Faculty: Science	
Department: Mathematics	**Program: Master**
Academic year: 2023- 2024	**Semester: Second**

Course Plan

First: Course Information

Course No. 0301752	***Course Title:*** Real Analysis (Measure theory and Lebesgue integration)	***Credit Hours:*** 3
Prerequisite: -----	***Section No.:*** 1	***Lecture Time:*** 4:30-7:30pm, Tues
Type Of Course:	☐ ***Obligatory Faculty Requirement*** ☐ ***Elective University Requirement*** ☐ ***Obligatory University Requirement*** ☐ ***Faculty Requirement*** ☐ ***Course Elective Specialty Requirement*** ■ ***Obligatory Specialization requirement***	
Type of Learning:	☐ ***Face-to-Face Learning*** ☐ ***Blended Learning (2 Face-to-Face + 1Asynchronous)*** ■ ***Online Learning (1 Synchronous+1 Asynchronous)***	

Second: Instructor's Information

Name: Prof. Waleed AlRawashdeh			***Academic Rank:*** Professor		
Office Number: 339 D			***Ext. Number:*** 1525		***E-mail:*** walrawashdeh@zu.edu.jo
Office Hours:	***Sunday*** 12:00-2:00	***Monday*** 1:00 – 2:00	***Tuesday*** 2:30-4:30	***Wednesday*** 1:00 – 2:00	***Thursday*** 12:00-2:00

Third: Course Description

This course is concerned with a generalization of the Riemann integral (of bounded real functions over bounded intervals) to Lebesgue integral of measurable functions over measurable sets of R. The course starts with the concept of outer measure and its properties then proceed to define the Lebesgue measure on certain sets of R that will be called measurable sets. Measurable functions over measurable sets will also be defined and studied. The Lebesgue integral of measurable functions over measurable sets will be defined through certain steps along with some properties. Its relation with Riemann integral is given and some main related theorems will be proved, like the Monotone Convergence Theorem and the Lebesgue Dominated Convergence Theorem. The course ends with a chapter on the spaces of measurable and Lebesgue integrable functions, in which some inequalities are studied that will be used to prove the completeness of these spaces.

Fourth: Learning Source

Main Reference:	Real Analysis	
Author: H. Royden	***Issue No.:*** 4th edition	***Publication Year:*** 2010
Additional Sources & Websites:	1. Lebesgue Measure and Integration, by Gupta 2. Measure theory and integration, by G. de Barra.	
Teaching Type:	☐ *Classroom* ☐ *Laboratory* ☐ *Workshop* ■ *MS Teams* ■ *Moodle*	

Fifth: Learning Outcomes

Number	*Course learning output*	*Associated Program Outcome Code*
	Knowledge	
K1	Learn the concept and properties of Lebesgue outer measure.	P(K1) P(K3) P(K4)
K2	Study the sigma-algebra of measurable sets and their properties.	P(K1) P(K3)
K3	Define the Lebesgue measure and demonstrate its properties.	P(K1) P(K2), P(K4)
K4	Define measurable functions and study their properties.	P(K1) P(K3)
K5	Understand Lebesgue integral and its relation with Riemann integral.	P(K1) P(K3) P(K4)
K6	State some related results and theorems concerning Lebesgue integrals.	P(K2) P(K3) P(K4)
K7	Study spaces of measurable Lebesgue integrable functions.	P(K1) P(K2)
	Skills	
S1	Reach to the properties of Lebesgue outer measure as a generalization of properties of the length.	P(S2)
S2	Use properties of sigma algebra of measurable sets to deal with the properties of the Lebesgue measure.	P(S1) P(S2)
S3	Recognize measurable functions and their properties.	P(S2)

S4	Reach to properties of Lebesgue integrals as a generalization of Riemann integral.	P(S1) P(S2)
S5	Deal with some Main theorems related to Lebesgue integrals.	P(S1) P(S2)
S6	Recognize the space of Lebesgue p-integrable functions and some related inequalities.	P(S1) P(S2)
Competences		
C1	Prove the properties of Lebesgue Outer Measure and some related theorems.	P(C1) P(C2)
C2	Prove properties of Lebesgue Measurable sets and some related theorems.	P(C1) P(C2)
C3	Prove properties of Lebesgue Measurable functions and some related theorems.	P(C1) P(C2)
C4	Prove properties of Lebesgue integrable functions and some related theorems.	P(C1) P(C2)
C5	Effectively communicate by conducting discussions and participating in class, asking questions intended to encourage the exchange of ideas in class.	P(C3) P(C4)
C6	Illustrate an ability to work together in teams, engaging in group work, and to develop more skills in the subject.	P(C3) P(C4)

* P: Program, **K: knowledge, ***S: skills, ****C: competencies.

