ECE 677/QIC 885, Quantum Electronics and Photonics

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General Description

Quantum physics provides not only an essential theory to study electrons and photons in nanoscale but also radical ways to do information processing, sensing, computation and communication. The rapid co-evolution of nanotechnology and quantum information processing raise growing interests in engineering students to learn and master quantum mechanics. This course offers a composition 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 solid state electronics, quantum photonics and quantum information processing. Fundamental concepts and engineering applications are emphasized in each subject. Examples and problems are designed to address the applications of the course contents to real problems in electronic, optoelectronic, photonic and superconductive devices. There is no need for previous exposure to quantum mechanics and the prerequisites of the course are the passion of knowledge, commitment, hard-work and a bit of classical physics and math!.

General Course Contents

1- Brief History of Quantum Physics; *Why, When and How?*

2- Wave Mechanics and the Schrödinger Equation; *Electron Meows!*

3- Electrons in Quantum Confined Structures (quantum well, wire, dot and superlattice); *Electrons' Ballroom Dance*

4- Axiomatic Structure of Quantum Mechanics; *Lets be Serious!*

5- Quantum Dynamics; *Time is Gold!*

6- Electrons in Electromagnetic Field; *Maxwell Meets Schrödinger*

7- Angular Momentum and Spin; *Irrotational Rotation!*

8- Quantum Statistics; *Coin tossing with Mr. Fermi and Mr. Bose!*

9- Electromagnetic (EM) Field Quantization; *When Dirac Meets Maxwell.*

10- Quantum States of EM Field; *Photon Face Lift!*

11- Electron/Photon & Atom-EM Field Interaction; *Electron-photon Cha Cha with social distancing!*

12- Cavity Quantum Electrodynamics; *Atom-Photon Tango with social distancing!*

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- Ph. Martin, F. Rothen, Many-Body Problems and Quantum Field Theory, 2nd ed., Springer, 2004.

5- C. Cohen-Tannoudji, B. Diu, F. Lalole, Quantum Mechanics, JW, 1971.

6- W. H. Louisell, Quantum Statistical Properties of Radiation, Wiley, 1973.

7- H.A. Bacher, T.C. Ralph, A Guide to Experiments in Quantum Optics, 2nd Edition, Wiley-VCH, 2003.

8- M. Fox, Quantum Optics, An Introduction, Oxford, 2005.

9- J.C. Garrison, R.Y. Chiao, Quantum Optics, Oxford, 2008..

10- D. Marcuse, Principles of Quantum Electronics, AP, 1980.

11- S. Datta, Quantum Transport, Atom to Transistor, Cambridge, 2005.

12- H. Bruus, K. Flensberg, Many-Body Quantum Theory in Condensed Matter Physics, Oxford, 2004.

Grading Policy: % 50 Assignments/mini-project, % 50 Final Exam.