Form: Course Syllabus	**Form Number**	EXC-01-02-02A
	Issue Number and Date	2/3/24/2022/2963 05/12/2022
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	Deans Council Approval Decision Number	2/3/24/2023
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	Number of Pages	09

1.	**Course Title**	**Functional Analysis**
2.	**Course Number**	0301712
3.	**Credit Hours (Theory, Practical)**	3
	Contact Hours (Theory, Practical)	3
4.	**Prerequisites/ Corequisites**	0301711
5.	**Program Title**	M.Sc. In Mathematics
6.	**Program Code**	
7.	**School/ Center**	Science
8.	**Department**	Mathematics
9.	**Course Level**	Compulsory specialization requirement
10.	**Year of Study and Semester (s)**	1st year, 2nd semester
11.	**Other Department(s) Involved in Teaching the Course**	None
12.	**Main Learning Language**	English
13.	**Learning Types**	■Face to face learning ☐Blended ☐Fully online
14.	**Online Platforms(s)**	■Moodle ■Microsoft Teams
15.	**Issuing Date**	Oct. 2024
16.	**Revision Date**	

17. Course Coordinator:

Name: Dr. Roshdi Khalil	Contact hours: Sun,Tue, Thu: 12:30-1:30
Office number: Math 315	Phone number: -
Email: roshdi@ju.edu.jo	

18. Other Instructors:

Name: Office number: Phone number: Email: Contact hour.

19. Course Description:

Normed spaces, Banah spaces, Linear Operators on Normed spaces: Bounded and continuous Linear operators. Linear Functionals on Normed spaces. Main Theorem. In Functional Analysis: Hahn-Banach Theorem, The Open Mapping Theorem, The Closed Graph Theorem, The Uniform Boundedness Principle, The Krein-Milman Theorem and Alouglu Theorem.

20. Program Student Outcomes (SO's):

(To be used in designing the matrix linking the intended learning outcomes of the course with the intended learning outcomes of the program)

SO1 Read, analyze and write logical arguments to prove mathematical and statistical concepts and theorems.

SO3 Communicate with mathematical and statistical ideas clearly and consistently, in writing and verbally.

SO7 Work effectively within work teams and communicate scientific knowledge and results with peers and experts in the field.

SO8 Apply methodologies and ethics of scientific research in preparation of scientific research in mathematics field.

21. Course Intended Learning Outcomes (CLO's):

(Upon completion of the course, the student will be able to achieve the following intended learning outcomes)

1. Understand fundamental concepts in normed spaces and Banach spaces.
2. Analyze bounded and continuous linear operators and functionals on normed spaces.
3. Apply key theorems in functional analysis, including the Hahn-Banach Theorem, Open Mapping Theorem, and Closed Graph Theorem.
4. Demonstrate the Uniform Boundedness Principle and its applications.
5. Explore advanced results in functional analysis, such as the Krein-Milman Theorem and the Alaoglu Theorem.
6. Develop problem-solving skills in the context of abstract mathematical spaces and operators.
7. Connect the theoretical results of functional analysis to practical mathematical applications.

Course CLOs	The learning levels to be achieved					
	Remembering	Understanding	Applying	Analysing	evaluating	Creating
1		■				
2				■		
3			■			
4		■				
5			■	■		
6					■	■
7			■		■	

22. The matrix linking the intended learning outcomes of the course with the intended learning outcomes of the program:

Program SO's / Course CLO's	SO (1)	SO (2)	SO (3)	SO (4)	SO (5)	SO (6)	SO (7)	SO (8)
CLO (1)	■							
CLO (2)	■							
CLO (3)	■							
CLO (4)	■							
CLO (5)	■							
CLO (6)			■					
CLO (7)								■

23. Topic Outline and Schedule:

Week	Lecture	Topic	CLO/s Linked to the Topic	Learning Types Face to Face (FF) Blended (BL) Fully Online (FO)	Platform Used	Synchronous (S) Asynchronous (A)	Evaluation Methods	Learning Resources
1	1.1	Definition and examples of normed spaces.	1	FF	Moodle/M. Teams	S		Class Notes+Textbook
	1.2	Properties of norms	1	FF	Moodle/M. Teams	S		Class Notes+Textbook

