Form: Course Syllabus	Form Number	EXC-01-02-02A
	Issue Number and Date	2/3/24/2022/2963 05/12/2022
	Number and Date of Revision or Modification	
	Deans Council Approval Decision Number	2/3/24/2023
	The Date of the Deans Council Approval Decision	23/01/2023
	Number of Pages	06

1.	**Course Title**	Group theory
2.	**Course Number**	0302955
3.	**Credit Hours (Theory, Practical)**	3
	Contact Hours (Theory, Practical)	0
4.	**Prerequisites/ Corequisites**	-
5.	**Program Title**	PhD
6.	**Program Code**	021
7.	**School/ Center**	Faculty of Science
8.	**Department**	Physics
9.	**Course Level**	Graduate
10.	**Year of Study and Semester (s)**	
11.	**Other Department(s) Involved in Teaching the Course**	
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**	
16.	**Revision Date**	

17. Course Coordinator:

Name:	Contact hours:
Office number:	Phone number:
Email:	

18. Other Instructors:

Name:
Office number:
Phone number:
Email:
Contact hours:
Name:
Office number:
Phone number:
Email:
Contact hours:

19. Course Description:

As stated in the approved study plan.

20. Program Intended Learning Outcomes: (To be used in designing the matrix linking the intended learning outcomes of the course with the intended learning outcomes of the program)

1. **SO1:** to be able to demonstrate an advanced and comprehensive understanding of core physics concepts and specialized knowledge in a chosen field of research, contributing to the frontier of physics.
2. **SO2:** to be able to develop and execute independent, original research projects that address complex scientific problems, advancing theoretical and experimental physics.
3. **SO3:** to be able to apply advanced mathematical and computational techniques to analyze complex physical phenomena and critically evaluate scientific literature and experimental results.
4. **SO4:** to be able to effectively communicate complex physics concepts, research findings, and their significance through academic writing, presentations, and public outreach.
5. **SO5:** to be able to adhere to high ethical standards and professional responsibility in conducting research, including data integrity, ethical treatment of subjects, and the responsible use of resources.
6. **SO6:** to be able to demonstrate leadership and collaborative skills within multidisciplinary teams, contributing to the development of new scientific knowledge and promoting knowledge-sharing across disciplines.
7. **SO7:** to be able to cultivate the ability to adapt to new scientific advancements and continuously engage in professional development to contribute to innovation in the field of physics.

8. SO8: to be able to master experimental and computational techniques relevant to the research field, demonstrating competency in operating and developing specialized physics instrumentation and software

21. Course Intended Learning Outcomes: (Upon completion of the course, the student will be able to achieve the following intended learning outcomes)

1. Explain the fundamental principles of group theory, including the definitions of groups, subgroups, cosets, and classes.
2. Identify and classify finite and continuous groups relevant to physical systems.
3. Derive the key properties of matrix representations, including reducibility and irreducibility.
4. Explain the orthogonality theorems and their significance in group theory.
5. Analyze the role of symmetry in quantum mechanics, solid-state physics, and crystallography.
6. Apply group theory to solve problems involving quantum mechanical operators, angular momentum, and symmetry-adapted wavefunctions.
7. Derive selection rules for physical processes, such as spectroscopy transitions, using group theoretical methods.
8. Use irreducible representations to analyze the vibrational and rotational spectra of molecules.
9. Analyze crystal structures and electronic band structures using group theory
10. Use group theoretical techniques to simplify the analysis of complex quantum systems.

Course ILOs	**The learning levels to be achieved**					
	Remembering	**Understanding**	**Applying**	**Analysing**	**evaluating**	**Creating**
1		**x**				
2		**x**				
3	**x**	**x**				
4	**x**	**x**				
5	x	x				
6			x	x		
7			x	x		
8			x	x		
9			x	x		
10					x	x

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

Program ILOs / Course ILOs	ILO (1)	ILO (2)	ILO (3)	ILO (4)	ILO (5)	ILO(6)	ILO(7)	ILO(8)
1	x						x	
2	x		x				x	
3			x					
4			x					
5				x				
6	x	x					x	
7		x				x		
8			x					x
9	x				x	x		
10		x		x				x

٢٣. Topic Outline and Schedule:

Week	Lecture	Topic	ILO/s Linked to the Topic	Learning Types (Face to Face/ Blended/ Fully Online)	Platform Used	Synchronous / Asynchronous Lecturing	Evaluation Methods	Learning Resources
1	1.	Introduction to Group Theory	CILO 1, CILO 2	Face-to-Face	Classroom	Synchronous		Hamermesh (Ch. 1)
	2	Definitions of Groups, Subgroups, and Classes	CILO 1	Face-to-Face	Classroom	Synchronous		Hamermesh (Ch. 1)

