هيئة تقويم التعليم
Education Evaluation Commission
المركز الوطني للتقويم والاعتماد الأكاديمي
National Center for Academic Accreditation and Evaluation

ATTACHMENT 5.

T6. COURSE SPECIFICATIONS (CS)

QUANTUM OPTICS

PHYS 636

January 2018

هيئة تقويم التعليم
Education Evaluation Commission

Course Specifications

Institution: KING SAUD UNIVERSITY	Date: 6/1/2018
College/Department : COLLEGE OF SCIENCES/DEPT. of PHYSICS & ASTRONOMY	

A. Course Identification and General Information

1. Course title and code: QUANTUM OPTICS – PHYS 636
2. Credit hours: 3
3. Program(s) in which the course is offered.
(If general elective available in many programs indicate this rather than list programs)
PhD-Laser Science
4. Name of faculty members responsible for the course
Dr. Andreas Lyras, Prof. Nabil Ben Nessib
5. Level/year at which this course is offered: PhD
6. Pre-requisites for this course (if any): Advanced Quantum Mechanics PHYS 505 and Classical Electrodynamics PHYS 507
7. Co-requisites for this course (if any):
8. Location if not on main campus:
9. Mode of Instruction (mark all that apply):

a. traditional classroom	YES	What percentage?	50%
b. blended (traditional and online)	YES	What percentage?	20%
c. e-learning	YES	What percentage?	30%
d. correspondence		What percentage?	
f. other		What percentage?	

Comments:

B Objectives

1. What is the main purpose for this course?
To provide the students with a solid background in the theory of the quantized electromagnetic (EM) field and its interaction with matter. To highlight the novel effects that arise when the EM is quantized and its quantum features critically affect its interaction with matter. To discuss the applications of these effects to novel areas of research such as optics at the nanoscale and quantum information processing.

2. Briefly describe any plans for developing and improving the course that are being implemented. (e.g. increased use of IT or web based reference material, changes in content as a result of new research in the field)
The fundamental principles and methods are well established and developed for some time now. However, intense research is devoted to nano optics and quantum information processing and as a result a periodic revision of the part of the course dealing with these applications may be necessary.

C. Course Description (Note: General description in the form used in Bulletin or handbook)

Course Description: The course is a reasonably comprehensive introduction to the fundamental principles, formalism and basic techniques of quantum optics. These are elucidated by applying them to the study of squeezed states of light, resonance fluorescence, field-induced atomic coherence, storage and transfer of coherence between field and matter, quantum theory of the laser, quantum theory of non-linear optical processes (e.g. parametric down conversion) and atom optics. It relies heavily on quantum operator algebra, the quantum density operator and its properties and master equations to provide detailed theoretical description of the effects and analyze related experimental results.

1. Topics to be Covered

List of Topics	No. of Weeks	Contact hours
Quantization of the EM field. Representations of the quantized EM field (Fock states, coherent states)	2	6
The Quantum Optics Hamiltonian	1	3
Correlation Functions and the Coherence properties of the quantized EM	1	3
Squeezed state of light	1	3
The density operator and its representations	2	6
Single-mode interaction with a two-level atom. The Jaynes-Cummings model	2	6
Open systems. RWA and non-RWA effects. Decoherence	2	6
The dressed-atom model	1	3

The Fokker-Planck equation	1	3
Laser Theory in the high-Q limit. Quantum theory of parametric down conversion	1	3
Atom motion in EM fields: cooling and trapping of atoms	1	3

2. Course components (total contact hours and credits per semester):

		Lecture	Tutorial	Laboratory/ Studio	Practical	Other:	Total
Contact Hours	Planed	30	15				45
	Actual	30	15				45
Credit	Planed						
	Actual						

3. Additional private study/learning hours expected for students per week. 6

4. Course Learning Outcomes in NQF Domains of Learning and Alignment with Assessment Methods and Teaching Strategy

On the table below are the five NQF Learning Domains, numbered in the left column.

First, insert the suitable and measurable course learning outcomes required in the appropriate learning domains (see suggestions below the table). **Second**, insert supporting teaching strategies that fit and align with the assessment methods and intended learning outcomes. **Third**, insert appropriate assessment methods that accurately measure and evaluate the learning outcome. Each course learning outcomes, assessment method, and teaching strategy ought to reasonably fit and flow together as an integrated learning and teaching process. (Courses are not required to include learning outcomes from each domain.)

