1. ECE 471B (ECE 481A1): Semiconductor Junctions

2. 1 credits: 2-75 minute lecture sessions/week – 5 weeks

3. Carmen Menoni

4. Semiconductor Physics and Devices: Basic Principles. Neamen, D. A. 2011.

5. Course Information
    a. Quantitative analysis of field, carrier and current distributions in pn and metal-semiconductor junctions
    b. Prerequisites: ECE 331 with a C or higher; ECE471A, may be concurrently enrolled
    c. Selected Elective: Computer Engineering; Electrical Engineering; Lasers & Optical Engineering

6. Goals for the Course
    a. Course Learning Objectives
        i. Describe and give examples of carrier generation and recombination processes
        ii. Calculate carrier distributions as the solution to the continuity equation given various boundary conditions
        iii. Determine the parameters of pn diode current-voltage and capacitance-voltage characteristics based on doping concentrations and semiconductor material parameters
        iv. Plot the charge, carrier, electric-filed and potential distributions in pn and metal-semiconductor junctions
        v. Draw band diagrams for pn junctions and Schottky diodes in reverse, zero, and forward bias
        vi. Explain deviations from idea theory for diodes
        vii. Describe design parameters that allow metal-semiconductor interfaces to function as ohmic contacts
    b. Student Outcomes
        1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics

7. Topics Covered

    Non-equilibrium semiconductor carrier processes

    Generation and recombination processes, quasi-fermi levels, continuity equation, time dependent diffusion

    Solutions of the carrier continuity equation for specific boundary conditions, approximations for homogenous, steady-state, and no E-field conditions, surface recombination, review of solution of 1-D Poisson equation for charge distribution

    pn junctions in reverse bias

    Built in voltage, abrupt depletion approximation, depletion capacitance, charge, electric field and potential distributions, one-sided junction approximation, band diagrams, non-uniformly doped junctions

    pn junctions in forward bias

Diffusion currents, derivation of current-voltage relationship, impact of doping concentrations, diffusion and depletion capacitance;
Non-ideal currents
Transient behavior
Metal-semiconductor junctions
Metal work function, metal-semiconductor band alignment, ideal and non-ideal barrier heights
Thermionic emission, ohmic contacts