ECE 677/QIC 885, Quantum Electronics and Photonics

University of Waterloo, Instructor: A.Hamed Majedi

EIT 3151, Wednesday 8:30-11:20, Winter 2018

General Description

Quantum physics provides not only an essential theory to study and control objects in nano and atomic scales but also radical ways to do information processing, sensing, computation and communication. Advances in nanotechnology and quantum information processing raise growing interests in engineering students to learn applied quantum mechanics that is also essential for understanding modern devices and systems in electronics and photonics.

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, nanotechnology, quantum photonics and quantum devices.

Fundamental concepts and engineering applications are emphasized and there is no need to 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- Quantum Physics; Why, When and How?

2- The Schrödinger Equation; Electron Meows!

3- Electrons in Quantum Confined Structures (quantum well, wire, dot and superlattice); Dance of Electrons in Various Ballrooms!

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

5- Quantum Dynamics; Time a Greatest Unknown!

6- Electrons in Electromagnetic Field; When Maxwell Meets Schrödinger!

7- Angular Momentum and Spin; Irrotational Rotation!

8- Quantum Statistics; Two Friends Mr. Bose & Mr. Fermi!

9- Review of Classical Electrodynamics; Maxwells Bows and Arrows!

10- Electromagnetic (EM) Field Quantization; Dirac, an electrical engineer, does it all!

11- Quantum States of EM Field; Photon Face/Off!

12- Electron/Photon & Atom-EM Field Interaction; Electron-Photon Cha Cha!

13- Cavity Quantum Electrodynamics; Atom-Photon on a Peace Table!

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.