1. Consider the thermionic emission model of a Schottky barrier diode, and use the standard I-V equation with ideality factor $\eta$. The measured forward current at 300 K is $3 \times 10^{-8}$ A at 0.2 V and $1 \times 10^{-6}$ A at 0.3 Volts. The diode area is 0.2 cm$^2$ and $\phi_B = 1$ V. Calculate the saturation current $I_s$, the ideality factor $\eta$, and the value of $A^*$ (Richardson constant).

2. Draw the energy band diagrams for an n-p-n transistor when it is biased in (a) the saturation region, and (b) the cutoff region.

3. Consider a p-n-p transistor biased in the normal active region of operation at room temperature. In this situation, both $I_B$ and $I_C$ flow out of the device. Now if $I_C$ is held constant and the temperature is raised gradually, $I_B$ will decrease and ultimately will flow into the Base terminal. Explain this behavior in terms of physical phenomena that occur in the device.

4. A symmetrical Ge p-n-p transistor with emitter-base and collector-base junctions, each 1 mm in diameter, has an impurity concentration of $5 \times 10^{15}$ cm$^{-3}$ in the base and $10^{18}$ cm$^{-3}$ in the emitter and the collector. The base-width is 10 $\mu$m, $\tau_B = 4 \times 10^{-6}$ sec, $\tau_E = 10^{-8}$ sec, and the emitter region is much longer than the diffusion length $L_E$. Calculate the current gains $\alpha$ and $h_{FE}$ of the transistor. Take $D_B = 47$ cm$^2$ sec$^{-1}$ and $D_E = 52$ cm$^2$ sec$^{-1}$.

5. A Si n-p-n transistor has the following parameters at 300 K: $N_A = 5 \times 10^{16}$ cm$^{-3}$, $N_D(E) = 1 \times 10^{18}$ cm$^{-3}$, $W_B = 2$ $\mu$m, $W_E = 0.2$ $\mu$m, $\mu_B = 1000$ cm$^2$ V$^{-1}$ sec$^{-1}$, $\mu_{B}(E) = 150$ cm$^2$ V$^{-1}$ sec$^{-1}$, $\tau_B = 10^{-6}$ sec, and $\tau_E = 10^{-8}$ sec. The emitter-base junction area is 0.01 cm$^2$, $I_E = 1$ mA, and the collector-base junction is reverse biased by 2 V. Neglect carrier generation and recombination in the two junction depletion regions. (a) Calculate the emitter-base junction voltage and the excess electron concentration in the base at the edge of the emitter-base junction depletion region. (b) Calculate $\gamma$, $\alpha_T$, and $h_{FE}$ for the transistor.

Homework assignments will appear on the web at:
http://www.ece.udel.edu/~kolodzey/courses/eleg646s05.html

Note: On each homework and report submission, you must please give your name, the due date, assignment number and the course number.