2	1	Cosets and Lagrange's Theorem	CILO 1	Face-to-Face	Classroom	Synchronous		Hamermesh (Ch. 2)
	2	Classes and Conjugacy	CILO 2	Face-to-Face	Classroom	Synchronous		Hamermesh (Ch. 2)
3	1	Finite and Continuous Groups	CILO 2	Blended	LMS (e.g., Moodle)	Synchronous		Hamermesh (Ch. 3)
	2	Matrix Representations of Groups	CILO 3	Face-to-Face	Classroom	Synchronous		Hamermesh (Ch. 4)
4	1	Reducibility and Irreducibility	CILO 3, CILO 4	Face-to-Face	Classroom	Synchronous		Hamermesh (Ch. 4)
	2	Orthogonality Theorems and Character Tables	CILO 4	Face-to-Face	Classroom	Synchronous		Hamermesh (Ch. 5)
5	1	Symmetry in Quantum Mechanics	CILO 5	Face-to-Face	Classroom	Synchronous		Hamermesh (Ch. 6)
	2	Symmetry-Adapted Wavefunctions	CILO 6	Face-to-Face	Classroom	Synchronous		Hamermesh (Ch. 6)
6	1	Applications to Angular Momentum	CILO 6	Blended	LMS	Synchronous		Hamermesh (Ch. 7)
	2	Selection Rules for Spectroscopy	CILO 7	Face-to-Face	Classroom	Synchronous		Hamermesh (Ch. 7)
7	1	Vibrational Spectroscopy	CILO 8	Face-to-Face	Classroom	Synchronous		Hamermesh (Ch. 8)
	2	Rotational Spectroscopy	CILO 8	Face-to-Face	Classroom	Synchronous		Hamermesh (Ch. 8)
8	1	Midterm						
	2	Symmetry in Crystals	CILO 9	Face-to-Face	Classroom	Synchronous		Hamermesh (Ch. 9)
9	1	Electronic Band Structures	CILO 9	Blended	LMS	Asynchronous		Hamermesh (Ch. 10)
	2	Simplifying Quantum Systems with Group Theory	CILO 10	Face-to-Face	Classroom	Synchronous		Hamermesh (Ch. 11)
10	1	Advanced Applications in Molecular Symmetry	CILO 5, CILO 8	Face-to-Face	Classroom	Synchronous		Hamermesh (Ch. 12)
	2	Advanced Crystallography	CILO 9	Blended	LMS	Synchronous		Hamermesh (Ch. 13)
11	1	Introduction to Lie Groups	CILO 2	Face-to-Face	Classroom	Synchronous		Hamermesh (Ch. 14)
	2	Continuous Symmetry Applications	CILO 2, CILO 5	Blended	LMS	Asynchronous		Hamermesh (Ch. 15)
12	1	Lie Algebras and Their Representations	CILO 3	Face-to-Face	Classroom	Synchronous		Supplementary materials
	2	Applications to Particle Physics	CILO 6,	Face-to-Face	Classroom	Synchronous		Hamermesh (Ch. 16)

			CILO 7					
13	1	Research Topics in Group Theory	CILO 10	Blended	LMS	Synchron ous		Supplementary materials
	2	Project Work and Presentation	All relev ant CILO s	Face-to-Face	Classro om	Synchron ous		All learning resources
14	1	Review	All CILO s cover ed	Face-to-Face	Classro om	Synchron ous		All learning resources
	2	Final Exam	All CILO s cover ed	Face-to-Face	Classro om	Synchron ous		

٢٤. Evaluation Methods:

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

Evaluation Activity	Mark	Topic(s)	ILO/s Linked to the Evaluation activity	Period (Week)	Platform
Midterm	30	CH1-CH7	1-8	8th week	Face
Project	30	All	All	13th week	Face
Final	40	All	All	Final week	Face

٢٥. Course Requirements:

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

2٦. Course Policies:

A- Attendance policies:

B- Absences from exams and submitting assignments on time:

C- Health and safety procedures:

D- Honesty policy regarding cheating, plagiarism, misbehavior:

E- Grading policy:

F- Available university services that support achievement in the course:

2٧. References:

A- Required book(s), assigned reading and audio-visuals:

"Group Theory and Its Application to Physical Problems" by Morton Hamermesh

B- Recommended books, materials, and media:

- "Mathematical Methods for Physicists" by George B. Arfken and Hans J. Weber
- "Group Theory: A Physicist's Survey" by Pierre Ramond

2٨. Additional information:

Name of the Instructor or the Course Coordinator:	Signature:	Date:
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Name of the Head of Quality Assurance Committee/ Department	Signature:	Date:
…….	……..……	……..……
Name of the Head of Department	Signature:	Date:
…….	……..……	……..……
Name of the Head of Quality Assurance Committee/ School or Center	Signature:	Date:
…….	……..……	……..……
Name of the Dean or the Director	Signature:	Date:
…….	……..……	……..……