1. **Inner product space**.

Vector space; inner product space; the space of square integrable functions L²**;**convergence in L²; orthogonal functions (9 lectures).

2. **The Sturm-Liouville theory**.

Linear second-order equations; self-adjoin differential operator; the Sturm-Liouville problem; existence and completeness of the Eigen functions; regular and singular problems (9 lectures).

3. **Fourier series**.

The fundamental theorem of Fourier series in L²; point wise theory of Fourier series; applications to boundary-value problems (6 lectures).

4. **Orthogonal polynomials**.

Legendre, Hermite, and Laguerre polynomials as solutions of certain singular Sturm-Liouville problems; their orthogonality and completeness properties; generalized Fourier expansions (9 lectures).

5. **Bessel functions**.

The gamma function; Bessel's equation and Bessel functions of the first kind; orthogonality properties (6 lectures).

6. **Fourier transformation**.

The Fourier transform; the Fourier integral; properties and applications in PDE (6 lectures).

**Required Textbook:**

**1.** Fourier Series And Integrals Of Boundary Value Problems

**Author**: J. Ray Hanna

**2.** The Strum-Liouville Theory And It’s Application

**Author**: M. A. Al-Gwaiz

**3.** Application Of LieGroups to Differential Equations

Second Edition