Suggested Reading: Read as many of the following as you can. All of the recommended references are on reserve at Barker Library.

1. Lundberg sections 6, 7, 8, 9, and 10.
2. Grebene section 8.3-8.5.
3. Gray and Meyer sections 7.2 and 7.3.

Problem 1: The AC schematics for four amplifiers are shown below. For each of the amplifiers, find the small-signal voltage gain and the -3dB frequency using the open-circuit time-constant method. Assume $\beta=200$, $I_C=2.5\text{mA}$, $c_w=50\text{pF}$, and $c_{\mu}=2\text{pF}$. Neglect $r_b$ and $r_o$ for this problem.

(a) Common-Emitter:

(b) Emitter-Follower:
(c) Common-Base:

\[ \text{Diagram of Common-Base Amplifier} \]

(d) CE with emitter degeneration:

\[ \text{Diagram of CE Amplifier with Emitter Degeneration} \]

**Problem 2:** For the following CB-CE amplifier, assume that \( V_{BE,ON} = 0.6V, \beta = 200, c_e = 20pF, \) and \( c_c = 2pF \) for both transistors. Neglect \( r_h \) and \( r_o \).

\[ \text{Diagram of Amplifier Circuit} \]

(a) Calculate the midband small-signal voltage gain.

(b) Estimate the -3dB frequency of the circuit gain using the OCT method.
**Problem 3:** For the amplifier shown below, use the following data: $I_s=0.5\text{fA}$, $\beta=200$, $c_{\mu 0}=0.5\text{pF}$, $c_{je}=4\text{pF}$ (in forward bias), and $f_T=500\text{MHz}$ at $I_C=1\text{mA}$ and $V_{CB}=2.5\text{V}$. Assume $m=0.5$ and $\Psi_0=0.7\text{V}$ for all junctions. Neglect $r_b$ and $r_o$.

![Amplifier Diagram](image)

(a) Calculate the low-frequency voltage gain.

(b) Use the OCT method to calculate the -3dB frequency of the circuit gain.

(c) Verify the above results in HSPICE. Turn in your HSPICE input file as well as a plot showing the high frequency roll-off.
Problem 4: For each of the two amplifiers shown below, assume that $V_{BE,ON}=0.6\text{V}$, $\beta=400$, $c_x=40\text{pF}$, and $c_{i}=4\text{pF}$ for both transistors. You may neglect $r_b$ and $r_o$. Find the small-signal voltage gain and the $-3\text{dB}$ frequency. Qualitatively, why does one have more bandwidth than the other?

(a) Single-ended Differential Amplifier:

(b) EF-CB:
**Problem 5:** In recitation, a capacitively loaded EF such as the one shown below was discussed.

![Circuit Diagram]

(a) Find the incremental input impedance. For simplicity, neglect $c_\mu$ in the small-signal model.

(b) Show that for sufficiently small values of $C_E$, the input impedance has a negative real part. Determine the critical value of $C_E$ in terms of transistor parameters.

(c) Why could a negative input impedance be a bad thing?