

## Course Specifications

<b>Course Title:</b>	<b>Functional Analysis</b>
<b>Course Code:</b>	<b>477Math-3</b>
<b>Program:</b>	<b>B.Sc. Mathematics</b>
<b>Department:</b>	<b>Mathematics</b>
<b>College:</b>	<b>Arts and Sciences</b>
<b>Institution:</b>	<b>Najran University</b>

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## A. Course Identification

1. Credit hours:3			
2. Course type			
a.	University <input type="checkbox"/>	College <input type="checkbox"/>	Department <input checked="" type="checkbox"/>
b.	Required <input checked="" type="checkbox"/>	Elective <input type="checkbox"/>	Others <input type="checkbox"/>
3. Level/year at which this course is offered: 8 / 4			
4. Pre-requisites for this course (if any): 372 Math-3			
5. Co-requisites for this course (if any): Non			

## 6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	3	100%
2	Blended	---	---
3	E-learning	---	---
4	Correspondence	---	---
5	Other	---	---

## 7. Actual Learning Hours (based on academic semester)

No	Activity	Learning Hours
<b>Contact Hours</b>		
1	Lecture	45
2	Laboratory/Studio	---
3	Tutorial	---
4	Others (Exams)	3
	<b>Total</b>	48
<b>Other Learning Hours*</b>		
1	Study	35
2	Assignments	10
3	Library	10
4	Projects/Research Essays/Theses	---
5	Office hours	15
	<b>Total</b>	118

\* The length of time that a learner takes to complete learning activities that lead to achievement of course learning outcomes, such as study time, homework assignments, projects, preparing presentations, library times

## B. Course Objectives and Learning Outcomes

## 1. Course Description

The course gives an introduction to functional analysis, which is a branch of analysis in which one develops analysis in infinite dimensional vector spaces. The central concepts which are studied, are metric, Banach and Hilbert spaces. Operators theory is studied in detail.



**2. Course Main Objective**

The main objective of the course is the study of principles of metric, Banach, Hilbert spaces and bounded linear operators.

**3. Course Learning Outcomes**

CLOs		Aligned PLOs
<b>1</b>	<b>Knowledge:</b>	
1.1	Define the basis terminology of functional analysis (metric space, Banach space, Hilbert space, linear operator, .....	K2
1.2	State famous elementary results of functional analysis	K1
<b>2</b>	<b>Skills :</b>	
2.1	Derive different situations of Hölder, Mikowski and Schwartz inequalities	S2
2.2	Construct different examples of (metric, Banach, Hilbert spaces)	S3
2.3	Solve various problems in functional analysis	S3
2.4	Prove elementary theorems in functional analysis	S2
<b>3</b>	<b>Competence:</b>	
3.1	Present the main concepts of functional analysis to others, both in oral and written form confidently.	C1

**C. Course Content**

No	List of Topics	Contact Hours
1	Metric spaces: Distance function, Hölder and Minkowski inequalities, some famous metric spaces ( $\mathbb{R}^n$ , $C[a, b]$ , $L_p[a, b]$ , $\ell_p$ , $C^{(k)}[a, b]$ ), convergence and Cauchy sequences, separable metric spaces, completeness, completion of metric spaces.	12
2	Normed spaces: linear spaces, normed function, normed spaces, some famous normed spaces, finite dimensional normed spaces, Banach spaces. dual Spaces.	12
3	Introduction to operator theory: Linear operators, bounded and continuous linear operators, compact operators, linear functionals	12
4	Inner product spaces: Inner product function, Inner product spaces, some famous inner spaces, Hilbert spaces, Schwartz inequality, triangle inequality, orthogonal sets, orthonormal bases sets, Hilbert-adjoint operators.	9
...		
<b>Total</b>		<b>45</b>



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

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
<b>1.0</b>	<b>Knowledge</b>		
1.1	Define the basis terminology of functional analysis	At the beginning of each lecture, some examples will be presented and discussed with students to encourage them to discover related concepts and provide definitions	Oral Exam Written Exam
1.2	State famous elementary results of functional analysis		Oral Exam Written Exam
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<b>2.0</b>	<b>Skills</b>		
2.1	Derive different situations of Hölder, Mikowski and Schwartz inequalities	Discussion and exercises during lecture time	Quiz Written Exam Homework
2.2	Give different examples of (metric, Banach, Hilbert spaces)	Discussion and exercises during lecture time	Quiz Written Exam Homework
2.3	Solve various problems in functional analysis	Discussion and exercises during lecture time	Quiz Written Exam Homework
2.4	Prove elementary theorems in functional analysis	Discussion and exercises during lecture time	Quiz Written Exam Homework
<b>3.0</b>	<b>Competence</b>		
3.1	Work as part of a team and independently	Group problems solving during tutorial	Rubrics
3.2	Present the main concepts of functional analysis to others, both in oral and written form confidently	Homework and discussions in the classes	Oral Exam Rubrics
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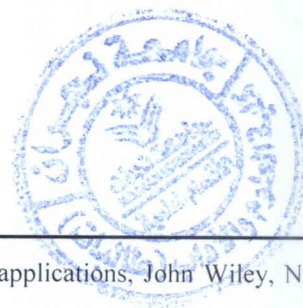
**2. Assessment Tasks for Students**

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	Exercises, Homework & Assignments	Open	10%
2	Oral Exam	14 <sup>th</sup> Week	5%
3	Quizzes	Open	5%
4	Written Test(1)	7 <sup>th</sup> Week	15%
5	Written Test(2)	13 <sup>th</sup> Week	15%
6	Final Exam	End of Semester	50%

\*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 :**

- Introducing the course syllabus, grading scale and the distribution of marks for the course in the first lecture of the course.
- The office hours for this course are 3 hours/ week.



## F. Learning Resources and Facilities

### 1. Learning Resources

<b>Required Textbooks</b>	E. Kreyszig, Introductory functional analysis with applications, John Wiley, New York, 1978
<b>Essential References Materials</b>	- Non
<b>Electronic Materials</b>	<ul style="list-style-type: none"> <li>Lectures on the Department of Mathematics YouTube Channel.</li> <li>Other electronic materials available on the internet</li> </ul>
<b>Other Learning Materials</b>	- Non

### 2. Facilities Required

Item	Resources
<b>Accommodation</b> (Classrooms, laboratories, demonstration rooms/labs, etc.)	Classroom with suitable seats
<b>Technology Resources</b> (AV, data show, Smart Board, software, etc.)	<ul style="list-style-type: none"> <li>Datashow</li> <li>Smart Board</li> <li>Wi Fi</li> </ul>
<b>Other Resources</b> (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	<ul style="list-style-type: none"> <li>None</li> </ul>

## G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Student course evaluation survey at the end of semester.	Students	Questionnaire (Indirect)
Effectiveness of teaching and assessment	Peer Reviewer	Rubrics (Indirect)
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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	
Reference No.	
Date	

