Concordia University
Department of Electrical and Computer Engineering
Winter 2018-19: Course outline

ELEC 6281/4 WW: Principles of Solid State Nano devices

Instructor: Dr. M. Z. Kabir
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Office hours: Monday & Wednesdays 10 – 11 a.m.

Course Web site: http://www.ensc.concordia.ca/~kabir/ELEC6281.htm

Lectures: Thursday, 2:45 – 5:15 pm, H 537

Calendar description:

Course Contents:
The Nanodevices is a new and exciting field. Much is known for Microdevices and the atomic physics deals very successfully with atomic sizes (less than 1 nm). This course presents the fundamental principles and analysis of a variety of Nano-devices, and briefly examines some notable applications. The emphasis is on a deep understanding of the fundamental concepts and principles, which apply to small devices and the challenges and opportunities ahead. Since the Nano devices is a new field, the fundamental concepts and principles of all the Nano devices have not yet settled to a point that standard textbook treatments are available. The course materials in the lecture notes are taken from various books and review papers from the literature, which will be made available on the course webpage. In addition, the references listed below are useful for parts of the course and the corresponding homework assignments/projects. Some of the homework assignments/projects will require a working knowledge of MATLAB.

Required Materials: Lecture notes

References:
Course outline:
1. Quantum mechanics for Nano Devices (Class notes, Refs. 1 & 6)
2. Quantum theory of semiconductors and carrier transport: Energy bands, density of states, quantum well, wire and dots, band gap energy, Fermi energy, carrier concentration, diffusive and ballistic transport, phonons, (Class notes, Refs. 3, 6 and 7)
3. Nano MOSFETs and Quantum Well Devices: MOSFETs and advanced concepts, Nano MOSFETs, FinFETs, Ballistic Nano Transistors, and Resonant tunnelling devices (Class notes, Refs. 2, 3, 4, and 5)
4. Quantum Wire Devices: Quantum transport in quantum wire, Ballistic Nano Wire Transistors (Class notes, Refs. 2, 3, 5, 10 and 11)
5. Quantum Dot Devices: Coulomb Blockade, Single Electron Transistors (Class notes, Refs. 2, 3, 8, 10 and 11)
6. Carbon Nanotube, graphene and their applications (Class notes, Refs. 3, 8, 10 and 11)
7. Spintronics and super conducting properties, and their devices (Class notes, Refs. 6 and 9)
8. Nano solar cells (Class notes)

Grading Scheme (tentative)
- Project: 30%
- Assignments: 20%
- Midterm exam (closed book): 20%
- Final exam (closed book): 30%

Project (Individual): Students will have to present a project and submit the report on a recent topic in Nano device area. Students will collect several very recent full length journal papers on a specific nano device. The students will collect those papers that explain the operation and characteristics of the device by preferably physics-based theoretical models (e.g., review papers). They may need to simulate the results of the papers to prove their understanding. They have to analyze the research work
critically, find its important contributions, drawbacks and limitations, and highlight current problems and research trends on the topic.

**Assignment:** Assignments are compulsory. They have to submit approximately 8/9 assignments. Approximately half of the assignments are conventional design and problem solving types, and the other half are research-type. For the research type assignments, they will be given research papers, and a few specific problems and questions will be asked based on the paper. Assignments and their submission deadlines will be announced in the class.

**Midterm exam:** *This closed book exam will be held on February 21, 2019.* Students are permitted to bring one 8.5” × 11” sheet of notes. They can use both sides. Notes must be hand written (original).

**Final exam:** *The final exam will be closed book.* Students are permitted to bring one 8.5” × 11” sheet of notes. They can use both sides. Notes must be hand written (original).

**Office hours:**
Office hours are provided for any extra help. If anyone finds the time schedule inconvenient, he/she should contact the instructor for getting an appointment.

**Expectations of originality and Professionalism:**
One important component of professionalism is academic integrity. Please pay attention to academic integrity. The copying of materials from anywhere (internet, books, labs and assignments of other students) is not permitted, and is deemed a serious academic offence. Plagiarism is a common form of academic misconduct. There are many other forms of academic misconducts. Please consult Concordia Website for detailed descriptions of academic misconducts. http://www.concordia.ca/students/academic-integrity.html

Cheating is a serious offence. You must abide by the Academic Code of Conduct as described in the University Calendar. *Any suspected violation of the Code will be reported* to the Associate Dean for investigation. Penalties can be as severe as dismissal from the University.

1. **Submit the expectations of originality form with your signature, full name, ID #, and date and attach with your first assignment.**
2. **Write “I certify that this submission is my original work and meets the faculty’s Expectations of originality” with your signature, full name, ID #, and date in all other assignments.**