Sixth: Course Structure

Lecture Date	Intended Teaching Outcomes (ILOs)	Topics	Teaching Procedures*	Teaching Method**	References***
Tuesday 5/3/2024	K1, S1, C1	• Introduction to the course. • Definition of outer measure and its properties.	Synchronous	Online Lecture on Microsoft Teams	Royden Ch2

Tuesday 12/3/2024	K1, K2, S1, C1	• More properties of outer Measure. • σ -Algebra of sets.	Asynchronous	Students' Activities on Moodle	Royden Ch2
Tuesday 19/3/2024	K1, K2, S1, S2, C1, C2, C5	• Definition and properties of Lebesgue Measurable Sets.	Synchronous	Online Lecture on Microsoft Teams	Royden Ch2
Tuesday 26/3/2024	K1, K2, S1, S2, C1, C2, C6	• Outer and Inner Approximation of Lebesgue Measurable Sets. • Definition of Lebesgue Measure.	Asynchronous	Students' Activities on Moodle	Royden Ch2
Tuesday 2/4/2024	K3, S2, C2	• Lebesgue Measure, and some properties. • Countable Additivity.	Synchronous	Online Lecture on Microsoft Teams	Royden Ch2
Tuesday 9/4/2024	K3, S2, C2, C6	• Continuity of the measure. • The Cantor Set. • Non-measurable sets.	Asynchronous	Students' Activities on Moodle	Royden Ch2
Tuesday 16/4/2024	K4, S3, C3, C5	• Lebesgue Measurable functions. • Examples, Sums, Products and Composition.	Synchronous	Online Lecture on Microsoft Teams	Royden Ch3
Tuesday 23/4/2024	K4, S3, C3, C6	• Pointwise, pointwise almost everywhere convergence and uniform convergence •Simple Approximation Theorem. •Egoroff Theorem and Lusin's Theorem.	Asynchronous	Students' Activities on Moodle	Royden Ch3
Tuesday 30/4/2024	K5, S4, S5, C4, C5	• Review of the Riemann Integral. Simple Functions. • The Lebesgue Integral of a Bounded Measurable Function over a Set of Finite Measure. • Bounded Convergence Theorem.	Synchronous	Online Lecture on Microsoft Teams	Royden Ch4
Tuesday 7/5/2024	K5, K6, S4, S5, C4, C6	• Lebesgue Integral of a Measurable Nonnegative Function. • Properties of the integral.	Asynchronous	Students' Activities on Moodle	Royden Ch4

		• Fatou's Lemma and the Monotone Convergence Theorem.			
Tuesday 14/5/2024	K5, K6, S4, S5, C4, C5	• The General Lebesgue Integral. • Lebesgue Dominated Convergence Theorem. • Countable Additivity of the Lebesgue integral.	Synchronous	Online Lecture on Microsoft Teams	Royden Ch4
Tuesday 21/5/2024	K5, K6, S4, S5, C4, C6	• Continuity of Integration. Uniform Integrability. • Characterizations of Riemann and Lebesgue integrals. • Continuity and Differentiability of Monotone Functions: Lebesgue Theorem.	Asynchronous	Students' Activities on Moodle	Royden Ch5
Tuesday 28/4/2024	K7, S6, C5	• Integrating Derivatives and Differentiating Indefinite Integrals. • The L^p Spaces: Definition and Some related Inequalities.	Synchronous	Online Lecture on Microsoft Teams	Royden Ch6 Ch7
Tuesday 4/6/2024	K-S-C	Revision	Asynchronous	Students' Activities on Moodle	Royden
9/6-27/6		**Final Exams**			

* Learning procedures: (Face-to-Face, synchronous and asynchronous). ** Teaching methods: (Lecture, video…..).
*** Reference: (Pages of the book, recorded lecture, video….).

Seventh: Assessment methods

Methods	Online Learning	Measurable Course (ILOs)
Participation and Activities	60	K-S-C
Final Exam	40	K-S-C

Eighth: Course Policies

- All course policies are applied on all teaching patterns (online, blended, and face-to-face Learning) as follows:
  a. Punctuality.
  b. Participation and interaction.
  c. Attendance and exams.
- Academic integrity: (cheating and plagiarism are prohibited).

Approved by:	Name	Date	Signature
Head of Department	Dr. Radwan Abu-Gdairi	3/3/2024	
Faculty Dean	Dr. Ibrahim Ghabar	3/3/2024