EE566 Solid State Devices

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Dept of Electrical Engineering
University of Notre Dame
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Assignment 6
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Due: 03/14/2005

Reading
Chapter 5 of Muller/Kamins/Chan **(MKC).** Stress on sections 5.3 - 5.6.

Problem 1[1] **(Recombination currents in the space-charge region)**

Problem 5.12, **MKC**.

Problem 2 (p-n junction switching characteristics)

Problem 5.14, **MKC**.

Problem 3 (Charge storage and transit times in short-base diodes)

Problem 5.18, **MKC**.

Problem 4 (Solar Cell Device Physics)

Consider a *single* junction solar cell in operation, with G_{op} being the generation rate of carriers. The open-circuit voltage V_{OC} is defined as the voltage at which the current through the cell is zero. Similarly, the short-circuit current I_{SC} is defined as the current flowing through the cell when the applied bias across it is zero. From your knowledge of diode current flow mechanisms, find the bias voltage V_{max} for the cell at which the conversion of solar power in to electric is *maximized*. Plot the minority carrier profiles inside, and around the edges of the depletion region when the cell is biased at $V_{bias}=0$, V_{max}, *and* V_{OC}.

Sketch the solar spectrum (intensity vs wavelength) on the earth's surface, and outside the atmosphere. Explain why, to convert the radiation into electrical energy with the *highest efficiency*, one needs to use p-n junctions made of *multiple* semiconducting materials (the so-called multi-junction cells). What is the highest efficiency reported till date for a semiconductor solar cell?

[1] Remember to use proper units and label every figure/plot. Use natural scales such as nm for length, KV/cm for electric fields, and eV for energies. Turn in your answers worked out neatly. Please attach this question sheet to your solution when you turn it in.