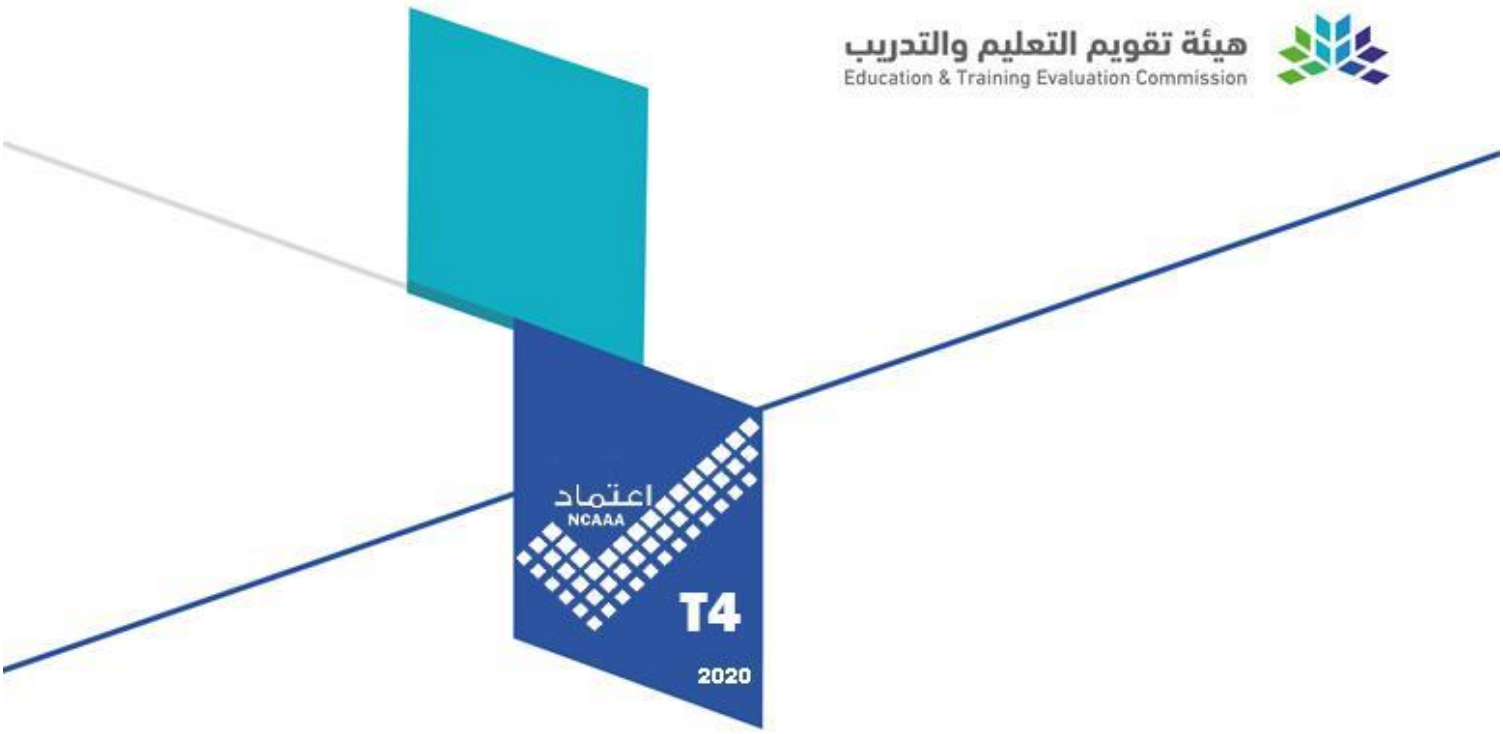
هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission



Course Specifications

Course Title:	Functional Analysis
Course Code:	Math 415
Program:	Bachelor of Science in Mathematics
Department:	Mathematics
College:	Science
Institution:	University of Tabuk

Table of Contents

A. Course Identification

1. Credit hours:	**03 Hours/Week**
2. Course type:	
a.	University ☐ College ☐ **Department** ☑ Others ☐
b.	**Required** ☑ Elective ☐
3. Level/year at which this course is offered:	**L8/Y4**
4. Pre-requisites for this course(if any)**:**	**Math 311**
5. Co-requisites for this course(if any)**:**	**None**

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	**Traditional classroom / Blackboard**	**45**	100 %
2	**Blended**		
3	**E-learning**		
4	**Distance learning**		
5	**Other**		

7. Contact Hours (based on academic semester)

No	Activity	Contact Hours
1	**Lecture**	45
2	**Laboratory/Studio**	
3	**Tutorial**	
4	**Others** (specify)	
	Total	**45**

B. Course Objectives and Learning Outcomes

1. Course Description

The aim of the course is to introduce students to the basic concepts and fundamental theorems of functional analysis, and learn how to apply these theorems to solve problems.

