



DEPARTMENT OF MATHEMATICS

Semester: VII

Integrated M.Sc. Mathematics
Subject: 060090702 Functional Analysis

Academic Year: 2019-20

Teaching Schedule

Course Objectives: To study the concepts of Function Analysis with results and methods those are applicable to other areas of mathematics and are the foundations for more advanced topics in functional analysis.

Course Outcomes: Upon completion of the course, students shall be able to

- CO1:** deal with various examples of metric spaces, work with completeness, have some familiarity with continuous maps.
- CO2:** recognize the fundamental properties of normed spaces and of the transformations between them.
- CO3:** explore the properties of linear spaces and linear operators.
- CO4:** describe the geometry and properties of inner product spaces, Provide suitable representations of functionals on Hilbert spaces.
- CO5:** check whether a linear operator is bounded, to find its adjoint and determine whether operators are normal, self-adjoint, unitary or positive.
- CO6:** utilize Zorn's lemma, Apply the Hahn-Banach theorem for complex vector spaces and normed spaces.

Unit	Sub Unit	No. of Lect.(s)	Topics	Reference Chapter/ Additional Reading	Teaching Methodology to be used	Active Learning Activities	Evaluation Parameter
Unit 1: Metric Spaces							
[10]	1.1	1	Metric space, Examples of Metric Space	Ch#1 Functional Analysis and its application E. Kreyszig	Chalk & Talk	For Slow Learner: Students must write answer of question(s) given by teacher after completion of unit For Active Learner: Student will solve extra examples other than examples which are given in assignment after completion of Unit.	Assignment-1
	1.2	2	Open sets, Closed sets				
	1.3	1	Neighborhood,				
	1.4	2	Convergence,				
	1.5	2	Cauchy sequence				
	1.6	2	Completeness and Completion of metric space				
Unit 2: Normed Spaces and Banach Spaces							





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[20]	2.1	2	Vector Space, Normed Space, Banach Space	Ch#2 Functional Analysis and its application E. Kreyszig	Chalk & Talk	For Slow Learner: Students must write some theorems given by teacher after completion of unit For Active Learner: Student will find the application after completion of Unit.	Unit Test -1 and Assignment-2
	2.2	1	Properties of Normed spaces				
	2.3	3	Finite Dimensional normed space and subspaces				
	2.4	3	Compactness and finite dimension				
	2.5	3	Linear operators, Bounded and continuous liner operators				
	2.6	3	Linear functionals, Linear operators and functionals on a Finite dimensional space				
	2.7	2	Normed spaces of operators				
	2.8	3	Dual spaces				
Unit 3: Inner Product Spaces, Hilbert Spaces							
[15]	3.1	2	Inner Product space, Hilbert space, Properties of Inner Product Space	Ch#3 Functional Analysis and its application E. Kreyszig	Chalk & Talk	For Slow Learner: Students must write some theorems given by teacher after completion of unit For Active Learner: Student will find the application after completion of Unit.	Unit Test -2 Assignment-3
	3.2	2	Orthogonal compliments and direct sums				
	3.3	2	Orthonormal sets and sequences				
	3.4	3	Series related to orthonormal sequences and sets, Total orthonormal sets and sequences				
	3.5	3	Representation of functionals on Hilbert spaces				
	3.6	3	Hilbert adjoint operator, Self-adjoint unitary and normal operator.				





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Unit 4: Fundamental theorems for Normed and Banach spaces

[15]	4.1	1	Zorn's Lemma	Ch#4 Functional Analysis and its application E. Kreyszig	Chalk & Talk	For Slow Learner: Students must write some theorems given by teacher after completion of unit For Active Learner: Student will find the application after completion of Unit.	Internal Examination and Assignment-4
	4.2	2	Hahn – Banach theorem, Hahn – Banach theorem for complex vector spaces and normed spaces				
	4.3	2	applications to Bounded linear functionals on $C[a, b]$				
	4.4	2	Adjoint operator, Reflexive spaces				
	4.5	2	Category theorem and uniform boundedness theorem				
	4.6	3	Strong and weak convergence, Convergence of sequences of operators and functionals				
	4.7	3	Weak convergence, Open mapping theorem, closed linear operators, Closed Graph theorem				

Text books:

1. E. Kreyszig, "Functional Analysis and its application", John Wiley and sons, 2007.

Reference books:

1. B.V. Limaye, "Functional Analysis", Wiley Eastern Ltd.
2. G.F. Simmons, "Introduction to Topology and Modern Analysis", McGraw - Hill.
3. J.N. Sharma and A Vashistha, "Functional Analysis".

Course Objectives and Course Outcomes Mapping:

- To study the fundamentals concepts of function analysis with results and methods those are applicable to other areas of mathematics and are the foundations for more advanced topics in functional analysis: CO1, CO2, CO3, CO4, CO5, CO6





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Course Units and Course Outcomes Mapping:

Unit No.	Unit	Course Outcomes					
		CO1	CO2	CO3	CO4	CO5	CO6
1	Metric Spaces	✓	✓				
2	Normed Spaces and Banach Spaces		✓	✓			
3	Inner Product Spaces, Hilbert Spaces				✓	✓	
4	Fundamental theorems for Normed and Banach spaces						✓

Programme Outcomes (PO)

PO1: Knowledge

Provides knowledge about the fundamentals of pure, applied and computing mathematics and its applications to students that creates the opportunities in industries and research centers.

PO2: Core Competence

Creates competency in science and mathematics to formulate, analyses and solve problem and/or also to pursue advanced study or research.

PO3: Breadth

Trains students having good knowledge in unearth core of academia and industry by the roots of mathematics.

PO4: Evaluation

Imparts in students to raise trial and error-based curiosity and problem-solving functionality with research based advanced tutorial for higher level decision makings tools.





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Programme Outcomes and Course Outcomes mapping:

Programme Outcomes	Course Outcome					
	C01	C02	C03	C04	C05	C06
P01		✓	✓	✓		
P02	✓				✓	✓
P03	✓			✓	✓	✓
P04	✓			✓	✓	✓

