**Code and Name:**

**MAT5450 Advanced Nonlinear Differential Equations**

**Unit:**

Institute of Science, Department of Mathematics

**Details:**

* **Term:** 2023-2024 Spring
* **Status:** Elective
* **Class Level:** 1
* **Credit Hours:** 3-0-0-3
* **ECTS:** 6
* **Language:** Turkish

**Course Instructors:**

* **Course Coordinator:** ...
* **Assistant Instructor:** ...
  + **Phone:** ...
  + **Email:** ...@firat.edu.tr
  + **Social Accounts:** ...

**Weekly Schedule**

| **Monday** | **Tuesday** | **Wednesday** | **Thursday** | **Friday** | **Saturday** |
| --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |

**Teaching Method:**  
Each weekly hour will include at least 45 minutes of face-to-face teaching.

**Location:**

* **In-person (YY):** Classroom (To be announced)
* **Remote (UE):** -

**Objective:**

To introduce students to the fundamental concepts, analysis, and applications of nonlinear differential equations and autonomous systems. The course emphasizes mathematical modeling, stability analysis, and the use of analytic and geometric techniques to study system behaviors. It also aims to develop students’ mathematical modeling, analytical thinking, and problem-solving skills through real-world applications.

**Materials:**

1. B.J. Gireesha, Rama S.R. Gorla, B.C. Prasannakumara, *Advanced Differential Equations*, 2017
2. P.D. Mottoni, L. Salvadori, *Nonlinear Differential Equations: Invariance, Stability, and Bifurcation*, Academic Press, 1981
3. D. Jordan, P. Smith, *Nonlinear Ordinary Differential Equations: An Introduction for Scientists and Engineers*, 2007
4. S.H. Strogatz, *Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry, and Engineering*, CRC Press, 2018

**Student Responsibilities:**

Students are required to attend at least 70% of the classes.

**Weekly Lesson Plan:**

| **Week** | **Topic** | **Methodology** |
| --- | --- | --- |
| 1 | Introduction to the course and key concepts | Face-to-Face |
| 2 | **Introduction**: Definition and importance of autonomous systems, comparison of linear and nonlinear differential equations | Face-to-Face |
| 3 | Mathematical modeling and application areas | Face-to-Face |
| 4 | Classification of nonlinear differential equations | Face-to-Face |
| 5 | Analytical solution techniques with examples and applications | Face-to-Face |
| 6 | Definition and properties of autonomous systems | Face-to-Face |
| 7 | Fixed points and their behavior, phase diagrams and portraits | Face-to-Face |
| 8 | Mathematical analysis of autonomous systems | Face-to-Face |
| 9 | **Midterm Exam** | Face-to-Face |
| 10 | Linearization techniques and their importance | Face-to-Face |
| 11 | Characterization and stability concepts of autonomous systems | Face-to-Face |
| 12 | Advanced linearization techniques | Face-to-Face |
| 13 | Dynamic behavior of autonomous systems: Analytical and graphical solutions | Face-to-Face |
| 14 | Analysis of real-world problems through mathematical models | Face-to-Face |

**Assessment and Evaluation:**

| **Method** | **Quantity** | **Weight** |
| --- | --- | --- |
| **Midterm Exam** | 1 | 50% |
| **Quizzes** | None | - |
| **Assignments** | Pre- and post-midterm activities | - |
| **Projects** | None | - |
| **Final Exam** | 1 | 50% |

**Learning Outcomes:**

1. Understand the analysis of nonlinear differential equations and learn analytical solution techniques.
2. Define and analyze autonomous systems, including fixed points and phase portraits.
3. Conduct stability analysis using the Jacobian matrix and linearization techniques.
4. Model and solve real-world problems involving dynamic systems, analyzing their behaviors both analytically and graphically.
5. Apply theoretical knowledge to practical problems and analyze results.

**Special Notes:**

* **UE:** Remote Education
* **YY:** Face-to-Face Education