1. You are given a bipolar transistor with the following parameters:

N_{dE} = 9 \times 10^{18} \text{ cm}^{-3}, \ W_{E} = 500 \text{ nm}

N_{aB} = 1.5 \times 10^{17} \text{ cm}^{-3}, \ W_{B} = 400 \text{ nm}

N_{dC} = 2 \times 10^{16} \text{ cm}^{-3}, \ A_{E} = 50 \mu\text{m}^2, \ A_{C} = 50 \mu\text{m}^2.

(a) Plot the thermal equilibrium charge density, electric field, and potential.

Bias voltages V_{BE} = 0.8 \text{ V} and V_{CE} = 2 \text{ V} are applied.

(b) Plot the minority carrier concentrations across the device. Be sure to label values for p_{nE}(-x_{BE}), n_{pB}(0), n_{pB}(W_{B}), and p_{nC}(W_{B} + x_{BC}).

(c) Find the base-emitter and base-collector junction capacitances.

(d) Find \alpha_F and \beta_F.

(e) Find I_C.

(f) Find g_m and r_t.

(g) Find the base diffusion capacitance.

A small signal component is added to V_{BE}, to make v_{BE} = 0.8 \text{ V} + 1 \text{ mV} \sin(wt).

(h) Find i_c, the small signal collector current.

(i) If load impedance of R_L = 2 \text{ k}\Omega is inserted between the collector and the voltage source, as shown below, find the small signal collector voltage swing v_o.

(j) If this is thought of as a linear amplifier from small signal v_{be} to small signal v_o, what is its gain (v_o/v_{be})?
2. Two diodes are configured as shown below:

They have the following parameters:
D1: $N_d = 9 \times 10^{18} \text{ cm}^{-3}$, $W_N = 500 \text{ nm}$, $N_a = 1.5 \times 10^{17} \text{ cm}^{-3}$, $W_P = 400 \text{ nm}$,
$A = 50 \mu\text{m}^2$
D2: $N_a = 1.5 \times 10^{17} \text{ cm}^{-3}$, $W_P = 400 \text{ nm}$, $N_d = 2 \times 10^{16} \text{ cm}^{-3}$, $W_N = 2 \mu\text{m}$,
$A = 50 \mu\text{m}^2$
$V_1 = 0.8 \text{ V}$, $V_2 = 2 \text{ V}$.

(a) Find $I_1$, $I_2$, and $I_3$.
(b) Does this configuration act like an NPN transistor? Why or why not?