	1.3	Completeness and examples of incomplete normed spaces	1	FF	Moodle/M. Teams	S		Class Notes+Textbook
2	2.1	Definition and examples of Banach spaces	1	FF	Moodle/M. Teams	S		Class Notes+Textbook
	2.2	Subspaces of Banach spaces	1	FF	Moodle/M. Teams	S		Class Notes+Textbook
	2.3	Finite-dimensional normed spaces are Banach spaces	1	FF	Moodle/M. Teams	S		Class Notes+Textbook
3	3.1	Problem set: showing completeness of spaces and properties of norms	1	FF	Moodle/M. Teams	S		Class Notes+Textbook
	3.2	Definition of bounded and continuous linear operators	2	FF	Moodle/M. Teams	S		Class Notes+Textbook
	3.3	Examples of bounded operators	2	FF	Moodle/M. Teams	S		Class Notes+Textbook
4	4.1	Norm of a bounded operator	2	FF	Moodle/M. Teams	S		Class Notes+Textbook
	4.2	Definition and examples of linear functionals on normed spaces	3	FF	Moodle/M. Teams	S		Class Notes+Textbook
	4.3	Dual spaces and examples	3	FF	Moodle/M. Teams	S		Class Notes+Textbook
5	5.1	Separation of points by functionals	3	FF	Moodle/M. Teams	S		Class Notes+Textbook
	5.2	Problem set: constructing linear functionals	3	FF	Moodle/M. Teams	S		Class Notes+Textbook
	5.3	Statement of the Hahn-Banach theorem.	3	FF	Moodle/M. Teams	S		Class Notes+Textbook
6	6.1	Proof for real normed spaces.	3	FF	Moodle/M. Teams	S		Class Notes+Textbook
	6.2	Extension of bounded linear functionals	3	FF	Moodle/M. Teams	S		Class Notes+Textbook

	6.3	Applications of Hahn-Banach theorem	3	FF	Moodle/M. Teams	S		Class Notes+Textbook
7	7.1	Extension to complex spaces	3	FF	Moodle/M. Teams	S		Class Notes+Textbook
	7.2	Statement and proof of the Open Mapping Theorem	3	FF	Moodle/M. Teams	S		Class Notes+Textbook
	7.3	Consequences: bounded inverse theorem	3	FF	Moodle/M. Teams	S		Class Notes+Textbook
8	8.1	Problem set: applications to solving operator equations	3,6	FF	Moodle/M. Teams	S		Class Notes+Textbook
	8.2	Statement and proof of the Closed Graph Theorem	3	FF	Moodle/M. Teams	S		Class Notes+Textbook
	8.3	Midterm	1,2,3	FF	On campus	S		Class Notes+Textbook
9	9.1	Relation to bounded operators	4	FF	Moodle/M. Teams	S		Class Notes+Textbook
	9.2	Problem set: identifying closed operators	3,6	FF	Moodle/M. Teams	S		Class Notes+Textbook
	9.3	Statement and proof of the Uniform Boundness principle	4	FF	Moodle/M. Teams	S		Class Notes+Textbook
10	10.1	Applications to convergence of operator families	4	FF	Moodle/M. Teams	S		Class Notes+Textbook
	10.2	Convex sets and extreme points	5	FF	Moodle/M. Teams	S		Class Notes+Textbook
	10.3	Statement of Krein-Milman Theorem, Examples and preliminary applications	5	FF	Moodle/M. Teams	S		Class Notes+Textbook
11	11.1	Proof of the Krein-Milman Theorem	5	FF	Moodle/M. Teams	S		Class Notes+Textbook
	11.2	Problem set: finding extreme points.	5,6	FF	Moodle/M. Teams	S		Class Notes+Textbook

