**Code and Name:**

**MAT5540 Spectral Theory of the Sturm-Liouville Operator**

**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 study the spectral theory of the Sturm-Liouville operator and apply it to physical problems.

**Materials:**

* B.M. Levitan, I.S. Sargsjan, *Introduction to Spectral Theory: Selfadjoint Ordinary Differential Operators*, AMS

**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 to Boundary Value Problems**: Eigenvalues, eigenfunctions, and self-adjointness | Face-to-Face |
| 3 | **Sturm-Liouville Operators**: Fundamental theorems in Sturm-Liouville theory | Face-to-Face |
| 4 | **Eigenfunctions and Eigenvalues**: Asymptotic formulas for normalization constants and spectral functions | Face-to-Face |
| 5 | **Zeros of Eigenfunctions**: Comparison theorems, oscillation theorem | Face-to-Face |
| 6 | **Periodic Solutions**: Expansion theorem | Face-to-Face |
| 7 | **Proof of Expansion Theorem**: Using finite difference methods | Face-to-Face |
| 8 | **Midterm Exam** | Face-to-Face |
| 9 | **Proof of Expansion Theorem**: Using integral equations | Face-to-Face |
| 10 | **Periodic Case**: Proof of expansion theorem using contour integration | Face-to-Face |
| 11 | **Trace Formulas**: Parseval's equality on the semi-plane | Face-to-Face |
| 12 | **Weyl Point and Circle**: Parseval's equality on the full plane | Face-to-Face |
| 13 | **Orthogonality of Expansions** | Face-to-Face |
| 14 | **Parseval's Equality**: For nth-order self-adjoint differential operators | 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. Prove fundamental theorems for the Sturm-Liouville operator.
2. Derive asymptotic formulas for eigenfunctions, eigenvalues, normalization constants, and spectral functions in Sturm-Liouville problems.
3. Prove expansion theorems and address periodic cases using contour integrals.
4. Analyze the Weyl point and circle.
5. Study Parseval's equality.

**Special Notes:**

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