هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

2023
TP-153

Course Specification
(Bachelor)

Course Title:	**Functional Analysis**
Course Code:	**2024115-3**
Program:	**Bachelor in Mathematics.**
Department:	**Mathematics and Statistics Department**
College:	**Faculty of sciences**
Institution:	**Taif university**
Version:	**1**
Last Revision Date:	**20-05-2023**

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A. General information about the course:

1. Course Identification

1. Credit hours: 3					
2. Course type					
A.	☐University	☐College	☒Department	☐Track	☐Others
B.	☐Required		☒Elective		
3. Level/year at which this course is offered: Level 7/ Fourth Year					
4. Course general Description:					

This course will cover the principles and methods of Functional analysis and its applications in metric spaces with example, Open and Closed set, Convergence, Cauchy sequences, Complete metric spaces with examples. Vector space, Normed space, Further properties of Normed spaces. Compactness and finite dimension, with different examples, Linear operators, Bounded and continuous Linear operators, Linear Functionals, Linear operators and Functionals on Finite Dimensional spaces, Banach spaces, Inner product spaces, Hilbert spaces, Further Properties of Inner product spaces. Riesz Representation Theorem, Self-ad joint, Unitary and Normal operators, Hilbert -Adjoint operator, Dual spaces, Reflexive spaces, Duals paces, Reflexive spaces, Adjoint operator, Orthonormal sets and sequences, Total orthonormal sets, Hahn- Banach Theorem, Uniform boundedness theorem, Open mapping theory and closed mapping theory, Banach Fixed point Theorem with applications, Spectral theory of Linear operators in Normed spaces.

5. Pre-requirements for this course (if any)**:**

Real Analysis (2) (2023202-4)

6. Co-requirements for this course (if any)**:**

None

7. Course Main Objective(s):

In this course, the student should be taught as follows:

1. Stating and defining metric and normed spaces.
2. Identifying and knowing linear operators and transformation, Reproducing Hahn Banach theorem and Hilbert spaces applications, Studying the fixed-point theorem.

and applying the spectral theory in finite and infinite dimensional

2. Teaching mode (mark all that apply)

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

3. Contact Hours (based on the academic semester)

No	Activity	Contact Hours
1.	**Lectures**	45
2.	**Laboratory/Studio**	NA
3.	**Field**	NA
4.	**Tutorial**	NA
5.	**Others (specify)**	NA
Total		45

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	State the definition of (metric spaces and Complete Spaces - normed space and Banach spaces – Hilbert space)	K2	• Lectures • Group discussions	• Quizzes • Assignments
1.2	Describe the (Convergence, Completeness) in a different space.	K2	• Lectures • Group discussions	• Exams • Assignments
...				
2.0	**Skills**			
2.1	Use Analytical techniques in solving many Applications in other disciplines.	S1	• Interactive classes • Group discussions	• Quizzes • Assignments

Code	Course Learning Outcomes	Code of CLOs aligned with program	Teaching Strategies	Assessment Methods
2.2	Explain the dual and reflexive spaces.	S1	• Lectures • Group discussions	• Exams • Quizzes
2.3	Summarize open and closed mapping.	S1	• Lectures • Self-learning through the website	• Exams • Quizzes • Assignments
3.0	**Values, autonomy, and responsibility**			
3.1	Show the responsibility for their own learning and continuing personal and professional development	V2	• Projects	• Through the oral presentation of the projects
3.2				

C. Course Content

No	List of Topics	Contact Hours
1.	Metric spaces, Further examples of metric spaces, Open and Closed set, Convergence, Cauchy sequences, Complete metric spaces with examples.	3
2.	Vector space, Normed space, Further properties of Normed spaces.	3
3.	Compactness and finite dimension, with example.	3
4.	Linear operators, Bounded and continuous Linear operators.	3
5.	Linear Functionals, Linear operators and Functionals on Finite Dimensional spaces.	3
6.	Banach spaces, Inner product spaces.	3
7.	Hilbert spaces, Further Properties of Inner product spaces.	3
8.	First Midterm Exam.	3
9.	Riesz Representation Theorem, Self-ad joint, Unitary and Normal operators, Hilbert -Adjoint operator.	3
10.	Dual spaces, Reflexive spaces. Duals paces, Reflexive spaces, Adjoint operator, Orthonormal sets and sequences, Total orthonormal sets	3
11.	Hahn- Banach Theorem, Uniform boundedness theorem	3
12.	Open mapping theory and closed mapping theory.	3
13.	Second Midterm Exam.	3
14.	Banach Fixed point Theorem with example.	3
15.	Spectral theory of Linear operators in Normed spaces.	3
Total		**45**

D. Students Assessment Activities

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
1.	Quizzes	Continues Evaluation	10 %
2.	Assignments	Continues Evaluation	10 %
3.	Midterm 1-exam	8^{th}-9^{th}	15 %
4.	Midterm 2- exam	12^{th}-13^{th}	15 %
5.	Final Exam	15^{th}-16^{th}	50 %

*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	**Zeidler, E. Applied Functional Analysis: Applications to Mathematical Physics. New York: Springer-Verlag, 1995.**
Supportive References	**K. Yosida, Functional analysis, Sixth Edition. Springer-Verlag. Berlin Heidelberg, 1980**
Electronic Materials	**Publisher's website at http://mathworld.wolfram.com/FunctionalAnalysis.htm**
Other Learning Materials	**Journal of functional analysis**

2. Required Facilities and equipment

Items	Resources
facilities (Classrooms, laboratories, exhibition rooms, simulation rooms, etc.)	**Lecture halls, containing white boards, and electronic monitors - The seats fit the number of students - Laboratories equipped with suitable numbers of computers**
Technology equipment (Projector, smart board, software)	**Data show, Blackboard**
Other equipment (Depending on the nature of the specialty)	**Wi-Fi internet connections**

F. Assessment of Course Quality

Assessment Areas/Issues	Assessor	Assessment Methods
Effectiveness of teaching	Students, Program	Direct & Indirect
Effectiveness of Students assessment	Faculty, Program Leader	Direct
Quality of learning resources	Students, Faculty	Indirect
The extent to which CLOs have been achieved	Faculty	Direct & Indirect
Other		

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

Assessment Methods (Direct, Indirect)

G. Specification Approval

COUNCIL /COMMITTEE	Department Council
REFERENCE NO.	4
DATE	October 2023

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