Course Specification

(Postgraduate Programs)

Course Title :	Introduction to Measure and Integration
Course Code:	MAT 6111
Program:	Master of Science in Mathematics
Department:	Mathematics and Statistics
College:	Science
Institution:	Imam Mohammad Ibn Saud Islamic University
Version:	2024 – V1
Last Revision Date:	1446/04/05 (08/10/2024)

Table of Contents

A. General information about the course:

1. Course Identification

1. Credit hours:					
4(3 Lectures, 0 Lab, 2 Tutorial)					
2. Course type					
A.	☐University	☐ College	☒ Program	☐Track	☐Others
B.	☒ Required		☐ Elective		
3. Level/year at which this course is offered: Level 2 / Year 1					
4. Course general Description:					
This course describes the most important ideas, theoretical results, and applications in measure and integration on the real line. The course includes the essential fundamentals of σ-algebra, measurable sets and functions, Lebesgue integral, convergence theorem and the L^1 space on R. It covers classical topics in Riemann's integral and makes comparison with the Lebesgue integral. The emphasis is on theoretical results and their applications.					
5. Pre-requirements for this course (if any):					
None.					
6. Co-requisites for this course (if any):					
None.					
7. Course Main Objective(s):					
The main purpose of this course is to provide the student with the basic concepts and theorems in measure and integration. We will introduce the Lebesgue measure and the Lebesgue integral on the real line. We will state and prove the main convergence theorems, including differentiation theorem. Other topics include the L^1-space.					

2. Teaching mode (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100%
2	E-learning	0	0%
3	Hybrid • Traditional classroom • E-learning	0	0%
4	Distance learning	0	0%

3. Contact Hours (based on the academic semester)

No	Activity	Contact Hours
1.	**Lectures**	45
2.	**Laboratory/Studio**	0
3.	**Field**	0
4.	**Tutorial**	30

5.	**Others (specify)**	0
Total		60

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	**To write the central role of sigma-algebras, outer measure, and measurable sets in integration theory.**	**K1, K2**	**3 lecture hours\week**	**Direct: Regular Exams**
1.2	**To recognize measurable functions and Lebesgue's integral.**	**K1, K2**	**2 tutorial hours\week Self-study**	**Direct: Short Quizzes**
2.0	**Skills**			
2.1	**To develop techniques of proof involved in Lebesgue integration.**	**S1, S2**	**Self-study**	**Direct:** • **Participations** • **Short Quizzes**
2.2	**To develop oral communication and technical writing skills through convergence theorems.**	**S4**	**Real-life problems**	**Direct: Homework and Mini projects**
2.3	**To use Internet in searching for different kind of Measures.**	**S3**	**Real-life problems**	**Direct: Short Quizzes**
2.4	**To demonstrate out deep and not short proofs in Lp spaces.**	**S1, S2**	**Self-study**	**Direct: Participations**
3.0	**Values, autonomy, and responsibility**			
3.1	**To work independently.**	**V1, V2**	**Personal questions**	**Direct: Participation**
3.2	**To collaborate with work groups.**	**V1, V3**	**Teamwork and class discussions.**	**Direct: Homework and**

Code	Course Learning Outcomes	Code of CLOs aligned with program	Teaching Strategies	Assessment Methods
				Mini projects

C. Course Content

No	List of Topics	Contact Hours
1.	**Basics:** The set R of the real line and its topology (open and closed sets, completion), countable and uncountable sets, sigma-algebras, Borel sets.	12
2.	**Lebesgue Measure:** Outer measure and the sigma-algebra of measurable sets, zero measure set, Cantor's set, nonmeasurable set. Borel set, G_δ and F_σ sets.	13
3.	**Lebesgue Measurable Functions:** Review of sequences of functions: pointwise and uniform convergence of sequences, interchange of limits (limit and continuity, limit and derivative). Measurable functions: main properties, step functions, approximation Lemma, Lusin's Theorem.	13
4.	**Lebesgue Integration:** The Riemann integral: definition, properties, Fundamental Theorems of Calculus, Interchange of limit and integral. The Lebesgue integral: Integrals of simple functions, integrals of non-negative measurable functions, integrals of measurable functions, general properties. Comparison with Riemann's integral, Lebesgue's Integrability Criterion of Riemann integral.	13
5.	**Convergence Theorems:** Monotone Convergence Theorem, Fatou's Lemma, Beppo-Levi Theorem, and Lebesgue Dominated Theorem. Continuity and Differentiation Theorems.	12
6.	**The L^p spaces:** The L^1 normed space. The L^p normed space for $1 \leq p < \infty$: Young, Holder and Minkovski Inequalities. The normed space L^∞. The Banach space L^p for $1 \leq p \leq \infty$	12
	Total	75

D. Students Assessment Activities

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
1.	**HomeWorks, Quizzes, Mini projects**	**During the semester**	**30%**
2.	**Midterm**	**Week 9-10**	**30%**
3.	**Final Exam**	**Week 16-17**	**40%**

*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	• **H.L. Royden, P.M. Fitzpatrik,** *Real Analysis*, Pearson, 4th Edition, 2010. **(Main Reference)**
Supportive References	1. **M. Capinski, P. E. Kopp,** *Measure, Integral and Probability*, Springer, 2003 2. **R.G. Bartle, D.R. Sherbert,** Introduction to Real Analysis, 3rd Edition, John wiley & Sons, 2000. 3. **C. W. Rudin**, *Real and Complex Analysis,* McGraw Hill, 3rd Edition, 1987. 4. **S. K. Berberian**, *Measure and Integration*, AMS/Chelsea Publishing, 2010.
Electronic Materials	**None**
Other Learning Materials	**None**

2. Educational and Research Facilities and Equipment Required:

Items	Resources
facilities (Classrooms, laboratories, exhibition rooms, simulation rooms, etc.)	▪ **Each class room should be equipped with a whiteboard and a projector.** ▪ **Laboratories should be equipped with computers and an internet connection.**
Technology equipment (projector, smart board, software)	**The rooms should be equipped with data show and Smart Board.**
Other equipment (depending on the nature of the specialty)	**None**

F. Assessment of Course Quality

Assessment Areas/Issues	Assessor	Assessment Methods
Effectiveness of teaching	**Students**	**During the semester and at the end of the course each student will complete two evaluation forms.**
Effectiveness of Students assessment	**Instructor**	**At the end of each semester the course instructor should complete the course report, including a summary of student questionnaire responses appraising progress and identifying changes that need to be made if necessary.**
Quality of learning resources	**Students**	**During the semester and at the end of the course each student**

Assessment Areas/Issues	Assessor	Assessment Methods
		will complete two evaluation forms.
The extent to which CLOs have been achieved	Instructor	At the end of each semester the course instructor should complete the course report, including a summary of student questionnaire responses appraising progress and identifying changes that need to be made if necessary.
Other	None	

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

Assessment Methods (Direct, Indirect)

G. Specification Approval

COUNCIL /COMMITTEE	MATHEMATICS AND STATISTICS DEPARTMENT COUNCIL
REFERENCE NO.	8/1446
DATE	05/04/1446 (08/10/2024)