



## Course Syllabus

### OSE6347 Quantum Optics, 3 Cr

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<b>Instructor:</b> Bahaa Saleh	<b>Term:</b> Spring 2019
<b>Email:</b> besaleh@creol.ucf.edu	<b>Class Meeting Days:</b> Monday, Wednesday
<b>Phone:</b> 407 882-3326	<b>Class Meeting Time:</b> 4:30–5:45 pm
<b>Office:</b> CREOL Rm 207	<b>Class Location:</b> CREOL 102
<b>Office Hours:</b> M, W 3:00-4:00 pm <sup>†</sup>	<b>Website:</b> Webcourse

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<sup>†</sup> I will be in my office at these times, but of course I will be happy to discuss the material with you anytime. I often get questions via e-mail that can be quickly answered.

#### Course Catalog Description:

Semi-classical treatment of light/matter interaction (quantized atomic states and Maxwell's equations), density matrix theory, coherent optical transition, pulse propagation.

#### Prerequisites:

Graduate Standing and OSE 5312 Light Matter Interaction, or Consent of Instructor

#### Detailed Description:

This course is an introduction to the quantum theory of light and light-matter interaction, both semiclassical and quantum. It begins with a review of quantum mechanics with a particular emphasis on the quantum theory of harmonic oscillators and two-level systems. Quantization of the electromagnetic field is subsequently introduced, including coherent, thermal, and squeezed states. The basic theories of quantum coherence, quantum interference, and photon statistics are covered, along with an introduction to two-photon entanglement and some of its applications. A basic theory of interaction of light with two-level atomic systems leads to a derivation of the rates of absorption, and stimulated and spontaneous emission. A semiclassical theory of optical interaction with two-level systems is formulated and applied to the study of coherent optical transitions, self-induced transparency and photon echo. A fully quantum treatment of such interactions is discussed briefly. The course ends with a study of the quantum theory of parametric interactions in nonlinear optics and a brief discussion of the quantum theory of the laser.

#### List of Topics:

- Overview of the postulates of quantum mechanics using Dirac notations
- Quantum theory of the harmonic oscillator
- Quantization of the electromagnetic field: The photon
- Special quantum states: number states, coherent states, number states, squeezed states
- Quantum theory of coherence and interference
- Entangled states of light.
- Interaction of light with an atom: Calculation of rates absorption, and spontaneous and stimulated emission
- Quantum theory of detection
- Semiclassical theory of coherent interaction of light with a two-level system: self-induced transparency and photon echo. Quantum theory of such interaction

- Quantum theory of parametric interactions for second-order nonlinear media
- Quantum theory of the laser.

**Textbook:**

None (Class notes will be provided)

**Recommended References:**

- R. Loudon, The Quantum Theory of Light, Oxford University Press, 3rd ed. 2000.
- P. Meystre and M. Sargent III, Elements of Quantum Optics, Springer-Verlag, 4th ed. 2007.
- G. S. Agarwal, Quantum Optics, Cambridge University Press, 2012.
- C. C. Gerry and P. L. Knight, Introductory Quantum Optics, Cambridge University Press, 2005.
- L. Mandel and E. Wolf, Optical Coherence and Quantum Optics, Cambridge University Press, 1995.

**Other required course material**

None

**Course Grading:**

Homework (20%), midterm exam (30%), final exam (50%)

**Make up Exam Policy:** If an emergency arises and a student cannot submit assigned work on or before the scheduled due date or cannot take an exam on the scheduled date, the student **must** give notification to the instructor **no less than 24 hours before** the scheduled date and **no more than 48 hours after the** scheduled

**Financial Aid and Attendance:** All faculty members are required to document students' academic activity at the beginning of each course. In order to document that you began this course, please complete the following academic activity by the end of the first week of classes, or as soon as possible after adding the course. Failure to do so will result in a delay in the disbursement of your financial aid.

Grade	Rubric Description
A	Excellent, has a strong understanding of all concepts and is able to apply the concepts in all and novel situations. Has full mastery of the content of the course.
B	Good, has a strong understanding of most or all of the concepts and is able to apply them to stated and defined situations.
C	Average, has a basic understanding of the major concepts of the course and is able to apply to basic situations.
D	Below average, has a basic understanding of only the simple concepts and is able to apply to only a limited number of the most basic situations.
F	Demonstrates no understanding of the course content.

**Grade Objections:**

All objections to grades should be made **in writing within one week** of the work in question. Objections made after this period has elapsed will **not** be considered – NO EXCEPTIONS.

**Class Website:**

Materials used for classes will be available on UCF Webcourses for download before each class or distributed during class.

**Professionalism and Ethics:**

Per university policy and plain classroom etiquette, mobile phones, etc. must be silenced during all classroom lectures, unless you are specifically asked to make use of such devices for certain activities. Academic dishonesty in any form will not be tolerated! If you are uncertain as to what constitutes academic dishonesty, please consult The Golden Rule in the UCF Student Handbook ([www.goldenrule.sdes.ucf.edu](http://www.goldenrule.sdes.ucf.edu)) for further details. As in all University courses, The Golden Rule Rules of Conduct will be applied. Violations of these rules will result in a record of the infraction being placed in your file and the student receiving a zero on the work in question AT A MINIMUM. At the instructor's discretion, you may also receive a failing grade for the course. Confirmation of such incidents can also result in expulsion from the University.

**Students with Special Testing/Learning Needs:**

Students with special needs and require special accommodations must be registered with UCF Student Disability Services prior to receiving those accommodations. Students must have documented disabilities requiring the special accommodations and must meet with the instructor to discuss the special needs as early as possible in the first week of classes. UCF Student Disability Services can be contacted at [www.sds.sdes.ucf.edu](http://www.sds.sdes.ucf.edu) or at (407) 823-2371.