**Code and Name:**

**MAT5590 Spectral Theory of the Hill Equation**

**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 the fundamental concepts related to the spectral theory of the Hill equation.

**Materials:**

1. M.S.P. Eastham, *The Spectral Theory of Periodic Differential Equations*, Edinburgh-London
2. M.S.P. Eastham, *Results and Problems in Spectral Theory of Periodic Differential Equations*, Lecture Notes in Mathematics
3. W. Magnus, S. Winkler, *Hill’s Equation*, Interscience Wiley, New York, 1966
4. P. Arbenz, W. Petersen, *Introduction to Parallel Computing*, Oxford University Press, 2004

**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 | **Hill Equation**: Definition, properties, existence and uniqueness theorems, Floquet theorem | Face-to-Face |
| 3 | **Hill Discriminant**: Definition, stability, instability, conditional stability concepts | Face-to-Face |
| 4 | **t-Periodic Case**: Eigenvalues, eigenvectors, and boundary conditions | Face-to-Face |
| 5 | Multiplicity criteria for t-periodic boundary value problems | Face-to-Face |
| 6 | **Green’s Function**: Definition and properties | Face-to-Face |
| 7 | **Graphing the Hill Discriminant**: Stability and instability regions | Face-to-Face |
| 8 | **Characteristic Values**: Stability intervals and asymptotic behavior | Face-to-Face |
| 9 | **Midterm Exam** | Face-to-Face |
| 10 | **Liapounov and Borg Theorems**: Applications | Face-to-Face |
| 11 | **Fourier Transform**: Periodic and semi-periodic problems | Face-to-Face |
| 12 | **Eigenvalue Problems**: Comparison of different eigenvalue problems | Face-to-Face |
| 13 | **Perturbation Method**: Application to differential equations, Lamé equation | Face-to-Face |
| 14 | **Whittaker-Hill Equation**: Definitions and general properties | 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 Hill equation, its discriminant, and stability concepts.
2. Learn eigenvalue and eigenvector concepts and integral operator methods.
3. Understand Green’s function and its properties.
4. Grasp the analytical properties of the discriminant, and Liapounov and Borg theorems.
5. Learn Fourier transform, oscillation theorem, and eigenvalue problems.

**Special Notes:**

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