**Code and Name:**

**MAT5420 Advanced Ordinary Differential Equations and Applications**

**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 explore linear systems and vector equations, phase diagrams for linear systems, stability theory, eigen-equations, and their solutions. To study the applications of Green’s function, first-order differential equations, comparison theorems for second-order equations, and well-posedness for higher-order equations. The course also aims to teach Laplace transforms, linear systems' properties, and their solutions.

**Materials:**

1. K.O. Friedrichs, *Advanced Ordinary Differential Equations: Institute for Mathematics and Mechanics*, New York University
2. B.J. Gireesha, Rama S.R. Gorla, B.C. Prasannakumara, *Advanced Differential Equations*, 2017

**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 | **Fundamental Results**: Linear phase diagrams | Face-to-Face |
| 3 | **Linear Systems**: Bifurcation, vector equations, matrix exponential functions, continuous systems | Face-to-Face |
| 4 | **Autonomous Systems**: Planar phase diagrams | Face-to-Face |
| 5 | **Planar Phase Diagrams for Linear Systems**: Stability analysis | Face-to-Face |
| 6 | **Nonlinear Systems**: Stability and linearization | Face-to-Face |
| 7 | **Second-Order Self-Adjoint Equations**: Sturm-Liouville problems, Green’s function | Face-to-Face |
| 8 | **Midterm Exam** | Face-to-Face |
| 9 | **First-Order Differential Equations**: Solutions, principles, separable and rational linear equations | Face-to-Face |
| 10 | **Second-Order Linear Equations**: Mechanical oscillation, uniqueness, Wronskian, comparison theorems | Face-to-Face |
| 11 | **Higher-Order Linear Equations**: Stability, well-posedness, uniform convergence | Face-to-Face |
| 12 | **Laplace Transform**: Solutions to differential equations, convolution, Dirac distribution | Face-to-Face |
| 13 | **Linear Systems**: Eigenvalues, eigenvectors, exponential matrices, phase spaces | Face-to-Face |
| 14 | **Linear Systems**: Autonomous planar systems, stability, Lyapunov methods, Poincaré-Bendixson theorem | 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 linear phase diagrams, linear systems, and matrix exponential functions.
2. Analyze autonomous systems and stability, and study nonlinear systems.
3. Explore linearization of nonlinear systems, Sturm-Liouville problems, and Green’s function.
4. Learn solutions to first- and second-order differential equations, mechanical oscillations, and comparison theorems.
5. Analyze higher-order linear equations, Laplace transforms, and Lyapunov functions.

**Special Notes:**

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