Course name	**ECE 52301 Nanosystems Principles**
Credit and contact hours	(3 cr.) Class 3
Course coordinator's name	Maher Rizkalla
Textbook	*Introduction to Nanoscale Science and Technology*, by M. Di Ventra, S. Evoy, J.R. Heflin, Springer, ISBN: 978-1-4020-77203
Course information	This is the introductory course in the nanosystems area. It introduces students to the principles and applications of nanosystems. The course begins with an introduction to the nanometer scale phenomena. It then introduces students to the basic elements resulting in nanosystems: nanoscale materials, processes, and devices. It also provides students with a basic understanding of the tools and approaches that are used for the measurement and characterization of nanosystems, and their modeling and simulation. **Prerequisites/ Co-Requisite** Graduate Standing ; ECE 25500 **Required, Elective, or Selected Elective:** EE Elective, CE Elective
Goals for the course	Upon successful completion of the course, students should be able to 1. Explain on the fundamental aspects of the field of nanotechnology, and analyze its wide range of applications and impact on the world economy. [6] 2. Integrate knowledge from interdisciplinary areas of math and science such as biology, chemistry, physics, and engineering into the nanosystems. [1,5] 3. Integrate atomic/molecular scale devices and design into integrated nanosystems related to information technology, energy, and medicine. [2, 1, 6] 4. Assimilate design methodology used in the fabrication, and characterization of nanosystems. [1] 5. Assess nano technology devices and systems and the economic significance of nanosystems including benefits and potential risks. [4] 6. Assess and analyze design methodologies from the literature, and communicate effectively in written and oral presentations in topics related to nanosystems. [3] 7. Solve engineering design issues using nanoscale devices and systems. [2,5]
List of topics to be covered	1. Introduction to Nanoscale Phenomena properties 2. Nanoscale Processes and Fabrication Methods – Top-down Methods, Cross-Cutting Technologies: Resist and Masks

	Photon-Based Nanolithography Techniques, Electron Beam Lithography, Focused Ion Beam Lithography, Emerging Nanolithographies, Bottom-up Methods, The advantage of Self-Assembly, Intermolecular Interactions and Molecular Recognition, Self-Assembled Monolayers (SAMs), Electrostatic Self-Assembly, Self-Organization in Block Copolymers 3. Nanoscale Materials – Bonding, Dimensionality, Topology, Curvature, Kinetics, Energetics and Surfaces of Nanoparticles, Nanotubes, and Nanorods, Bionanomaterials, Advanced Materials Properties 4. Nanoscale Devices and Integrated Nanosystems Nanochip(brief history of Microelectronics Devices and technology, Basic of Semiconductors, Structure and Operation of MOS Transistor, Scaling of Transistor Dimensions, Small-Dimension Effects, Nanoscale MOSFET Transistor: Extending Classical CMOS Transistors, Beyond Traditional CMOS, and Molecular Electronics: Tools and Ways to Build and Probe Molecular Devices, Conductance Measurements, and Integration Strategies), Fuel Cells: Proton Exchange Membrane and its Properties, Batteries: Materials, Processes and Devices, Solar Cells: Materials, Processes and Devices, Nanoelectromechanical Systems (NEMS) (3 classes): Surface Machining and Characterization, Dynamics, Dissipative Process, Mechanical Models, Fabrication and Readout, and Performance, and BioMEMS 5. Nanosystems Measurement and Characterization – Principles and Operation Mechanism of: Scanning Tunneling Microscopy, Electron Microscopy (SEM, TEM), and Atomic Force Microscopy, X-Ray Nanomaterials Analysis Systems (XRD and XPS) Four-Probe Measurements of Thin Films (Resistivity and Hall Effect) 6. Nanosystems Applications – 3 Classes Lab on a Chip: Select Examples, Drug Delivery Systems: Select Examples, Medicine and Information Technology/Consumer Goods, Poster Presentation (1 class)
Syllabi approved by	Maher Rizkalla
Date of approval	04/10/2021