**Code and Name:**

**MAT5140 Spectral Theory of Differential Operators**

**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 teach the fundamental definitions and theorems of the spectral theory of differential operators. The course covers topics such as the Weyl point and Weyl circle, resolvent, discrete spectrum, Parseval’s identity, Fourier integrals, Legendre and Bessel problems, and orthogonal problems.

**Materials:**

* B.M. Levitan and I.M. Levitan, *Introduction to Spectral Theory: Self-Adjoint Ordinary Differential Operators*, AMS, 1975

**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 basic concepts in spectral theory | Face-to-Face |
| 2 | Sturm-Liouville operator, self-adjoint operators, spectrum, resolvent | Face-to-Face |
| 3 | Eigenvalue reality, orthogonality of eigenfunctions, and simple eigenvalues | Face-to-Face |
| 4 | Asymptotic representation of eigenvalues, eigenfunctions, and normalizing constants | Face-to-Face |
| 5 | Expansion theorem via finite difference and integral equations | Face-to-Face |
| 6 | Dirac equation system, one-dimensional Dirac systems | Face-to-Face |
| 7 | Trace calculation for Sturm-Liouville problems | Face-to-Face |
| 8 | Spectral problems on the half-line and full line, Weyl point and Weyl circle | Face-to-Face |
| 9 | Midterm Exam | Face-to-Face |
| 10 | Integral representation of resolvent, higher-order Sturm-Liouville problems | Face-to-Face |
| 11 | Parseval's identity and its proof for Sturm-Liouville problems | Face-to-Face |
| 12 | Discrete spectrum and its properties; Dirac systems and discrete spectrum | Face-to-Face |
| 13 | Fourier integrals, Fourier-Bessel expansions, Legendre and Bessel problems | Face-to-Face |
| 14 | Orthogonal polynomials and their properties; asymptotic expansions | 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 basic problems and properties of spectral analysis, including Sturm-Liouville operators.
2. Learn self-adjoint operators, spectrum, eigenvalues, eigenfunctions, and oscillation theorems.
3. Grasp the one-dimensional Dirac equation system and spectral problems on the half-line.
4. Understand Weyl points, Weyl circles, resolvents, and higher-order Sturm-Liouville problems.
5. Learn Parseval’s identity, discrete spectrum, Fourier integrals, Legendre and Bessel polynomials, and orthogonal polynomials.

**Special Notes:**

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