ECE 770: Topic 14/QIC 885

Quantum Electronics and Photonics

Instructor: A. Hamed Majedi

Lecture Time & Location: Winter 2013, Wednesday 8:30-11:20, EIT 3151.

General Description:

This course is designed for engineers who are interested to learn applied quantum mechanics to study quantum behavior of electron, photon and their interaction. The course content is a mix of topics usually covered in more conventional courses such as quantum electronics and quantum optics to invite a wide range of audiences who are working on areas such as engineering electromagnetics, solid state electronics, nanotechnology, applied quantum optics and quantum devices for classical and quantum information processing. The course is introductory and emphasizes on the fundamental concepts and engineering applications without a previous exposure to quantum mechanics. Examples and problems are designed to address the applications of the course contents to real problems in electronic, optoelectronic, photonic and superconductive devices.

General Course Contents:

1- Origins & Brief History of Quantum Physics
2- The Schrodinger Equation
3- Electrons in Quantum Confined Structures (quantum well, wire, dot and superlattice)
4- Axiomatic Structure of Quantum Mechanics
5- Quantum Dynamics
6- Electrons in Electromagnetic Field
7- Angular Momentum and Spin
8- Quantum Statistics
9- Review of Classical Electrodynamics
10- Electromagnetic (EM) Field Quantization
11- Quantum States of EM Field
12- Electron/Photon & Atom-EM Field Interaction
13- Cavity Quantum Electrodynamics
14- Quantum Information Processing

Text:

1- Course notes and slides.

Some References:

1- D.J. Griffiths, *Introduction to Quantum Mechanics*, 2nd Edition, Prentice Hall, 1995.
2- H. Kroemer, *Quantum Mechanics for Engineering, Material Science and Applied Physics*, Prentice Hall, 1994.
3- A.F.J. Levi, *Applied Quantum Mechanics*, 2nd ed., Cambridge, 2006.

4- W. Greiner, *Quantum Mechanics An Introduction, 4th ed.*, Springer, 2001.
5- Ph. Martin, F. Rothen, *Many-Body Problems and Quantum Field Theory*, 2nd ed., Springer, 2004.
6- C. Cohen-Tannoudji, B. Diu, F. Lalole, *Quantum Mechanics*, JW, 1971.
7- W. H. Louisell, *Quantum Statistical Properties of Radiation*, Wiley, 1973.
8- U. Leonhardt, *Measuring Quantum State of Light*, Cambridge, 1997.
9- H.A. Bacher, T.C. Ralph, *A Guide to Experiments in Quantum Optics*, 2nd Edition, Wiley-VCH, 2003.
10- M. Fox, *Quantum Optics, An Introduction*, Oxford, 2005.
11- J.C. Garrison, R.Y. Chiao, *Quantum Optics*, Oxford, 2008.
12- D. Marcuse, *Principles of Quantum Electronics*, AP, 1980.
13- S. Datta, *Quantum Transport, Atom to Transistor*, Cambridge, 2005.
14- H. Bruus, K. Flensberg, *Many-Body Quantum Theory in Condensed Matter Physics*, Oxford, 2004.

Grading Policy: %50 Assignments/mini-project, %50 Final Exam
Five Homeworks (HWs) due dates: Jan 30, Feb. 13, Feb. 27, March 13, Apr 3.

Collaboration Policy on Assignment: Discussion among students, professor and TAs is permitted and encouraged. Assignments submitted must be your own work. It should reflect your own attempt, wording and write up for solution to the assignments. Copying from any source without explicit reference is a violation of this policy (plagiarism).

Late grading policy: Late assignment submission (deadline of each assignment is different) will be reduced 10% daily up to the maximum of 50%. There is no exception to this rule, other than any medical, rare situation and University-established emergency cases (a letter from authorized official is required). This late grading policy will be just enforced for fairness to all.

Academic Integrity: In order to maintain a culture of academic integrity, members of the University of Waterloo community are expected to promote honesty, trust, fairness, respect and responsibility. [Check www.uwaterloo.ca/academicintegrity/ for more information.]

Grievance: A student who believes that a decision affecting some aspect of his/her university life has been unfair or unreasonable may have grounds for initiating a grievance. Read Policy 70, Student Petitions and Grievances, Section 4, www.adm.uwaterloo.ca/infosec/Policies/policy70.htm. When in doubt please be certain to contact the department's administrative assistant who will provide further assistance.

Discipline: A student is expected to know what constitutes academic integrity [check www.uwaterloo.ca/academicintegrity/] to avoid committing an academic offence, and to take responsibility for his/her actions. A student who is unsure whether an action constitutes an offence, or who needs help in learning how to avoid offences (e.g., plagiarism, cheating) or about "rules" for group work/collaboration should seek guidance

from the course instructor, academic advisor, or the undergraduate Associate Dean. For information on categories of offences and types of penalties, students should refer to Policy 71, Student Discipline, www.adm.uwaterloo.ca/infosec/Policies/policy71.htm. For typical penalties check Guidelines for the Assessment of Penalties, www.adm.uwaterloo.ca/infosec/guidelines/penaltyguidelines.htm.

Appeals: A decision made or penalty imposed under Policy 70 (Student Petitions and Grievances) (other than a petition) or Policy 71 (Student Discipline) may be appealed if there is a ground. A student who believes he/she has a ground for an appeal should refer to Policy 72 (Student Appeals) www.adm.uwaterloo.ca/infosec/Policies/policy72.htm.

Note for Students with Disabilities: The Office for Persons with Disabilities (OPD), located in Needles Hall, Room 1132, collaborates with all academic departments to arrange appropriate accommodations for students with disabilities without compromising the academic integrity of the curriculum. If you require academic accommodations to lessen the impact of your disability, please register with the OPD at the beginning of each academic term.

Turnitin.com: Plagiarism detection software (Turnitin) might be used to screen assignments in this course. This is being done to verify that use of all material and sources in assignments is documented.
Note: students must be given a reasonable option if they do not want to have their assignment screened by Turnitin.
See: http://uwaterloo.ca/academicintegrity/Turnitin/index.html for more information.