

## **Physics of Semiconductor Devices (RP 4.1.6)**

**Semiconductor fundamentals** : Band theory, E-k diagram, effective mass, density of states, statistics, carrier density, degeneracy, compensation. (4)

**Transport**: Ohm's law, mobility, Boltzmann equation, Hall mobility, diffusion, scattering mechanisms, hot electrons (3)

**Excess carriers**: Recombination in direct gap, SRH theory, traps, continuity equation (3)

**P-N Junction theory**: Band diagram of semiconductor P-N junction, depletion width, built-in potential, I-V characteristics, varactor diode (3)

**Basic theory of MOSFETs**: Band diagram under depletion, inversion and accumulation, threshold voltage and its control; C-V curves; I-V characteristics, gradual channel approximation, charge sheet model, Pao-Sah current formulation, subthreshold; current conduction, channel length modulation; hot electrons. (8)

**Advanced Theory of MOSFETs**: CMOS scaling, short channel effects, threshold voltage roll-off, DIBL, GIDL, gate leakage current, hot carrier injection, punch through, silicon-on-insulators (SOI) MOSFETs, low power and high speed design issues. (7)

**Heterostructures and Quantum Wells**: Quantization and low dimensional electron gas, influence on MOSFET characteristics, band alignment in Si/SiGe heterostructures, SiGe CMOS, high electron mobility transistors (HEMTs), heterostructure bipolar transistors (HBTs). (5)

**Recent advances**: Introduction to advanced devices. (2)