Estd 1864

Forman Christian College, Lahore
(A Chartered university)
Department of Mathematics

SPRING 2022
MATH-407
Section: A

Instructor Information:

Imrana Shafique
Assistant Professor
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Office: S-411 (Armacost Science Building)

Office Hours:

Monday & Wednesday:	10:00 am - 10:50 am
	12:00 pm - 02:00 pm
Tuesday & Thursday:	12:30 pm - 02:00 pm
Friday:	10:00 am - 10:50 am

Course Information:

Course Code: MATH-407 Course Title: Functional Analysis
Credit hours: 3 Prerequisite: MATH-311
Section: A Room: S-413
Class timings: M W F: 9:00 am – 09:50 am

Recommended Text:

Introductory Functional Analysis with Applications,
By Erwin Kreyszig
Elements of Topology and Functional Analysis,
By Dr. Abdul Majeed

Course Contents:

This is a course describing pure Mathematics. Course content include the following: Normed spaces, Banach spaces, convex spaces, equivalent norms, quotient spaces, finite dimensional normed spaces, linear operators, continuous or bounded linear operators, dual spaces, inner product spaces, orthonormal sets and

basis, Hilbert spaces, annihilators, projections and decomposition theorem in Hilbert spaces, linear functionals on Hilbert spaces and reflexivity of Hilbert spaces.

Course Objectives:

The objective of this course is to enable the student to deal with pure Mathematics. It will help the students to understand the key concepts like norms, spaces, functionals and operators and generalize the concepts from Topology and Metric spaces with notation of norms. It will develop skills and confidence in students to deal with Mathematical analysis with proof techniques.

Course Requirements:

Students are expected to attend every class and to arrive at each class on time and remain in class for the entire class period. If a student arrives **10 minutes** late, he/she will not be marked as present. Instructor may choose to lower a student's grades because of tardiness. Consult the instructor during office hours. If your visit may tend to be lengthy, make an appointment with the instructor so that she may set aside some time for you. Cell phones will be turned off / on silent while the student is in the classroom. **No cell phone calculators are allowed to be used in physical exams**.
Minimum 70% attendance is required to appear in the final term exam.
After due date, assignment will not be graded. There will be no make-up quiz. Only make up of mid-term or final can be considered if solid proof will be provided within three days after exam. In case of make-up exam there will be a **0-20% deduction** in marks depending upon case to case basis. Academic dishonesty or cheating will result in zero points (grade F) and will be referred to AIC (Academic Integrity Committee) at FCC for necessary action.

Learning Outcomes:

Students will be able to

- understand the key concepts such as norm, normed spaces, Banach spaces etc.
- discuss convergence in normed spaces,
- recognize inner product spaces,
- identify dual spaces of normed spaces,
- understand functionals,
- explain some properties of Hilbert spaces,
- deal with abstract Mathematics,
- connect Topology and Metric spaces with Functional analysis.

Course Evaluation:

Grading will be based on following criteria:

Assignments	10%
Quizzes	15%
Mid Term	30%
Presentation	10%
Final Exam	35%

Grades	Quality Points	Numerical Value	Meaning
A	4.00	93-100	Superior
A-	3.70	90-92	
B+	3.30	87-89	
B	3.00	83-86	Good
B-	2.70	80-82	Fair
C+	2.30	77-79	
C	2.00	73-76	Satisfactory
C-	1.70	70-72	
D+	1.30	67-69	
D	1.00	60-66	Passing
F	0.00	59 or below	Failing

Course Outline:

Week	Topics	Assessment
1	Discussion of Course Plan: course introduction, policies, requirements and grading criteria. A brief review of vector spaces and metric spaces. **Normed spaces:** Norm.	
2	Normed spaces and its examples.	
3	Banach spaces and its examples. Convergence in normed space and its basis.	Quiz- 1
4	Convergence in normed space and its basis (cont.)	
5	Convex set.	Assignment 1
6	Quotient spaces, Equivalent norms.	
7	Finite dimensional normed spaces. **Linear Operators:** Linear operators, inverse of linear operators.	Quiz 2

8	Continuous or bounded linear operators.	**Mid Term**
9	Linear functionals.	
10	Dual spaces of a normed space. **Hilbert Spaces:** Inner product spaces,	
11	Cauchy Schwarz Inequality, Theorems on inner product spaces,	Quiz-3
12	inner product spaces as metric spaces.	
13	Orthogonal and Orthonormal systems. Orthogonalisation theorem.	Assignment 2
14	**Decomposition Theorems in Hilbert Spaces:** Annihilators. Projections in Hilbert spaces.	Quiz 4
15	Linear functionals on Hilbert spaces.	Presentation
27/06/22 to 06/07/22	**FINAL EXAM**	**As announced by university**