Due Monday, February 28th in class

Always assume that $\beta$ is known unless specified otherwise.

1a. (2 pts) Assume that $\lambda = 0$, $\gamma = 0$ (body effect), $kn'=114\mu A/V^2$ and $Vt = 0.7V$. If $Vdd = 5V$, what is $ID$? What is the DC level of the output $VB$? Be sure to show each of your steps clearly.

1b. (1 pt) The capacitor $C1$ forms a high pass filter on the input. If we assume that the gate capacitance of the nFET can be ignored at low frequencies, what is the “knee” frequency (in Hz) of this filter?

1c. (1 pt) At high enough frequencies where we can ignore $C1$, what is the small signal gain $(vb/va)$?

1d. Using PSPICE, simulate this circuit using the model parameters provided to the class. Compare your results to the solutions you arrived at in parts a-c. In what way is the simulation producing different results? Discuss where you think the simulation is different from your analysis. Include a printout of your schematic page and show a plot of an AC sweep, showing the frequency response of the amplifier. Use a small signal input (~10mV amplitude) for $va$.

2a. (3 pts) In the circuit on the right, a tiny capacitor $C$ appears between the base and collector. With $C = 0$, solve for equations that describe the collector current and the small signal gain $(vb/va)$? Assume that the transistor is in the forward-active mode.

2b. Including the $C$ into your equations, solve again for the small signal gain. Try to make this equation similar in format to the equation you solved for in part a. What is the effect of $C$ on the gain? Justify your answer by referring to parts of your equation. For this analysis, assume that $C$ is the only relevant capacitance.

3. (5 pts) Assume that $Vdd = 9V$. Using the amplifier configuration on the right, design an amplifier that has a small signal gain = -10 with an input resistance > 50K (i.e. equivalent resistance to ground at node $VB$) using a NPN transistor that has a $\beta = 100$. Pick $C$ so that the input high-pass filter only passes signals > 200 Hz. Be sure to explain/justify every step of your design.