

Nanoscale Devices and Systems (NDS)

Students who are taking the MS Written Comprehensive Exam with their major in Nanoscale Devices and Systems should have taken the core sequence of ECE 212 A-B-C. One graduate-level exam question on the ECE MS Exam will be based on the material taught in ECE 212ABC.

The required materials for the Written Comprehensive Exam are the class lectures, notes, and assigned reference books for the courses.

Topics that will be tested are those covered in the lectures, including

- (1) Quantum Fundamental effects and important phenomena at nanoscale dimensions, electronic spectra and densities of states in 3D, 2D, 1D, and 0D
- (2) Properties in low dimensional systems, such as
 - a) Low dimensional transport and ballistic transport,
 - b) 1D problems: energy levels of confined structures (e.g., wells), wavefunctions
 - c) Transmission and scattering matrix formalism
 - d) Contact resistance, single mode conductance, low dimensional electrostatics
 - e) Single electron charging and Coulomb blockade in quantum dots and other 0D systems,
 - f) Collective excitations in nanostructures – plasmon and phonon effects, Two-port versus four-port resistance
- (3) Near field and subwavelength optical phenomena, such as
 - a) S and T matrices for optical systems
 - b) Sub-resolution imaging and metrology single photon devices
 - c) Basic formulation and evanescent fields,
 - d) Photonic crystals
 - e) Plasmonic phenomena and applications in novel optical imaging
- (4) Surface related effects, Casimir forces, and thermal/phonon effects. Beyond the classical limits of transport, measurement, and imaging.