**University of Management and Technology**

**Course Outline**

Course Code: MTH-611 Course title: [Advanced Functional Analysis](http://sst.umt.edu.pk/newsite/courses/Spring15/Maths/Advanced%20Functional%20Analysis%20Prof.Dr.Shaukat-Rahim-Ch.docx)

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| --- | --- |
| Program | MS/PhD |
| Credit Hours | 03 |
| Duration | 01 Semester |
| Prerequisites | Basic acquiring general knowledge in and concepts of Real and complex analysis enabling students to successfully apply it when needed in other courses. |
| Resource Person | Dr. Naeem Saleem |
| Counseling Timing  (Room# ) | 3S-39 |
| Contact | [naeem.saleem@umt.edu.pk](mailto:naeem.saleem@umt.edu.pk)  03214262145 |

**Chairman/Director signature………………………………….**

**Dean’s signature…………………………… Date………………………………………….**

**Learning Objective:**

This course has been designed for graduate students of computer sciences, economics, mathematics and applied mathematics.

The first part of the course deals with the basics of various metric spaces, and notions like convergence and continuity in these spaces. We will discuss fixed point results in several metric saces. Second part of this course is about the application fixed point theorems in these spaces. Moreover, some applications in computer sciences, game theory, economics, behavioral sciences and biology will be covered as well.

**Learning Methodology:**

After successfully completing the course, students should be

* Able to apply and extend the several theoretical results to real word problems.
* Comparative analysis can be made amongst the latest techniques
* Able to read, understand and explore research articles about the latest techniques of non-linear analysis.

**Grade Evaluation Criteria**

Following is the criteria for the distribution of marks to evaluate final grade in a semester.

**Marks Evaluation Marks in percentage**

Quizzes 10

Assignments 10

Mid Term 25

Attendance & Class Participation 00

Term Project 10

Presentations 05

Final exam 40

Total

**Recommended Text Books:**

1. A Course in Functional Analysis, 2nd ed. by John B. Conway.
2. Introductory Functional Analysis with Applications by Erwin Kreyszig

**Reference Books:**

1. Linear Functional Analysis by Bryan P. Rynne and Martin A. Youngson
2. Functional Analysis 2nd Edition by [Walter Rudin](https://www.amazon.com/Walter-Rudin/e/B00456TAWE/ref=dp_byline_cont_book_1)
3. Elements of the Theory of Functions and Functional Analysis by: [A. N. Kolmogorov](http://doverpublications.ecomm-search.com/search?keywords=A.%20N.%20Kolmogorov), [S. V. Fomin](http://doverpublications.ecomm-search.com/search?keywords=S.%20V.%20Fomin)
4. **We will also discuss maximum possible latest research paper on the techniques non-linear functional analysis**

**Calendar of Course contents to be covered during semester**

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| --- | --- | --- | --- | --- |
| **Week** | **Course Contents** | | **Reference Chapter(s)** | |
| 1 | 1. Metric spaces and related topological notions 2. Cauchy sequences and convergence in metric spaces | | Chapter 01 | |
| 2 | 1. Normed spaces, examples and its properties 2. Finite dimensional normed spaces | | Chapter 02 | |
| 3 | 1. Banach spaces 2. Continuous linear transformations. | | Chapter 02 | |
| 4 | 1. Further properties of continuous linear transformation. 2. Hilbert spaces and related examples of Hilbert spaces | | Chapter 02 | |
| 5 | 1. Orthogonality. 2. Representation of functionals on Hilbert spaces | | Chapter 03 | |
| 6 | 1. Hilbert-adjoint operator. 2. Normal, self-adjoint and unitary operators. | | Chapter 03 | |
| 7 | 1. Zorn’s Lemma 2. Hahn-Banach Theorem | | Chapter 04 | |
| 8 | 1. Adjoint operators and its applications 2. Reflexive spaces | | Chapter 04 | |
| 9 | 1. Uniform boundedness principle 2. Fourier series and uniform boundedness principle | | Chapter 04 | |
| 10 | | 1. Strong, weak and weak\* convergence 2. Numerical integration and weak\* convergence | | Chapter 04 | |
| 11 | | 1. Open mapping and closed graph theorems 2. Application to Bounded linear functional C[a,b] | | Chapter 04 | |
| 12 | | 1. Convergence of sequences of operators and functional 2. Application to summability of sequences | | Chapter 04 | |
| 13 | | 1. Banach fixed point theorem 2. Application of Banach fixed point theorem to linear equations | | Chapter 05 | |
| 14 | | Application of Banach fixed point theorem to differential equations | | Chapter 05 | |
| 15 | | Application of Banach fixed point theorem to integral equaltions Equations | |  | |
| 16 | | Project presentations/final term | |  | |