GEORGE MASON UNIVERSITY

ELECTRICAL AND COMPUTER ENGINEERING DEPARTMENT

SPRING 2008

ECE 699: NANOELECTRONICS

Time and location: F 2:00 pm – 4:15 pm, ST1 Rm. 110
Instructor: Dimitris Ioannou, ST-II Rm#247, tel. 993-1580, dioannou@gmu.edu
Office Hours: F 11:00 am – 12:15 pm; other times by appointment.

Required Textbook: "The Physics of Low-Dimensional Semiconductors", J.H. Davies, Cambridge.

COURSE CONTENT

Nanoelectronics is a new and exciting field, which on the main deals with the question of what happens to an (electronic) device when one or more of its dimensions is in the nano-range, say in the range of 100 nm down to 1 nm. Much is known for devices with sizes larger than that (Microelectronics) and the atomic physics deals very successfully with atomic sizes (less than 1 nm). This course presents the design and analysis of a variety of nano-devices (also referred to as "quantum" or "mesoscopic" devices), and briefly examines some notable applications. The emphasis is on a deep understanding of the fundamental concepts and principles which govern the operation of such small devices and the challenges and opportunities ahead. A student should thus have a good grasp of introductory modern physics (as presented in typical undergraduate engineering programs) and some "affinity" towards physics in general. The course is still under development and evolving, and the material has not yet settled to a point that standard textbook treatments are available. Extensive use will therefore be made of chapters from various books and review papers from the literature, which will be made available. The required course textbook listed above is a very good source for the fundamental ideas of this course, which also presents some of the key devices that the course covers. In addition, the references listed below are useful for parts of the course and the corresponding homework assignments/projects. Reference 4 in particular presents a wide range of nano-devices and their applications. Some of the homework assignments/projects will require a working knowledge of MATLAB.

REFERENCE LIST

1) Lectures on the Electrical Properties of Materials, by L. Solymar and D. Walsh (Oxford Science Publications, 7th Edition).
2) Quantum Mechanics, by D.K. Ferry (Institute of Physics Publishing)
3) Mesoscopic Electronics in Solid State Nanostructures, by T. Heinzel (Wiley-VCH)
4) Nanoelectronics and Information Technology, Edited by Rainer Waser (Wiley, 2nd Edition)

COURSE OUTLINE

1. Schrodinger's equation (one week)
2. Counting and Filling States (one week)
3. Tunneling (one week)
4. Resonant Tunneling Diodes (one week)
5. Single Electron Transistors (one week)
6. Quantum Dots (one week)
7. **First Midterm Exam**
8. NanoWires and (one week)
9. Carbon Nanotubes (one week)
10. Molecular Electronics – Electronic Noses (one week)
11. Nano-scale Fabrication Techniques (one week)
12. Scanning Probe Techniques (one week)
13. Bulk and SOI Nano-MOSFET (one week)
14. **Course Review/Outlook**

GRADING

Homework/projects - 20%
Midterm Exam - 40%
Final Exam - 40%