

# Quantum Optics, IPT5340 (PHYS6840)

Time: W3W4Wn (10:10 AM-01:00 PM, Wednesday), at Room 210, EECS bldg.

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## • Course Description:

- The field of quantum optics has made a revolution on modern physics, from laser, precise measurement, Bose-Einstein condensates, quantum information process, to the fundamental issues in quantum mechanics.
- Through this course, I want to provide an in-depth and wide-ranging introduction to the fundamental concepts for quantum optics, including physical concepts, mathematical methods, simulation techniques, basic principles and applications.
- Current researches on non-classical state generation, quantum noise measurement, nonlinear quantum pulse propagation, quantum interference, quantum information science, Bose-Einstein condensates, and atom optics would also be stressed.
- Background requirements: Basics of quantum mechanics, electromagnetic theory, and nonlinear optics.

## • Text Books and References:

1. In-class handouts.
2. D.F. Walls and G.J. Milburn, "*Quantum Optics*", 2nd Ed. Springer (2008).
3. Marlan O. Scully, and M. Suhail Zubairy, "*Quantum Optics*", Cambridge (1997).
4. Yoshihisa Yamamoto, Atac Imamoglu, "*Mesoscopic Quantum Optics*", Wiley (1999).

## • Teaching Method:

in-class lectures with discussion and project studies.

## • Syllabus:

1. Quantization of the Electromagnetic Fields, [Textbook] Ch. 2, (3/4, 3/11)
2. Coherence properties of the EM fields, [Textbook] Ch. 3, (3/18, 3/25)
3. Representation of the EM fields, [Textbook] Ch. 4, (4/1, 4/8)
4. Quantum phenomena in simple nonlinear optics, [Textbook] Ch. 5, (4/15, 4/22)
5. Input-Output Formulation of optical cavities, [Textbook] Ch. 7, (5/6, 5/13)
6. Squeezed lights, [Textbook] Ch. 8, (5/20, 5/27)
7. Atom-field interaction, [Textbook] Ch. 10, (6/3, 6/10)
8. Cavity Quantum ElectroDynamics (Cavity-QED), [Textbook] Ch. 11, (6/17)
9. Midterm, (5/6) and Semester reports, (6/24).
10. ~~Quantum theory of Laser, [Textbook] Ch. 12,~~
11. ~~Quantum Non-demolition Measurement, [Textbook] Ch. 14,~~
12. ~~Quantum Coherence and Measurement theory, [Textbook] Ch. 15,~~
13. ~~Quantum Information, [Textbook] Ch. 13 and Ch. 16,~~
14. ~~Ion Trap, [Textbook] Ch. 17,~~
15. ~~Light Forces, [Textbook] Ch. 18,~~
16. ~~Bose-Einstein Condensation, [Textbook] Ch. 19,~~

## • Evaluation

1. Homework  $\times 4$  (monthly), 50%
2. Midterm, (take home exam) 30%
3. Semester Report, (oral presentation) 20%

## • Office hours: Office hours: 3:00-5:00, Thursday at Room 523, EECS bldg.

## • More information:

<http://mx.nthu.edu.tw/~rkleee>

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