BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, Pilani
Hyderabad Campus

SECOND SEMESTER 2022 -2023
Course Handout (Part II)

Date: 16/01/2023

In addition to Part I (General Handout for all courses appended to the time table) this portion gives further specific details regarding the course.

Course No. : **MATH F341**
Course Title : **INTRODUCTION TO FUNCTIONAL ANALYSIS**
Instructor-in-Charge: **Jhuma Sen Gupta**
Name of other Instructor: **Anshid Aboobacker and Debarati Mondal**

1. Scope and Objective of the Course:

Objective of the course is to present some basic tools of Functional Analysis in a form suitable for Engineers Scientists & Mathematicians. Ideas are not always generated by logical processes. An engineer may have a feeling for a problem which may lead him in a method of solution but justifying part of that needs Analysis. In this course we give such motivation and also cover the analysis part. Several concepts of Functional Analysis were invented as there were needs from other areas such as differential equations, optimization, Integral equations etc. Modern theory of partial differential equations relies heavily on the fundamental tools of Functional Analysis.

2. Text-book: Erwin Kreyszig, *Introductory Functional Analysis with Applications*, Reprinted 2010, John Wiley

3.. Reference Books:

- *Bryan P. Rynne* et al., Linear Functional Analysis, Springer Undergraduate Mathematics series, 2nd ed. 2008
- *S. Kesavan*, Functional Analysis,TRIM (52), 2017.
- *John B. Conway*., A course in Functional Analysis, John B. Conway, GTM, 2nd ed, 2010.

4. Course Plan:

Lecture no.	Learner's objective	Topics to be covered		Chapter in the Text Book
1-2	Review of linear Algebra and Real Analysis	some concepts of Vector spaces, dimension, finite dimensional vector spaces, Metric spaces, space of continuous functions, Compactness		Chapter 1 & Chapter 2: Sec 2.1
3 – 6	Introduction to normed linear spaces and Banach spaces	Normed Linear Spaces, Banach spaces and examples such as l_p, c, c_0, $C[a,b]$		Chapter 2 : Sec 2.2
7 – 9	Studying properties of normed linear spaces	Properties of normed linear spaces		Chapter 2 : Sec 2.3
10 – 11	Investigating the equivalence of norms on a normed linear space	Finite-Dimensional normed linear spaces and compact sets		Chapter 2: Sec 2.4 and 2.5
12 – 16	Studying continuity of linear transformations on normed linear spaces	Continuous linear transformations, linear functionals, dual spaces, reflexivity		Chapter 2: Sec 2.6 - 2.10
17 – 18	How a continuous linear functional defined on a subspace can be extended to the whole space	Hahn-Banach Theorem and its applications		Chapter 4: Sec 4.1- 4.3, 4.6
19 – 25	Investigating when a family of Continuous linear transformations are uniformly bounded, when a continuous linear map a homeomorphism	Category theorem, uniform boundedness principle, strong and weak convergence, Open Mapping theorem, Closed graph theorem		Chapter 4: Sec 4.7 – 4.13
26 - 30	How concept of dot product can be generalized to certain vector spaces	Inner Product spaces, Hilbert spaces, orthogonal sets, direct sum, Bessel's inequality, continuous linear functionals on Hilbert space		Chapter 3 Sec 3.1 – 3.6
31 – 35	Dual of a Hilbert space, how transpose of a matrix has generalization to continuous linear transformations in Hilbert spaces	Riesz Representation theorem, Symmetric and self adjoint operators		Chapter 3: Sec 3.8 -3.10
36 - 40	Are there finite rank transformations defined on infinite dimensional spaces	Compact linear operators and their spectral properties		Chapter 8: Sec 8.1-8.3

5. Evaluation Scheme:

Sl. No.	Evaluation Component	Duration	Weightage (%)	Date and Time	Nature of Component
1	Mid Semester Test	90 mins	30	15/03 4.00 - 5.30PM	Closed
2	Assignments		10 + 10	There will be two components, one before the mid-semester and one after the mid-semester exam	Open
3	Surprise Quiz		10	One quiz will be conducted at tutorial/lecture hours and will be of surprise nature	Open
4	Comprehensive Exam	180 mins	40	06/05 FN	Closed

6. **Announcements:** All the announcements in relation to the above course will be put up on CMS.
7. **Total Marks: 100**
8. **Make up policy:** Make up for the mid-semester/comprehensive examination will be given to the genuine cases.
9. **Chamber consultation hours:** To be announced in the class.
10. **Academic Honesty and Integrity Policy**: Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

INSTRUCTOR-IN-CHARGE
MATH F341