	11.3	Applications to convex hulls in functional analysis	5	FF	Moodle/M. Teams	S		Class Notes+Textbook
12	12.1	Definition of weak-* topologyand examples	5	FF	Moodle/M. Teams	S		Class Notes+Textbook
	12.2	Statement of Alaoglu's Theorem	5	FF	Moodle/M. Teams	S		Class Notes+Textbook
	12.3	Compactness in dual spaces	5	FF	Moodle/M. Teams	S		Class Notes+Textbook
13	13.1	Proof of Alaoglu's Theorem	5	FF	Moodle/M. Teams	S		Class Notes+Textbook
	13.2	Applications to bounded sequences in dual spaces	5	FF	Moodle/M. Teams	S		Class Notes+Textbook
	13.3	Problem set: understanding weak-* topology	5,6	FF	Moodle/M. Teams	S		Class Notes+Textbook
14	14.1	Reflexive spaces and examples	5	FF	Moodle/M. Teams	S		Class Notes+Textbook
	14.2	Dual of L^p spaces	5	FF	Moodle/M. Teams	S		Class Notes+Textbook
	14.3	Problem set: duality-based problem solving.	5,6	FF	Moodle/M. Teams	S		Class Notes+Textbook
15	15.1	Summary of main theorems and their applications	5,6	FF	Moodle/M. Teams	S		Class Notes+Textbook
	15.2	Solving advanced problems integrating multiple concepts	6	FF	Moodle/M. Teams	S		
	15.3	Applications in optimization, partial differential equations	7	FF		S		

24. Evaluation Methods:

Opportunities to demonstrate achievement of the CLOs are provided through the following assessment methods and requirements:

Evaluation Activity	Mark	Topic(s)	CLO/s Linked to the Evaluation activity	Period (Week)	Platform
Quizzes	30		(CLO/s 1+2, 4+5+6)	Throughout the term	on campus
Midterm	30		(CLO/s 1+2+3)	8th week	on campus
Final	40	All	All		on campus

25. Course Requirements:

(e.g.: students should have a computer, internet connection, webcam, account on a specific software/platform…etc.):

26. Course Policies:

A. Attendance policies: Attendance is absolutely essential to succeed in this course. You are expected to attend every class; please notify your instructor if you know you are going to be absent. If a student is absent for more than 10% of lectures without an excuse of sickness or due to other insurmountable difficulty, then he/she shall be barred from the final examination also he/she will get a failing grade in this course.

B. Absences from exams and submitting assignments on time: All exams must be taken at the scheduled time. Exceptions will be made only in extreme circumstances, by prior arrangement with the instructor. Students must attend all the exams, students with acceptable excuse will have an average of the other exams. Medical certificates shall be given to the University Physician to be authorized by him.

C. Health and safety procedures:

D. Honesty policy regarding cheating, plagiarism, misbehavior: Cheating is prohibited. The University of Jordan regulations on cheating will be applied to any student who cheats in exams or on quizzes.

E. Grading policy: Test papers shall be returned to students after correction. His/her mark is considered final after a lapse of two days following their return.

F. Available university services that support achievement in the course: We will use Elearning /Microsoft Teams platforms to upload lecture notes, videos and other useful material.

27. References:

A- Required book(s), assigned reading and audio-visuals: Introductory Functional Analysis with Applications by Erwin Kreyszig. **B-** Recommended books, materials, and media: **1.** Functional Analysis: A first course by M. Thamban Nair.

28. Additional information:

Name of the Instructor or the Course Coordinator: **prof. Roshdi Khalil**	Signature: ……	Date: Oct 7,2024
Name of the Head of Quality Assurance Committee/ Department: **Prof. Manal Ghanem**	Signature: ……	Date: ……
Name of the Head of Department: **Prof. Baha Alzalg**	Signature: ……	Date: ……
Name of the Head of Quality Assurance Committee/ School of Science; **Prof. Emad A. Abuosba**	Signature: ……	Date: ……
Name of the Dean or the Director: **Prof. Mahmoud I. Jaghoub**	Signature: ……	Date: ……