Course Specification

(Postgraduate Programs)

Course Title:	**Functional Analysis**
Course Code:	**MAT 7115**
Program:	**Doctor of Philosophy in Mathematics**
Department:	**Mathematics and Statistics**
College:	**Science**
Institution:	**Imam Mohammad Ibn Saud Islamic University**
Version:	**2024 – V1**
Last Revision Date:	**None**

Table of Contents

A. General information about the course:

1. Course Identification

1. Credit hours:					
4 (4 Lectures, 0 Lab, 0 Tutorial)					
2. Course type					
A.	☐ University	☐ College	☒ Program	☐ Track	☐ Others
B.	☒ Required		☐ Elective		
3. Level/Year at which this course is offered: Level 2 / Year 1					
4. Course general Description:					
This course describes the most important ideas and theoretical results of applied functional analysis. The main topics of this course concern the functional analysis of infinite-dimensional linear spaces. The course also deals with the theory of operators: positive definite operators, Fredholm operators, compact operators, self-adjoint operators.					
5. Pre-requirements for this course (if any):					
None.					
6. Co-requisites for this course (if any):					
None.					
7. Course Main Objective(s):					
The objective of this course is to provide a deep knowledge of applied functional Analysis and to study some major theorems and concepts that can be applied in functional analysis and various problems including partial differential equations.					

2. Teaching mode (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100%
2	E-learning	0	0%
3	Hybrid • Traditional classroom • E-learning	0	0%
4	Distance learning	0	0%

3. Contact Hours (based on the academic semester)

No	Activity	Contact Hours
1.	**Lectures**	60
2.	**Laboratory/Studio**	0
3.	**Field**	0
4.	**Tutorial**	0
5.	**Others (specify)**	0

Total	60

B. Course Learning Outcomes (CLOs), Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Code of CLOs aligned with program	Teaching Strategies	Assessment Methods
1.0	**Knowledge and understanding**			
1.1	**Identify the fundamentals of the operator and spectral theories.**	**K1, K2**	**4 lecture hours\week**	**Direct: Regular Exams**
1.2	**Describe the weak topology and weak and weak* convergence.**	**K1, K2**	• **4 lecture hours\week** • **Self-study**	**Direct: Short Quizzes**
2.0	**Skills**			
2.1	**Use techniques of proof in weak topologies.**	**S1, S2**	**Self-study**	**Direct:** • **Participations** • **Short Quizzes**
2.2	**Develop oral communication and technical writing skills through linear operators.**	**S4**	**Real-life problems**	**Direct: Homework and Mini projects**
2.3	**Analyze Internet in searching for resolvents of compact operators.**	**S3**	**Real-life problems**	**Direct: Short Quizzes**
2.4	**Choose out deep and not short proofs in functional theorems.**	**S1, S2**	**Self-study**	**Direct: Participations**
3.0	**Values, autonomy, and responsibility**			
3.1	**Work with independence and responsibility.**	**V1, V2**	**Personal questions**	**Direct: Participation**
3.2	**Lead team works.**	**V1, V3**	**Teamwork and class discussions.**	**Direct: Homework and Mini projects**

C. Course Content

No	List of Topics	Contact Hours
1.	**Duality for normed linear spaces:** Weak topologies, locally convex topological spaces, Mazur's Theorem, Krein-Milman Theorem, Alaoglu's Compactness Theorem.	**20**
2.	**Linear Operators:** Continuous and bounded linear operators, adjoint operators, self-adjoint operator, compact operators, orthonormal bases in Hilbert Spaces.	**15**

3.	**Spectrum of self-adjoint compact operators:** resolvents, the spectral theorem, Hilbert-Schmidt Theorem, Riesz-Schauder Theorem and Fredholm Alternative Theorems.	**25**
Total		**60**

D. Students Assessment Activities

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
1.	**HomeWorks, Quizzes, Mini projects**	**During the semester**	**30%**
2.	**Midterm**	**Week 9-10**	**30%**
3.	**Final Exam**	**Week 15-16**	**40%**

*Assessment Activities (i.e., Written test, oral test, oral presentation, group project, essay, etc.).

E. Learning Resources and Facilities

1. References and Learning Resources

Essential References	• **H. Brezis:** Functional Analysis, Sobolev spaces, and Partial Differential Equations, Springer, New York, 2010.
Supportive References	1. **P. Lax,** Functional Analysis with Applications, John Wiley & Sons, 2002. 2. **Y. Eidelman, V. Milman, and Tsolomitics,** Functional Analysis, An Introduction, Graduate Texts in Mathematics, American Mathematical Society, 2004. 3. **J. Cerda,** Linear functional Analysis, Graduate Texts in Mathematics, American Mathematical Society, 2010. 4. **J.B. Conway,** A course in Functional Analysis, Second Edition, Springer, Graduate Texts in Mathematics v. 96, 1990. 5. **W. Rudin,** Functional Analysis, McGraw-Hill Company, 1973.
Electronic Materials	**None**
Other Learning Materials	**None**

2. Educational and Research Facilities and Equipment Required:

Items	Resources
facilities (Classrooms, laboratories, exhibition rooms, simulation rooms, etc.)	▪ **Each class room should be equipped with a whiteboard and a projector.** ▪ **Laboratories should be equipped with computers and an internet connection.**

Items	Resources
Technology equipment (projector, smart board, software)	**The rooms should be equipped with data show and Smart Board.**
Other equipment (depending on the nature of the specialty)	**None**

F. Assessment of Course Quality

Assessment Areas/Issues	Assessor	Assessment Methods
Effectiveness of teaching	**Students**	**During the semester and at the end of the course each student will complete two evaluation forms.**
Effectiveness of Students assessment	**Instructor**	**At the end of each semester the course instructor should complete the course report, including a summary of student questionnaire responses appraising progress and identifying changes that need to be made if necessary.**
Quality of learning resources	**Students**	**During the semester and at the end of the course each student will complete two evaluation forms.**
The extent to which CLOs have been achieved	**Instructor**	**At the end of each semester the course instructor should complete the course report, including a summary of student questionnaire responses appraising progress and identifying changes that need to be made if necessary.**
Other	**None**	

Assessors (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify)

Assessment Methods (Direct, Indirect)

G. Specification Approval

COUNCIL /COMMITTEE	**MATHEMATICS AND STATISTICS DEPARTMENT COUNCIL**
REFERENCE NO.	**8/1446**
DATE	**05/04/1446 (08/10/2024)**