Problem # 1:

Plot and label the C-V curve of a PMOS capacitor with P⁺ gate, substrate doping of $N_A = 6 \times 10^{16}$ cm$^{-3}$ and SiO$_2 = 3$ nm.
Problem #2:

An $I_D$ - $V_D$ characteristic derived from an ideal MOSFET is shown above. Note that $I_{D_{sat}} = 10^{-3}$ A and $V_{D_{sat}} = 5$ V for the given characteristic.

a. Sketch the inversion layer and depletion region inside the MOSFET corresponding to point 1 on the graph. Show and label all parts of the transistor.

b. Given a turn-on voltage of $V_T = 1$ V, what is the gate voltage one must apply to the MOSFET gate to obtain the pictured characteristic?

c. If $x_0 = 0.1$ μm, what is the inversion layer charge / cm$^2$ at the drain end of the channel when the MOSFET is biased at point 2?
d. Suppose the gate voltage is readjusted so that $V_G - V_T = 3$ V. For the new condition, determine $I_D$ if $V_D = 4$ V.

e. If $V_D = 0$ (i.e., the drain is shorted to the source and back), sketch the general shape of $C_G$ (gate capacitance) versus $V_G$ to be expected from the MOSFET.
Problem # 4:

The most widely encountered MOSFET characteristics are a plot of $I_D$ versus $V_D$ with $V_G$ or $V_{G-V_T}$ held constant at select values. An alternative plot of $I_D$ versus $V_G$ or $V_{G-V_T}$ with $V_D$ held constant at select values is sometimes useful. Sketch the shape of the $I_D$ versus $V_{G-V_T}$ characteristics to be expected from an ideal n-channel MOSFET. Specifically show the characteristics corresponding to $V_D = 1, 2, 3,$ and $4 \text{ V}$. Explain how you arrived at the sketch.
Problem # 5:

Suppose a battery $V_B > 0$ is connected between the gate and drain of an ideal n-channel MOSFET as pictured. Sketch the $I_D$ versus $V_D$ ($V_D > 0$) if $V_B = V_T /2$ and $2V_T$. 
Problem # 5:

The $\frac{\Delta n_e}{n_{E0}}$, $\frac{\Delta p_B}{p_{B0}}$ and $\frac{\Delta n_C}{n_{C0}}$ distributions in the quasineutral regions of a $pnp$ BJT are shown above.

a. What is the polarity of $V_{EB}$?

b. What is the polarity of $V_{CB}$?

c. What is the magnitude of $V_{CB}$?
Problem # 6:

Complete the table below by indicating whether the noted change in a BJT device parameter increases, decreases or has no effect on the listed performance parameters.

<table>
<thead>
<tr>
<th>Change</th>
<th>Effect on $\gamma$</th>
<th>Effect on $\alpha$</th>
<th>Effect on $\beta$</th>
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<tr>
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<tr>
<td>Increase $\tau_B$</td>
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