Engineering Faculty Document No. 36-05

April 26, 2006

TO: The Faculty of the College of Engineering

FROM: The Faculty of the School of Electrical and Computer Engineering

RE: ECE 659 Course Title, Description and Textbook Changes

The faculty of the School of Electrical and Computer Engineering has approved the following changes in ECE 659. This action is now submitted to the Engineering Faculty with a recommendation for approval.

From:

ECE 659 Quantum Phenomena in Semiconductors
Sem. 2, Class 3, Cr. 3
Prerequisites: EE 606 and MA 511 or equivalent
Corequisites: None

This course is designed for graduate students familiar with semiconductor fundamentals, with engineering electromagnetics and with linear algebra, but having no significant acquaintance with either quantum mechanics or statistical mechanics. The purpose of the course is to introduce the relevant concepts of quantum mechanics and non-equilibrium statistical mechanics as possible using device-related examples. Topics include: preliminary concepts, equilibrium, restoration of equilibrium, transport, effective mass equation, optical properties, advanced concepts.

To:

ECE 659 Quantum Transport

Sem. 2, Class 3, Cr. 3
Prerequisites: Graduate Standing
Prerequisites by Topic: Matrix Algebra, MATLAB or equivalent, Partial ifferential equations. Familiarity with semiconductor device physics useful but not essential.
Corequisites: None

This course is designed for graduate students familiar with differential equations and linear algebra, but having no significant acquaintance with either quantum mechanics or statistical mechanics. The purpose of the course is to introduce the relevant concepts of quantum mechanics and non-equilibrium statistical mechanics using device-related examples. We use MATLAB-based numerical examples to provide concrete illustrations and the homeworks require students to set up their own computer program on a PC to reproduce the results.

Reason: ECE 659 was originally developed by me in the late 1980's and taught by a number of Professors during the 1990's including Profs. Lundstrom and Gray using the text: S. Datta, Quantum Phenomena, Addison-Wesley (1989), written by me. Around 1999, I felt the need to modify the course suitably to adapt to the changes in the field and to incorporate MATLAB-based examples. I started writing what I thought would be a second edition of the book, but it turned out to be essentially a new book which has just appeared: S. Datta, Quantum Transport: Atom to Transistor, Cambridge University Press (2005), ISBN 0-521-63145-9.

I would like to request that this new book be adopted as the text for the course. The approach used in the book is unique and there is no other comparable text at this time. I would also like to request that the title be modified from Quantum Phenomena in Semiconductors to Quantum Transport since the emphasis (like the earlier version of the course) is distinctly on transport or current flow, although the discussion has been broadened beyond semiconductors.

Mark Smith, Head
School of Electrical & Computer Engineering

Required Text :
S. Datta, Quantum Transport: Atom to Transistor, Cambridge University Press (2005), ISBN 0-521-63145-9.

Course Outline:
1 / An atomistic view of electrical resistance Lectures 1-5
2 / Schrodinger equation Lectures 6-8
3 / Self-consistent field and Coulomb Blockade Lectures 9-12
4 / Basis functions Lectures 13-16
5/ Bandstructure Lectures 17-20
6 / Subbands Lectures 21-23

MIDTERM

7 / Quantum vs. electrostatic capacitance Lectures 24-26

8 / Level broadening Lectures 27-30
9 / Coherent transport Lectures 31-34
10 / Non-coherent transport Lectures 35-39
11 / Atom to transistor Lectures 40-41
12 / Spin Lectures 42-43

FINAL

Course History: This course was offered in the Springs of 2001, 2002, 2003, 2004, 2005 and 2006 semesters with enrollments of 10, 14, 25, 33, 19, and 14 students respectively.