

BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, Pilani

**Hyderabad Campus**

**SECOND SEMESTER 2022 -2023**

**Course Handout (Part II)**

Date: 09/01/2024

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***: Sangeeta Dhawan and Sunil Rampuria**

**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.

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| **Lecture no.** | **Learner’s objective** | **Topics to be covered** | **Chapter in the Text Book** |
| 1-2 | Review of some concepts of linear Algebra and Real Analysis | 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  *lp*, *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 finite dimensional normed linear space | Finite-Dimensional normed linear spaces and compact sets | Chapter 2: Sec 2.4 and 2.5 |

**4. Course Plan:**

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| 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 - 41 | 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:**

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| **Sl. No.** | **Evaluation Component** | **Duration** | **Weightage**  **(%)** | **Date and Time** | **Nature of Component** |
| 1 | Mid Semester Test | 90 mins | 30 | 13/03 - 2.00 - 3.30PM | Closed |
| 2 | Assignments/Group Presentations/viva |  | 10 + 10 | There will be two components, one before the mid-semester and one after the mid-semester exam | Open |
| 3 | Surprised Quiz |  | 10 | One quiz will be conducted at tutorial/lecture hours and will be of surprise nature | Open |
| 4 | Comprehensive Exam | 180 mins | 40 | 11/05 AN | Closed |

1. **Announcements:** All the announcements in relation to the above course will be put up on CMS.
2. **Total Marks: 100**
3. **Make up policy:** Make up for the mid-semester/comprehensive examination will be given to the genuine cases.
4. **Chamber consultation hours:** To be announced in the class.
5. **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**