Course Specification

(Postgraduate Programs)

Course Title:	**Algebraic Topology**
Course Code:	**MAT 7171**
Program:	**Doctor of Philosophy in Mathematics**
Department:	**Mathematics and Statistics**
College:	**Science**
Imam Mohammad Ibn Saud Islamic University	
Version:	**2024 – V1**
Last Revision Date:	**None**

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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 2 / Year 1					
4. Course General Description:					
The course first recalls some basic notions about compactness, connectedness, and path-connectedness of topological spaces. The quotient topology is investigated in detail with applications to the constructions of some classical surfaces. Then the homotopy theory and the retraction theory are developed with application to the computations of the fundamental groups of some spaces and surfaces. Finally, the simplicial, singular, and relative homologies are introduced together with the computations of some homology groups. Applications to properties of maps on the sphere and to fixed point theory complete the course.					
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 a detailed description of advanced topics in point set topology and to present the basic notions of Algebraic Topology: The retraction theory and Poincare fundamental groups. Homotopy theory and three types of Homology theories are also investigated.					

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 record some fundamental groups and Homology groups.	K1, K2	4 lecture hours\week	Direct: Regular Exams
1.2	To recognize the basic concepts and applications of Algebraic Topology.	K1, K2	Self-study	Direct: Short Quizzes
2.0	Skills			
2.1	To develop techniques of proof in Topology and Homotopy Theory.	S1, S2	Self-study	Direct: • Participations Short Quizzes
2.2	To develop oral communication and technical writing skills through computations of some homotopy groups.	S3	Real-life problems	Direct: Homework and Mini projects
2.3	To use Internet in searching for some homotopy and homology groups of spaces.	S4	Real-life problems	Direct: Short Quizzes
2.4	To carry out proofs in singular homology.	S1, S2	Self-study	Direct: Participations
3.0	Values, autonomy, and responsibility			

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
3.1	To work individually.	V1, V3	Personal questions	Direct: Participation
3.2	To work in groups.	V1, V2	Teamwork and class discussions.	Direct: Homework and Mini projects

C. Course Content:

No	List of Topics	Contact Hours
1.	Basics in Topology: separation theorems, compactness, para-compactness, connectedness, path-connectedness, local-connectedness. Homeomorphism, embedding, stereographic projection.	6
2.	Quotient topology and topological constructions: identification map, projection map. Equivalence given by a set, a function. Factorization theorem.	6
3.	Homotopy Theory: homotopy of paths and loops, The Poicare fundamental group. Fundamental group of the product. Simply connected and contractible spaces. Covering and covering spaces. Existence of lifting maps. Fundamental groups of the circle and the sphere.	10
4.	Borsuk's theory of retracts: Retraction, Deformation retraction, and Strong Deformation retraction. Constructions (cylinder, Torus, Mobius band, Klein bottle). Borsuk's non-retraction of the ball in Euclidean plane. Brouwer's fixed point theorem for the disk.	10
5.	The Seifert-Van Kampen Theorem. Computations of Fundamental Groups of some spaces and surfaces (Projective plane, punctured plane, Torus, punctured Torus, wedge sum of spaces, Figure theta and Figure eight, Mobius band, Klein bottle).	10
6.	Homology theories: Simplicial and Singular Homology, Relation Between Homotopy Groups and Homology Groups. Poincare-Hurewicz theorem. Induced homomorphism. The Relative Homology (Eilenberg-Steenrod axioms), The Mayor-Vietoris exact sequence. Properties. Homology groups of the quotient space, the Torus, the Klein bottle. Local homology groups.	10
7.	Applications: Brouwer's fixed point theorem for any dimension. Jordan-Brouwer separation theorem. Degree of a map between spheres. Antipodal and reflection maps. The hairy-ball and applications. Antipode-preserving maps and and Borsuk-Ulam Theorem. Equivalent formulations	8
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	**J. Munkres;** Topology, Prentice-Hall 2000. **(Main Reference)**
Supportive References	• **M. Greenburg & J. Harper,** *Algebraic Topology*, Binjamin/Cummings 1981. • **G. McCarty;** *Topology*, Dover 2003.
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.

Assessment Areas/Issues	Assessor	Assessment Methods
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 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)