Course Specification

(Postgraduate Programs)

Course Title:	Quantum Optics
Course Code:	PHYS621
Program:	Master of Science in Physics
Department:	Physical Sciences
College:	Science
Institution:	Jazan University
Version:	
Last Revision Date:	20/4/2024

Table of Contents

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 2 or 3) / (year 1 or 2)				
4. Course general Description:				
This course is designed to provide the semiclassical description of EM field as well as its quantum mechanical quantization. It treats the optical cavity, optical coherence, interferometry and photo detection using quantum mechanical operators. It also considers atom-field interaction, Jaynes-Cummings model, analyses of open quantum mechanical systems as well as discrete system.				
5. Pre-requirements for this course (if any)**:Non**				
6. Co-requirements for this course (if any)**:Non**				

7. Course Main Objective(s):

The main objectives of this course are focused on the following:

- **Analyze some semiclassical descriptions as well as quantization of EM.**
- **Discuss the basics of mixed and pure optical quantum states and their calculation.**
- **Formulate mathematical derivation of quantum states and their representations as well as their measurements.**
- **Analyze the atom-light interaction using semi-classical and quantum mechanical approaches.**
- **Describe various quantum systems, optical processes and quantum electrodynamics.**
- **Solve problems related to quantum state and quantum electrodynamics.**

2. Teaching Mode: (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1.	Traditional classroom	45	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	45
2.	Laboratory/Studio	
3.	Field	
4.	Tutorial	
5.	Others (specify)	
	Total	45

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: **Upon completing the course students will be able to**			
1.1	Identify basic ideas such as quantum description of lasers, optics, quantum states, coherence, atomic structures Describe quantum nature of light, notion of a photon, photodetection processes, coherent and squeezed states of the radiation field, lasers, and nonlinear optics, atomic coherence and interference effects	PLO1.1	Lectures, tutorials, and class discussions	Direct: In class interactive questioning, quizzes, written exams Indirect: student survey

Code	Course Learning Outcomes	Code of CLOs aligned with program	Teaching Strategies	Assessment Methods
1.2	Compare between classical, semiclassical, and quantum concepts of matter-light interactions Understand how some modern experiments in quantum optics are carried out about photodetection processes, and quantum computing in the framework of quantum mechanics	PLO1.2	Lectures, tutorials, and class discussions	Direct: In class interactive questioning, quizzes, written exams Indirect: student survey
2.0	Skills: **Upon completing the course students will be able to**			
2.1	Solving problems of quantum states and electrodynamics	PLO2.1	Lectures, Problem Based Teaching and Interactive Discussions	Direct: In class interactive questioning, quizzes, written exams Indirect: student survey
2.2	Formulate and treat mathematical descriptions of basic quantum optical phenomena in terms of the quantized EM field	PLO2.1	Lectures, Problem Based Teaching and Interactive Discussions	Direct: In class interactive questioning, quizzes, written exams Indirect: student survey
2.3	Formulate and treat mathematical descriptions of quantum optical coherence and incoherence as well as open quantum system dynamics	PLO2.1	Lectures, Problem Based Teaching and Interactive Discussions	Direct: In class interactive questioning, quizzes, written exams Indirect: student survey
3.0	Values, autonomy, and responsibility: **Upon completing the course students will be able to**			
3.1	Show the ability to link the topics of quantum optics to the topics of other branches of physics	PLO3.2	Expository and Discovery, and Interactive Discussions	Group assignments, discussion Indirect: student survey

C. Course Content:

No	List of Topics	Contact Hours
1.	Field quantization	7.5
2.	Coherent states	4.5
3	Atom-field interactions	7.5
4	Quantum coherence functions	4.5
5	Beam splitters and interferometers	4.5
6	Nonclassical light	4.5
7	Dissipative interactions and decoherence	4.5
8	Optical test of quantum mechanics	4.5
9	Experiments with trapped ions and atoms	3
Total		45

D. Students Assessment Activities:

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
1.	**Assignments, and Classroom Activities**	**3,5,7,13**	**20**
2.	**Mid-term exams**	**6,12**	**30**
3.	**Final Exam**	**16**	**50**

*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	C. C. Gerryand P.L. Knight, Introductory Quantum Optics, 2nd ed. Cambridge University Press; 2023
Supportive References	1. Marlan O. Scully and M. Suhail Zubairy, Quantum Optics, (Cambridge University Press, 1997). 2. R. Loudon, The Quantum Theory of Light,3rd edition, (Oxford Science Publications,2000). 3. G. Grynberg, A. Aspect, C. Fabre , Introduction to Quantum Optics, (CambridgeUniv.Press,2010). 4. Z. Ficek and S. Swain, Quantum Interference and Coherence, Theory and Experiments, (Springer, New York, 2005) 5. P. Rice, an introduction to Quantum Optics, IOP Publishing Ltd, 2020.
Electronic Materials	D.A. Steck, Quantum and atom optics, (2007). *URL http://steck.us/teaching* (2007).
Other Learning Materials	1. Quantum Optics YouTube lectures by Prof. Immanuel Bloch

	2. Quantum Optics YouTube lectures by Prof. Wolfgang Ketterle

2. Educational and Research Facilities and Equipment Required:

Items	Resources
facilities (Classrooms, laboratories, exhibition rooms, simulation rooms, etc.)	Classroom
Technology equipment (projector, smart board, software)	smart board, data show
Other equipment (depending on the nature of the specialty)	

F. Assessment of Course Quality:

Assessment Areas/Issues	Assessor	Assessment Methods
Effectiveness of teaching	Students, peer, and program leader	Indirect peer evaluation
Effectiveness of students assessment	Students, and program assessment committee	Direct/Indirect
Quality of learning resources	Students, and faculty members	Indirect
The extent to which CLOs have been achieved	Instructor	Direct/Indirect
Other		

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

Assessment Methods (Direct, Indirect)

G. Specification Approval Data:

COUNCIL /COMMITTEE	**Department Council**
REFERENCE NO.	**Psci2415**
DATE	**1/10/2024**