 Jan | 1.3 Systems of First-Order Equations |
| | | 1.6 Existence, Uniqueness, and Continuity |
| 3 | 30 Jan – 3 Feb | 1.7 The Gronwall Inequality Exercise Session |
| 4 | 6-10 Feb | 2.2 Existence and Uniqueness for Linear Systems |
| | | 2.3 Linear Homogeneous Systems |
| | | 2.4 Linear Nonhomogeneous Systems |
| 5 | 13-17 Feb | 2.5 Linear Systems with Constant Coefficients |
| 6 | 20-24 Feb | 2.6 Similarity of Matrices and the Jordan Canonical Form |
| | | 2.7 Asymptotic Behavior of Solutions of Linear Systems with Constant Coefficients |
| **Major Exam 1. Material: 1.1-2.5. Date: Tuesday (March 01, 2022). Time: 2:00PM – 4:00PM** | | |
| 7 | 27 Feb – 3 Mar | 2.8 Autonomous Systems – Phase Space – Two dimensional Systems |
| | | 2.9 Linear Systems with Periodic Coefficients |
| 8 | 6-10 Mar | 3.1 Existence in the Scalar Case Exercise Session |
| 9 | 13-17 Mar | 3.2 Existence Theory of Systems of First-Order Equations |
| | | 3.3 Uniqueness of Solutions |
| 10 | 20-24 Mar | 3.4 Continuation of Solutions |
| | | 3.5 Dependence on Initial Conditions and Parameters |
| 11 | 27-31 Mar | 4.2 Definitions of Stability |
| | | 4.3 Linear Systems |
| 12 | 3-7 Apr | 4.4 Almost Linear Systems |
| | | 4.5 Conditional Stability |
| **Major Exam 2. Material: 2.6-2.9 & 3.1-3.5. Date: Thursday (April 7, 2022). Time: 2:00PM – 4:00PM** | | |
| 13 | 10-14 Apr | 4.6 Asymptotic Equivalence |
| | | 4.7 Stability of Periodic Solutions |
| 14 | 17-21 Apr | 5.2 Lyapunov's Theorems |
| | | 5.3 Proofs of Lyapunov's Theorems |
| **24 Apr – 5 May:  Eid Al-Fitr Holidays** | | |
| 15 | 8-12 May | 5.4 Invariant Sets and Stability |
| | | 5.5 The Extent of Asymptotic Stability – Global Asymptotic Stability |
| **Final Exam: Comprehensive. Date: TBD** | | |

Grading Policy:

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

**Attendance:**          9 unexcused absences will result in a DN grade.

**Academic Integrity:**          All KFUPM ethics policies apply in this course.