

Functional Analysis & Topology

1.1 Course Number: MA 311

1.2 Contact Hours: 3-0-0 Credits: 9

1.3 Semester-offered: 3rd Year-Odd

1.4 Prerequisite: Linear Algebra, Real Analysis, Complex Analysis

1.5 Syllabus Committee Member: Dr. C. Kundu, Dr. M.K. Rajpoot, Dr. A. Kumar,
Dr. G. Rakshit

2. **Objective:**

To obtain knowledge of topological spaces and their various properties. To get familiar with continuity of functions and their applications in Physical sciences. To learn connectedness, compactness of various spaces and its properties.

3. **Course Content:**

Unit-wise distribution of content and number of lectures

Unit	Topics	Sub-topic	Lectures
1	Topology	Topological spaces, Basis for a topology, Limit points and closure of a set, Continuous and open maps, Homeomorphisms, Subspace topology, Product and quotient topology. Connected and locally connected spaces, Path connectedness, Components and path components, Compact and locally compact spaces.	15
2	Introduction to Normed Linear Space and Banach Spaces	Normed linear spaces, Banach spaces and their examples, quotient spaces, bounded linear operators, finite dimensional Banach spaces, L_p Spaces, L_p spaces as examples for Banach spaces.	10
3	Hilbert Spaces	Hilbert spaces - Inner product spaces and its properties, Hilbert spaces and examples, best approximation in Hilbert spaces, orthogonal complements, orthonormal basis	8
4	Important Theorems	Hahn Banach theorems, Uniform boundedness principle, open mapping theorem, closed graph theorem, transpose of an operator.	7
		Total	40

4. Readings

4.1 Textbook:

- *Introduction to Topology and Modern Analysis* by G.F. Simmons
- *Functional Analysis* by B. V. Limaye

4.2 Reference books:

- *Topology* by James R. Munkres
- *Introductory functional analysis with applications* by E. Kreyszig

5 Outcome of the Course:

- Apply problem-solving using functional analysis technique applied to diverse situations in physics, engineering and other mathematical context.
- Appreciate the role of Zorn's lemma.
- Topology uses to analyze complex networks
- It applies Differential Topology to probability to identify multivariate interactions.