2. Course Main Objective

- Students will be able to recall the basic concepts of functional analysis through the study of function spaces, functions, operators and functionals and real-valued functions on the function spaces such as metric, norm and inner-product.
- Students recognize different types of operators and their applications.

3. Course Learning Outcomes

	CLOs	Aligned PLOs
1	**Knowledge and Understanding:**	
1.1	Students will be able to recall the basic concepts and theorems of functional analysis.	K1
2	**Skills :**	
2.1	Students will be able to apply theorems and results that they have learnt in this course to solve complex problems.	S3
2.2	Students will be able to justify the analytical procedures to prove the right target theorems.	S1
2.3	Students will be able to demonstrate proficiency in communicating functional analysis theorems and concepts.	S5
3	**Values:**	
3.1	Students will be able to develop enhanced self-learning.	V1
	Students will be able to work independently and in groups.	V2

C. Course Content

No	List of Topics	Contact Hours
1	Linear subspace, Linear dependence and Linear combination	3 Hrs
2	Dimension and Basis, Spanning, Direct sum decomposition for V(F)	3 Hrs
3	Cauchy Schwarz inequality- Minkowski inequality, Polarization identity	3 Hrs
4,5	Orthogonal sets of vectors, Orthogonalization (Gram-Schmidt)	6 Hrs
6	**Mid-Exam#1**	
6	Holder inequality, general Minkowski inequality	3 Hrs
7,8	Metric and Metric spaces, Some topological notion in metric spaces	6 Hrs
9	Convergent and completeness, Cauchy sequence, Convergent sequence, Complete metric space	3 Hrs
10	Continuity and uniform continuity on metric spaces, Fixed points and Contraction mappings.	3 Hrs
11	**Mid-Exam#2**	
11	Banach Contraction Principle, Orthogonal system, Fourier coefficient	3 Hrs
12	Bounded operators, Continuous, Linear functional in Hilbert H-adjoint operator, Self-adjoint operator, Normal operator, Unitary operator, Isometric operators, Symmetric operators, Positive Operators	3 Hrs
13	Projection operators. Closed operator, Graph of an operator	3 Hrs
14	The formal differential operator $(i\frac{d}{dx})$ – Eigenvalues and Eigenvectors , Spectrum of self-adjoint operator	3 Hrs
15	**Review and Final Exam**	3 Hrs
Total		**45 Hrs**

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	**Knowledge and Understanding**		
1.1	Recall the basic concepts and theorems of functional analysis.	Introducing new ideas through case study Lectures Class Discussions	Quizzes I II Midterm Exams Final Exams homework assignments.
2.0	**Skills**		
2.1	Apply theorems and results that they have learnt in this course to solve complex problems.	- Lectures Group work - Case Study - Brainstorming	- Quizzes -Assignments -Midterm exams - Final exam
2.2	Justify the analytical procedures to prove the right target theorems.		
2.3	Demonstrate proficiency in communicating functional analysis theorems and concepts.		
3.0	**Values**		
3.1	Students will be able to develop enhanced self-learning.	Cooperative learning and Teamwork	- Quizzes -Assignments -Class participation
3.2	Students will be able to work independently and in groups.		

2. Assessment Tasks for Students

#	Assessment Task*	Week Due	Percentage of Total Assessment Score
1	Mid Exam 1	Sixth	25%
2	Mid Exam 2	Eleventh	25%
3	Quiz 1	Seventh	3%
4	Quiz 2	Twelfth	3%
5	Home Assignments		4%
6	Final Exam	Fifteenth	40%

***Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice :

Six office hours per week in the lecturer schedule.

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	**Erwin Kreyszig,** Introductory Functional Analysis with Applications, John Wiley and Sons, New York, **1989.**

	Balmohan V. Limaye, Linear Functional Analysis for Scientists and Engineers, Springer Singapore (2016)
Essential References Materials	• **Lax. P.,** Functional Analysis, Wiley-Inter Science, **2002**. • **Rudin W.,** Functional Analysis, McGraw-Hill Science, **1991**. • **John B. Conway**, A Course in Functional Analysis (Graduate Texts in Mathematics), Second Edition, Springer, **2007**. • **Bryan P. Rynne** and **Martin A. Youngson,** Linear Functional Analysis, Second Edition, Springer Verlog, London, **2008.**
Electronic Materials	None
Other Learning Materials	None

2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	1.Lecture Room with max capacity of 30 students and equipped with White Board, Overhead projector and internet connection. 2.Library
Technology Resources (AV, data show, Smart Board, software, etc.)	Projectors
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	None

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Effectiveness of teaching and assessment	Students	Direct and Indirect
Extent of achievement of course learning outcomes	Teachers	Direct
Quality of learning resources	Students	Indirect

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes, Quality of learning resources, etc.)
Evaluators (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify)
Assessment Methods (Direct, Indirect)

H. Specification Approval Data

Council / Committee	Program and study plan committee
Reference No.	

Date	25/08/2021