Course Specification

(Postgraduate Programs)

Course Title:	**Homological Algebra**
Course Code:	**MAT 7229**
Program:	**Doctor of Philosophy in Mathematics**
Department:	**Mathematics and Statistics**
Science	
Institution:	**Imam Mohammad Ibn Saud Islamic University**
Version:	**2024 – V1**
Last Revision Date:	**None**

Table of Contents

A. General information about the course:

1. Course Identification:

1. Credit hours:					
4 (4 Lectures, 0 Lab, 0 Tutorial)					
2. Course type					
A.	☐ University	☐ College	☒ Program	☐ Track	☐ Others
B.	☐Required		☒ Elective		
3. Level/Year at which this course is offered: Level 3 / Year 2					
4. Course General Description:					
The course starts with the introduction of basic concepts in homology and cohomology theories, such as: Covariant and Contravariant Functors, Additive Functors, Left and Right Exact Functors, as well as exact Sequences. Categories of Left and Right Modules, Tensor Products, Hom and Tensor Functors, Free Modules, Projective, Injective, and Flat Modules are also described. The course ends with the main properties of Chain and Cochains Complexes, Homology and Cohomology Groups, and Derived Functors.					
5. Pre-requirements for this course (if any):					
None.					
6. Pre-requirements for this course (if any):					
None.					
7. Course Main Objective(s):					
The objective of this course is to give new tools in order to deal with algebraic problems. It turns out that several important problems in topology, commutative algebra, and representation theory became handy by the aid of homology and cohomology.					

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	60
2.	Laboratory/Studio	0
3.	Field	0
4.	Tutorial	0
5.	Others (specify).....	0
	Total	60

B. Course Learning Outcomes (CLOs), Teaching Strategies and Assessment Methods:

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
1.0	Knowledge and understanding			
1.1	To list new tools that are useful in answering deep questions in homological algebra.	K1, K2	4 lecture hours\week	Direct: Regular Exams
1.2	To recognize algebraic and topological problems that are easily treated by applying these methods.	K1, K2	• 4 lecture hours\week • Self-study	Direct: Short Quizzes
2.0	Skills			
2.1	To develop techniques of proof using categories and functors.	S1, S2	Self-study	Direct: • Participations Short Quizzes
2.2	To develop oral communication and technical writing skills through exact sequences.	S3	Real-life problems	Direct: Homework and Mini projects
2.3	To use Internet in searching for some categories of modules.	S4	Real-life problems	Direct: Short Quizzes

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
2.4	**To carry out deep proofs in Homology Theory.**	**S1, S2**	**Self-study**	**Direct: Participations**
3.0	**Values, autonomy, and responsibility**			
3.1	**To work with independence and responsibility.**	**V1, V3**	**Personal questions**	**Direct: Participation**
3.2	**To lead team works.**	**V1, V2**	**Teamwork and class discussions.**	**Direct: Homework and Mini projects**

C. Course Content:

No	List of Topics	Contact Hours
1.	**Categories and Functors:** Basics, Covariant and Contravariant Functors, Additive Functors, Left and Right Exact Functors.	**10**
2.	**Sequences:** Exact and Split Exact Sequences, 5-Lemma and Snake Lemma, Natural Equivalence of Functors.	**10**
3.	**Categories of Modules:** Categories of Left and Right Modules, Tensor Products, Hom and Tensor Functors.	**10**
4.	**Some Types of Modules:** Free Modules, Projective, Injective and Flat Modules.	**10**
5.	**Homology and Cohomology groups:** n-Chain and Chain and Cochains Complexes, Homology and Cohomolgy Groups, The Long Exact Sequences and The Connected Homomorphism δ_n.	**10**
6.	**Ext and Tor Functors:** The Projective Resolution of a Module, The Derived Functor, Tor and Ext Functors, The Two Long Exact Sequence Theorems for Tor and Ext.	**10**
Total		**60**

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 15-16**	**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	**M. Osborne,** *Basic Homological Algebra*, GTM, Springer-Verlag 2000. **(Main Reference)**
Supportive References	• **P. Hilton and U. Stammbach,** *A course in Homological Algebra*, GTM, Springer-Verlag 1970. **J. Rotman,** *An Introduction to Homological Algebra*, GTM, Springer-Verlag 2009.
Electronic Materials	**None**
Other Learning Materials	

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 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**

Assessment Areas/Issues	Assessor	Assessment Methods
		and identifying changes that need to be made if necessary.
Other	None	

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

Assessment Methods (Direct, Indirect)

G. Specification Approval Data:

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