Course name	**ECE 52601 Integrated Nanosystems Processes and Devices**
Credit and contact hours	(3 cr.) Class 3
Course coordinator's name	Maher Rizkalla
Textbook	1. *Introduction to Nanoscale Science and Technology*, by M. Dir Ventra, S. Evoy, J.R. Heflin, Springer, ISBN: 978-1-4020-7720-3 2. Research and Review Papers
Course information	This course covers processes and devices associated with integrated nanosystems. Integrated nanosystems refer to systems which consist of integrated micro-, meso-, and/or macro-scale parts and their core components are realized by nano-scale materials, processes, and devices. The course, while covering processes which result in integrated nanosystems, will focus on the theory and operation of select electronic, electromechanical, and biomedical devices which are used for information technology, sensing, medical, and other applications. The lectures will be complemented by hands-on laboratory experience. **Prerequisites/ Co-Requisite** ECE 52301 Nanosystems Principles **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. Analyze the photolithography, material deposition, and material etching process techniques for the development of integrated nanosystems. [1,3]. 2. Evaluate the major classes and components of integrated nanosystems. [6,2,1] 3. Assemble design methods to integrate atomic/molecular-scale devices into nanosystems for informational, electromechanical, and biotechnology applications. [1,2,6] 4. Verify the design of integrated nanosystems through simulations, working prototypes, and characterizations. [1.6,2] 5. Design, simulate, and build integrated nanosystems such as electronics, cantilever beams, and micro/nanofluidics devices. [5,6] 6. Compose a final research paper, a lab design project report and an oral presentation. [3]
List of topics to be covered	1. Introduction to Integrated Nanosystems Processes and Devices

	2. Nanoscale Processes and Fabrication Methods – 2 classes Review of Lithography Process; Pattern Transfer by Etching Techniques; Material Deposition Techniques; Review of Electrostatic Self-Assembly; Measurements Techniques: Review of AFM and STM, Four Probe Method, Optical Microscopy 3. Micro/Nanoelectronics Devices: Theory and Implementation – 5 classes Fundamentals of Micro/Nanoelectronics Devices, PN Junctions: Equilibrium Conditions; Forward- and Reverse- Biased Junction; Reverse-Bias Breakdown, The MOS Field-Effect Transistor: Leakage Characteristics of Gate Dielectrics; Output and Transfer Characteristics; Short Channel MOSFET I-V Characteristics; Subthreshold Characteristics; Substrate Bias, Hot Electron, Short Channel, and Narrow width Effects, Nanoelectronics: Device Characteristics; Contact Resistance and Quantized Conductance; Molecular Switches and Transistors; Electronics with DNA; Transport Mechanism and Current-Induced Effects; Integration Strategy and Applications, Single Electronics: Single Electron Tunneling (SET); Superconducting SET; Implementation of SET; Applications of SET 4. Micro/Nanoelectromechanical Systems (MEMS/NEMS): Theory and Implementation – 4 classes, Mechanics of structures (Modeling Beams, Plates and Membranes); Resonators (Modeling Single and multi-degree of freedom systems); Transduction; Near Field Interactions; Dissipation; Nonlinearity of MEMS/NEMS; Noise in MEMS/NEMS; Uncertainty in MEMS/NEMS; Examples and Applications of MEMS/NEMS 5. Micro/Nanoscale Devices for Biomedical Applications: Theory and Implementation – 3 classes, Fluid Mechanics; Fundamentals of Fluidic at Micro/Nanoscale; Integration of Nanofluidic Devices with Bionanosensors; Applications of Nanofluidics and Bionanosensor Devices 6. Laboratory Component: Thirteen sessions to introduce students to hands-on laboratory and simulation experience, reinforcing theory learned through lectures. Students are expected to turn-in a project report at the end of the course. (Total lab sessions will count as 1 credit hour for the course). Three classes of devices in integrated nanosystems will be evaluated such as electronics, cantilever beams, and micro/nanofluidics. 7. Research Paper and Poster presentation – 1 class
Syllabi approved by	Maher Rizkalla
Date of approval	03/25/2021