



EE 599 (30490) Quantum Optics

Units: 4

Term: Fall 2023

Day: TTH

Time: 2:00-3:50 pm

Location: TBA-

**Course Monitor: Prof. Demetrios Christodoulides,
demetri@usc.edu**

Instructor: Dr. Demetrios Christodoulides

Office: EEB 504

Office Hours: Friday, 12:30pm-1:30pm

Contact Info: demetri@usc.edu

Cell: 407-721-3811

Teaching Assistant: TBA

Office: TBA

Office Hours: TBA

Contact Info: TBA

IT Help:

Course Description: Quantum Optics

- Hilbert space-foundations of quantum mechanics
 - Dirac Formulation
 - Hermitian operators-observables
 - Dynamical evolution of a quantum system
 - Schrödinger and Heisenberg picture
- Field quantization
 - Quantum harmonic oscillator-Fock states
 - Quantization of a single-mode field
 - Quantum fluctuations-vacuum fluctuations
 - Multimode and thermal fields
- Coherent states
 - Eigenstates of the annihilation operator
 - Displaced vacuum states
 - Wave packets-time evolution
 - Density operators and phase-space probability distributions
- Emission and absorption of radiation by atoms
 - Atom interaction with a classical or a quantized field
 - The Rabi semi-classical model
 - Jaynes-Cummings model
 - Dressed states
- Quantum coherence functions
 - Classical and quantum coherence functions
 - Higher-order coherence functions
- Beam splitters and interferometers
 - Quantum mechanics of beam splitters
 - Single and bi-photon interferometry
 - Interferometry with coherent states of light
- Non-classical light
 - Quadrature squeezing
 - Photon anti-bunching
 - Schrödinger cat states and higher-order squeezing
- Dissipative interactions and decoherence
 - Ensembles
 - Lindblad master equation
 - Decoherence
- Optically testing quantum mechanics
 - Bell inequalities
 - Spontaneous parametric down conversion and other quantum sources
- Quantum information processing
 - Quantum teleportation
 - Quantum cryptography
 - Quantum communication

Learning Objectives

Students will be exposed to the fundamental principles and techniques in the general area of quantum optics.

Prerequisite(s): N/A

Co-Requisite(s): Concurrent Enrollment: N/A

Recommended Preparation: Be familiar with basic linear algebra and basic concepts in quantum mechanics

Course Notes

Grading Type: letter grade

The course is Web-Enhanced (Blackboard).

Copies of lecture slides and other class information will be posted on Blackboard.

Technological Proficiency and Hardware/Software Required

N/A

Required Readings and Supplementary Materials

Required textbook: C. C. Gerry and P. L. Knight, Introductory Quantum Optics

Additional recommended text: M. O. Scully and M. S. Zubairy, Quantum Optics

Additional (required) reading: Literature on quantum optics

Description and Assessment of Assignments

Students will be assigned a homework every week or bi-weekly. Homework will involve solving textbook problems and will include problems of current interest. There will be two midterms and one final.

Grading Breakdown

Assignment	% of Grade	
participation	5%	
homework	20%	
mid-term	25%	
mid-term	25%	
final exam	25%	
TOTAL	100%	

Grading Scale: Course will be graded on a curve

Assignment Rubrics

N/A

Assignment Submission Policy

Homework assigned on Tuesday (or first day of class of the week), to be submitted one week after assignment, same day of the week.

Late assignments will be penalized (10%), unless valid reason, e.g., medical problem, family or other emergency

Grading Timeline

Graded homework are expected to be returned within one week.

Additional Policies

Attendance of the lectures is expected.

Cellphones are to be turned off before beginning of class.

IMPORTANT:

In addition to in-class contact hours, all courses must also meet a minimum standard for out-of-class time, which accounts for time students spend on homework, readings, writing, and other academic activities. **For each unit of in-class contact time, the university expects two hours of out of class student work per week over a semester.**

(Please refer to the [Contact Hours Reference guide](#).)

Statement on Academic Conduct and Support Systems

Academic Conduct:

Plagiarism – presenting someone else’s ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in *SCampus* in Part B, Section 11, “Behavior Violating University Standards” policy.usc.edu/scampus-part-b. Other forms of academic dishonesty are equally unacceptable. See additional information in *SCampus* and university policies on scientific misconduct, <http://policy.usc.edu/scientific-misconduct>.

Support Systems:

Student Counseling Services (SCS) – (213) 740-7711 – 24/7 on call

Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention. engemannshc.usc.edu/counseling

National Suicide Prevention Lifeline – 1 (800) 273-8255

Provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week. www.suicidepreventionlifeline.org

Relationship and Sexual Violence Prevention Services (RSVP) – (213) 740-4900 – 24/7 on call

Free and confidential therapy services, workshops, and training for situations related to gender-based harm. engemannshc.usc.edu/rsvp

Sexual Assault Resource Center

For more information about how to get help or help a survivor, rights, reporting options, and additional resources, visit the website: sarc.usc.edu

Office of Equity and Diversity (OED)/Title IX Compliance – (213) 740-5086

Works with faculty, staff, visitors, applicants, and students around issues of protected class. equity.usc.edu

Bias Assessment Response and Support

Incidents of bias, hate crimes and microaggressions need to be reported allowing for appropriate investigation and response. studentaffairs.usc.edu/bias-assessment-response-support

The Office of Disability Services and Programs

Provides certification for students with disabilities and helps arrange relevant accommodations. dsp.usc.edu

Student Support and Advocacy – (213) 821-4710

Assists students and families in resolving complex issues adversely affecting their success as a student EX: personal, financial, and academic. studentaffairs.usc.edu/ssa

Diversity at USC

Information on events, programs and training, the Diversity Task Force (including representatives for each school), chronology, participation, and various resources for students. diversity.usc.edu

USC Emergency Information

Provides safety and other updates, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible. emergency.usc.edu

USC Department of Public Safety – UPC: (213) 740-4321 – HSC: (323) 442-1000 – 24-hour emergency or to report a crime.
Provides overall safety to USC community. dps.usc.edu