

INSTRUCTION DIVISION
FIRST SEMESTER 2016-2017
Course Handout (Part II)

In addition to part-I (General Handout for all courses appended to the timetable) this portion gives further specific details regarding the course.

Course No. : PHY F420
 Course Title : Quantum Optics
 Instructor-in-Charge : SUBHASH KARBELKAR

Course Description : This course aims at an elementary introduction to the quantum optics dealing with atom light interaction.

Scope & Objectives : The course has two part structure. The first part deals with the physics underlying atom light interaction. Topics covered include quantization of light, quantum interactions between light and matter. The second part aims at providing a cursory glimpse into the fascinating applications such as theory of lasers, laser cooling, dressed atoms, entangled states and experiments with single photons.

Reference Books:

1. Quantum Optics, 2nd edition, Miguel Orszag, Springer SIE, 2008 **(R1)**
2. Introductory Quantum Optics, Gerry and Knight, Cambridge, 2005 **(R2)**
3. Elements of Quantum Optics, 3rd edition, Meystre and Sargent III, Springer SIE, 1999 **(R3)**
4. Quantum Optics, an introduction, Mark Fox, Oxford, 2006 **(R4)**

Course Plan:

Lect. No.	Learning Objectives	Topics to be covered	Reference to reference book
1-4	review of classical electrodynamics and optics	radiation, coherence	class notes
5-8	(EM) Field quantization	modes, Hamiltonian for EM fields in free space, quantization of single EM field mode	class notes; R1: ch 3; R2: ch 2; R3: ch13
9-12	Coherent States, squeezed states, quantum coherence	QM of SHO, coherent states; semi classical (phase space) descriptions of quantum states	class notes; R1: ch 4, ch 5 R2: ch 3; R3: ch 17
13-16	Atom field interaction	Interaction of charged particle with classical EM field, Einstein's theory of atom radiation interaction; Time dependent perturbation theory, Rabi oscillations	class notes R1: ch 1, ch 2 R3: ch 3
17-20	Atom field interaction	interaction taking into quantized EM fields, spontaneous emission, Jayne Cumming model	class notes; R1: ch 8; R3: ch 14
21-24	Laser cooling, optical lattices	Laser theory, mechanical effects of radiation, Doppler and sub-Doppler cooling, BEC and ultracold atoms	class notes; R3: ch 6, ch 7
25-28	Tests of quantum mechanics; entangled states	Entangled states, Bell's theory, and teleportation	class notes; R1: ch 21; R2: ch 9
29-32	ion/atom traps,	experiments with cavity QED and trapped ions	class notes; R1: ch 19; R2: ch 10 R3:ch 18
33-36	quantum computation	Qubits,	class notes;

			R1: ch 19; R2: ch 10 R3:ch 18
37-40	special topics	atom optic, experiments with single photons	class notes R2: ch 10; R3 ch 12

Evaluation Scheme:

EC No	Evaluation Component.	Duration.	Weightage	Date & Time	Nature of Component.
1	Midsem Test		30%	8/10 10:00 - 11:30 AM	Closed Book
2	Project		20%		Take home / presentation/ test on common study**
3	Tutorial tests		20%		closed book
4	Comprehensive Examination	3 Hours.	30%	13/12 FN	Open Book/closed book

**** Project:** Details of project work will be announced in the class. It will be based on studying, in depth, few (common to all) seminal articles in the field and on the selected/allotted topic (individually/ group of students). The understanding of the common articles will be tested in the as a tut test (as open book) and the individual/group topic will be evaluated as presentation and handwritten submission.

Chamber Consultation Hour: To be announced in the class.

Notices: Notices concerning the course will be put up on the **NALANDA** SITE only.

Make-up Policy: No Make will be granted for tutorial tests. Make-up for the test/s will be granted only for genuine (bedridden/fever etc but not stomach upset) cases of health problems or urgency for going out of town with prior permission. In case of medical grounds for make-ups, the students must arrange to send the application, which must mention the location of student, with their trusted friends or by email (only snkarbelkar@gmail.com) so as to reach the instructor not later than the end of that test (a personal “get well soon” visit to places/Bhavans other than Meera may be carried out! For Meera Bhavan residents a warden may be requested to convey the “get well soon” message).

Instructor-in-charge
SUBHASH KARBELKAR