Course Specification

(Postgraduate Programs)

Course Title:	Symmetry in Physics
Course Code:	PHY 6235
Program:	Master of Science in Physics
Department:	Physics
College:	Science
Institution:	Imam Mohammad Ibn Saud Islamic University
Version:	3
Last Revision Date:	*26/09/2024*

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A. General information about the course:

1. Course Identification:

1. Credit hours: 3				
2. Course type				
A.	☐ University	☐ College	☒ Department	☐ Track
B.	☐ Required		☒ Elective	
3. Level/year at which this course is offered: Level 3 or 4/Year 2				
4. Course General Description:				
This course covers knowledge of broad principles of symmetry groups and gives a deep understanding of symmetry groups and their applications in diverse problems in physics. In addition, it provides mathematical tools needed for the physical symmetry problems.				
5. Pre-requirements for this course (if any): **None**				
6. Pre-requirements for this course (if any): **None**				
7. Course Main Objective(s):				

At the end of this course, students will be able to:

- **Demonstrate knowledge of broad principles of symmetry groups.**
- **Develop a deep understanding of symmetry groups and their applications in diverse problems in physics.**
- **Develop the knowledge of mathematical tools needed for the physical symmetry problems.**

2. Teaching Mode: (mark all that apply)

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

3. Contact Hours: (based on the academic semester)

No	Activity	Contact Hours
1.	**Lectures**	**30**
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 PLOs aligned with the program	Teaching Strategies	Assessment Methods
1.0	**Knowledge and understanding**			
1.1	**Interpret the principles of symmetry in physics.**	**K1**	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Participation. ▪ Discussions.
1.2	**Suggest and perform a calculation by using mathematical tools.**	**K1, K2**	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Homework. ▪ Quizzes.
1.3	**Describe the Lie groups and Lie algebras.**	**K2, K3**	• Lectures. • Class discussions. • Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.
2.0	**Skills**			
2.1	**Explain the basic knowledge gained from studying symmetry in physics.**	**S1, S2**	• Lectures. • Class discussions. Tutorials.	▪ Exams. ▪ Discussions. Participation.
2.2	**Develop the students ability to solve and analyze problems in physics related the topics covered by the course.**	**S2, S3**	• Problem classes and group tutorial. • Homework assignments as well as problems solutions.	▪ Exams. ▪ Discussions. ▪ Homework.
2.3	**Communicate in a clear and concise manner orally, and**	**S3, S4**	• Lectures. • Class discussions. • Tutorials.	▪ Exams. ▪ Participation and activities of

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
	using IT for acquiring and analyzing information.		• Encourage students to use electronic mail and internal network for submitting homework and assignments. • Use digital library.	students in the course community and blackboard. ▪ Homework.
3.0	**Values, autonomy, and responsibility**			
3.1	**Show the collaboration and inter-professionalism in class discussions or team works, as well as solve problems independently.**	**V1, V2, V3**	• Small team tasks • Open discussion at classroom. • Office hours.	▪ Participation ▪ Homework. ▪ Mini-project(s).

C. Course Content:

No	List of Topics	Contact Hours
1.	**Introduction to symmetries: The idea of Symmetry, Symmetries of the square.**	**10**
2.	**Mathematical preliminaries : Sets, Maps, and Algebras**	**10**
3.	**Discrete Groups: Finite groups, Dihedral, Cyclic, Permutation, Symmetric groups. Lagrange's Theorem. Cayley's Theorem.**	**10**
4.	**Matrix Groups and Representation Theory: Continuous Groups. Matrix groups. Vector Spaces. Representation Theory. Orthogonality Theorem. Schur's Lemmas. Characters.**	**10**
5.	**Lie Groups and Lie Algebras: Analyticity. Innitisimal generators of Lie Groups. so(3) Lie Algebra**	**8**
6.	**Application: Rotation Symmetry in Quantum Mechanics, Representations of SO(3) and SU(2). Ladder Operators. Hydrogen Atom.**	**8**
7.	**Introduction to symmetries: The idea of Symmetry, Symmetries of the square.**	**4**
Total		**60**

D. Students Assessment Activities:

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
1.	Class Activities (class quizzes, homework, solving problems, etc.....)	weekly	20 %
2.	Midterm Exam 1	6th week	20 %
3.	Midterm Exam 2	12th week	20 %
4.	Final Exam	16th week	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	
Supportive References	*-G. Hooft, M. J. G. Veltman, Lie Groups in Physics, Utrecht University, 2007.* *-H. Georgi, Lie Algebras in Particle Physics, Benjamin Cummings, 1982.* *-K. Huang, Quarks, Leptons and Gauge Fields, 2nd Edition, World Scientific, 1992.*
Electronic Materials	https://units.imamu.edu.sa/colleges/en/science/Pages/default.aspx
Other Learning Materials	Multimedia associated with the textbook and the relevant websites.

2. Educational and Research Facilities and Equipment Required:

Items	Resources
facilities (Classrooms, laboratories, exhibition rooms, simulation rooms, etc.)	- Classrooms - Simulation rooms
Technology equipment (Projector, smart board, software)	- Classroom equipped with a whiteboard and a projector.
Other equipment (Depending on the nature of the specialty)	

F. Assessment of Course Quality:

Assessment Areas/Issues	Assessor	Assessment Methods
Effectiveness of teaching	- Students. - Second examiner	Indirect (The student will complete evaluation forms at the end of

Assessment Areas/Issues	Assessor	Assessment Methods
		semester. Final exam is evaluated by the second examiner)
Effectiveness of students' assessment	- Instructors	Direct (exams, HW, project, ...)
Quality of learning resources	- Faculty - Students	Indirect (surveys)
The extent to which CLOs have been achieved	- Instructors - Program Leaders	Direct (excel sheet)
Other		

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

Assessment Methods (Direct, Indirect)

G. Specification Approval Data:

COUNCIL /COMMITTEE	Quality Unit-Physics Department
REFERENCE NO.	Department council No. 6
DATE	26/09/2024