Code #	NQF Learning Domains And Course Learning Outcomes	Course Teaching Strategies	Course Assessment Methods
1.0	**Knowledge**		
1.1	Define the quantization of the EM field and its representations.	Combination of lectures, tutorials, micro-group.	These skills can be assessed by examinations, quizzes and coursework
1.2	Write the Quantum Optics Hamiltonian.		
1.3	Describe the Squeezed State of Light.		
2.0	**Cognitive Skills**		
2.1	Explain the single-mode interaction by a two-level atom and the Jaynes-Cummings Model.	These skills can be acquired by lectures, practical work, tutorials and supervision of	These skills can be assessed by examinations, small group discussions and oral
2.2	Describe open systems, RWA effects and Decoherence.		
2.3	Analyze the dressed-atom model and calculate		

	the Fokker-Planck equation.	advanced work.	presentations.
2.4	Summarize the Laser theory in the high-Q limit.		
2.5	Explain the atom motion in EM field.		
3.0	**Interpersonal Skills & Responsibility**		
3.1	Learn independently	These skills can be acquired by assignments, homework and oral presentations. The students are encouraged to work in group to submit different projects and homework assignments in different subjects of the course.	Assessment of group assignment includes component for individual contribution. The instructor will evaluate the contribution and commitment of each member of the group during meetings and through questions to specific members of the group. Capacity for independent study is assessed in individual assignments.
3.2	Work as a team		
3.3	Acknowledge others' work		
4.0	**Communication, Information Technology, Numerical**		
4.1	Efficient use of networks in search for information in different web sites and research discussions.	The student is asked to do some research on the web about the quantization of the EM field, squeezed state of light, Rotating Wave Approximation and decoherence.	These skills can be evaluated via discussions with students.
4.2	Advancing abilities to use mathematical packages (Mathematica, Matlab, Maple, etc).		
4.3	Analyze related scientific papers	Library	Oral presentation
5.0	**Psychomotor** N/A		
5.1			

5. Schedule of Assessment Tasks for Students During the Semester

	Assessment task (i.e., essay, test, quizzes, group project, examination, speech, oral presentation, etc.)	Week Due	Proportion of Total Assessment
1	HOMEWORK I	3	5%
2	HOMEWORK II	6	5%
3	HOMEWORK III	9	5%
4	MIDTERM EXAM	7	20%
5	WRITTEN ASSIGNMENT /ORAL PRESENTATION	14	25%
6	FINAL EXAM	15	40%

D. Student Academic Counseling and Support

1. Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice. (include amount of time teaching staff are expected to be available each week) 3 office hours per week.

E Learning Resources

1. List Required Textbooks: • Z. FICEK & M. R. WAHIDDIN, Quantum Optics for Beginners, Pan Stanford Publishing, 2014, ISBN 978-981-4411-75-2 • P. LAMBROPOULOS & D. PETROSYAN, Fundamentals of Quantum Optics & Quantum Information, Springer, 2007, ISBN 978-3-540-34572-5 • D. F. WALLS & G. J. MILBURN Quantum Optics, Springer, 2nd ed., 2008, ISBN 978-3-540-28573-1 • M. ORSZAG Quantum Optics, Springer, 3rd ed., 2016, ISBN 978-3-319-29035-5
2. List Essential References Materials (Journals, Reports, etc.) **Journals:** Optical and Quantum Electronics Journal of Optics Journal of Modern Optics
3. List Electronic Materials, Web Sites, Facebook, Twitter, etc.
4. Other learning material such as computer-based programs/CD, professional standards or regulations and software. Showing animations for theoretical models in quantum optics using smart-board.

F. Facilities Required

Indicate requirements for the course including size of classrooms and laboratories (i.e. number of seats in classrooms and laboratories, extent of computer access, etc.)
1. Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.) A medium sized classroom with Smart Board.
2. Technology resources (AV, data show, Smart Board, software, etc.) Smart Board and computer for mathematical softwares.
3. Other resources (specify, e.g. if specific laboratory equipment is required, list requirements or attach list)

G Course Evaluation and Improvement Processes

1. Strategies for Obtaining Student Feedback on Effectiveness of Teaching Questionnaires in the middle and at the end of the semester.
2. Other Strategies for Evaluation of Teaching by the Instructor or by the Department
3. Processes for Improvement of Teaching By analyzing the evaluation of the students and the faculty staff by the Development and Quality Committee.
4. Processes for Verifying Standards of Student Achievement (e.g. check marking by an independent member teaching staff of a sample of student work, periodic exchange and remarking of tests or a sample of assignments with staff at another institution)
5. Describe the planning arrangements for periodically reviewing course effectiveness and planning for improvement.

Name of Course Instructors: Dr. Andreas Lyras, Prof. Nabil Ben Nessib.

Signature: ______________________ Date Specification Completed:

Program Coordinator: ____

Signature: _________________________ Date Received: ________________