

Syllabus – EE531, Winter 2007

- Semiconductor Fundamentals (6 hours)
 - Poisson and continuity equations
 - Recombination (direct, Auger, trap-assisted)
 - Equilibrium carrier concentrations (electron statistics, density of states, effective mass, bandgap narrowing)
 - Review of PN and MS diodes.
- Quantum Mechanics Fundamentals (4 hours)
 - Basic Quantum Mechanics
 - Crystal symmetry and band structure
 - 2D/1D density of states
 - Tunnelling
- Modeling and Simulation of Carrier Transport (6 hours)
 - Carrier Scattering (impurity, phonon, carrier-carrier, remote/interface)
 - Boltzmann Transport Equation, Monte Carlo
 - Hydrodynamic
 - Drift-diffusion
- MOS Capacitors (4 hours)
 - Modes of operation (accumulation, depletion, strong/weak inversion).
 - Capacitance versus voltage.
 - Gated diode.
 - Nonideal effects (poly depletion, surface charges).
 - High field effects (tunneling, breakdown).
- Long Channel MOSFET Devices (4 hours)
 - Review of operation.
 - I-V characteristics.
 - Subthreshold conduction.
 - Threshold voltage.
- Short Channel MOSFET Devices (6 hours)
 - Scaling effects (short channel, narrow channel effects, drain induced barrier lowering)
 - Channel velocity limitations (saturation velocity, interface scattering, mobility models).
 - Hot carrier effects (impact ionization, gate/substrate currents, threshold voltage degradation, velocity overshoot, ballistic effects)
 - Quantum mechanical effects
- CMOS Device Design (4 hours)
 - Scaling relationships.
 - Threshold voltage control.
 - On/Off currents.
 - Channel doping profiles
 - * Implanted channel, buried channel, retrograde wells
 - * S/D extension, HALO/LATID structures
 - Circuit and switching behavior
- Advanced Device Technology (4 hours)
 - SOI
 - SiGe, strained Si
 - Alternative oxide/gate materials
 - Alternative geometries (raised source/drain, dual gate, vertical, FinFET)
 - Memory Devices (DRAM, Flash)