ESE 334, Spring 2025

Instructor	*Email*
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Course Syllabus

Course Description

The major goals and objectives are to provide undergraduate students with initial knowledge and understanding of nanoelectronic devices. The course will cover physical properties of low-dimensional structures (quantum wells, quantum wires, quantum dots and superlattices) that create a basis for operation of nanoelectronic devices as well as nanostructure fabrication, characterization and applications in nanoelectronics. Additionally, the course will cover applications of nanotechnology in biology and medicine.

Objectives

The course intends to give students a broad understanding of fundamentals, fabrication technologies, characterization and applications of nanoscale structures. Students will also be trained for literature study and critique, problem formulation and solution development, and formal writing.

Prerequisites **ESE 331;**

Recommended Textbooks

- "Introduction to Nanoelectronics: Science, Nanotechnology, Engineering, and Applications", V. Mitin, V. Kochelap, and M. Stroscio, Cambridge University Press, 2008.
- "Nano comes to life: How nanotechnology is transforming medicine and the future of biology", S. Contera, Princeton University Press, 2019.

Content

Week 1	Introduction (from classical electronics to nanoelectronics) **R. Feynman, "**There's Plenty of Room at the Bottom**"**
Week 2	Fabrication of nanostructures – *Top-Down and Bottom-up Fabrication* – *MBE and MOCVD for fabrication of quantum wells and superlattices* – *Nanolithography*
Week 3	Characterization of nanostructures – *Atomic Force Microscopy (AFM)* – *Scanning Electron Microscopy (SEM)* – *Transmission Electron Microscopy(TEM)*
Week 4	Quantum mechanical concepts – *Wave-particle duality, Uncertainty Principle, Pauli Principle*
Week 5	Quantum mechanical concepts *(continued)* – *Schrödinger wave equation*
Week 6	Electrons in low-dimensional structures – *Electron in quantum well* – *Electron in quantum wire* – *Electron in quantum dot*

Week 7	Electrons in low-dimensional structures – *Electron Tunneling* – *Electron in superlattice* **Solving problems, preparation for the Midterm Exam**
Week 8	Statistics of the electrons and holes in semiconductors – *Time and length scales of the electrons in solids* – *Electron transport in nanostructures*
Week 9	Nanoelectronic transistors (MOSFET) – *Historical and Future Trend of MOSFETs* – *MOSFET scaling* – *FIN FET*
Week 10	Nanoelectronic devices (CARBON NANOTUBES) – *Electronic Structure of a CNT* – *Electron Transport* – *The ideal Transistor* – *Operation of the CNT FET*
Week 11	Nanoelectronics sensors – *Quantum dot-based sensors* – *Nanowire-based sensors* – *CNT-based sensors*
Week 12	Nanotechnology for medicine and biology – *DNA and protein nanotechnology*
Week 13	Nanotechnology for medicine and biology – *Nano in medicine*
Week 14	**Term paper group presentations*)**
***)** After the Midterm Exam, student teams will be given topics to prepare their Presentations and Reports	

Grading

Homework assignments	15%
Midterm	45%
Presentation and Report	40%

Disability

If you have a physical, psychological, medical, or learning disability that may impact your course work, please contact the Student Accessibility Support Center, Stony Brook Union Suite 107, (631) 632-6748, or at sasc@Stonybrook.edu. They will determine with you what accommodations are necessary and appropriate. All information and documentation is confidential.

Students who require assistance during emergency evacuation are encouraged to discuss their needs with their professors and the Student Accessibility Support Center. For procedures and information go to the following website: https://ehs.stonybrook.edu//programs/fire-safety/emergency-evacuation/evacuation-guide-disabilities and search Fire Safety and Evacuation and Disabilities.

Academic Honesty

Each student must pursue his or her academic goals honestly and be personally accountable for all submitted work. Representing another person's work as your own is always wrong. Any suspected

instance of academic dishonesty will be reported to the Academic Judiciary. For more comprehensive information on academic integrity, including categories of academic dishonesty, please refer to the academic judiciary website at http://www.stonybrook.edu/uaa/academicjudiciary/

Conduct

The University at Stony Brook expects students to maintain standards of personal integrity that are in harmony with the educational goals of the institution; to observe national, state, and local laws and University regulations; and to respect the rights, privileges, and property of other people. Faculty are required to report disruptive behavior that interrupts faculty's ability to teach, the safety of the learning environment, and/or students ability to learn to Judicial Affairs.