FREQUENCY RESPONSE
Sample Problems - Dr. Aydın İ. Karşılıyan

1. For the following circuit, assume that \( V_{i,dc} = 0 \), \( \beta = 100 \), \( r_b = 0 \) and \( V_A = \infty \) for all transistors. Find the differential-mode transfer function \( A_{dm}(s) = \frac{v_{od}(s)}{v_{id}(s)} \) and sketch its magnitude Bode plot. Determine the required \( C_\pi \) and \( C_\mu \) values using PSPICE (use Q2N2222 transistors).

2. Find the differential-mode transfer function \( A_{dm}(s) = \frac{v_{od}(s)}{v_{id}(s)} \) for the circuit below. Assume that all transistors are active, \( V_G \) is a DC voltage, and \( \chi = 0 \).

3. In the following circuit, all transistors are active with \( \beta = 100 \), \( V_A = \infty \), \( C_\mu = 0 \) and \( r_b = 0 \). Find the differential-mode transfer function \( \frac{v_{od}(s)}{v_{id}(s)} \) and sketch its magnitude Bode plot.

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<tr>
<th></th>
<th>NPN</th>
<th>PNP</th>
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<td>( f_T )</td>
<td>200 MHz</td>
<td>100 MHz</td>
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4. In the circuit below, all transistors are active with $C_{gd} = 0$, $\chi = 0$, and $\lambda$ is nonzero.

(a) Find the differential-mode transfer function $v_{od}(s)/v_{id}(s)$ in terms of small signal parameters.

(b) Sketch the magnitude Bode plot of $v_{od}(s)/v_{id}(s)$ if $g_m$, $r_o$ and $C_{gs}$ are identical for all transistors.

![Circuit Diagram 1]

5. In the circuit below, all transistors are active with $C_{gd} = 0$, $\chi = 0$, and $\lambda$ is nonzero. Using the open-circuit time-constants method, find the dominant pole of the differential-mode transfer function. Also find the low-frequency gain $v_{od}/v_{id}$ in terms of small-signal parameters and resistors.

![Circuit Diagram 2]

6. In the following circuit, assume that all transistors are active with $\chi = 0$, $C_{gs} = C_{gd} = 0$, and $\lambda = 0$. Derive the differential-mode transfer function $(v_{od}(s)/v_{id}(s))$ in terms of small-signal parameters.

![Circuit Diagram 3]
7. In the following circuit, all transistors are active with \( \beta = 100, V_T = 25 \text{ mV}, V_A = \infty, C_\mu = 0, r_b = 0, f_{T,npn} = 400 \text{ MHz}, \) and \( f_{T,pnp} = 200 \text{ MHz}. \) Find the differential-mode transfer function \( \frac{v_{od}(s)}{v_{id}(s)} \) and sketch its magnitude Bode plot.

8. In the following circuit, all transistors are active, \( r_b = 0, \) and \( V_A \) is finite. Using the open-circuit time-constants method, find the dominant pole of the differential-mode transfer function, and the low-frequency gain \( (v_{od}/v_{id}) \) in terms of small-signal parameters and resistors.

9. In the following circuit, assume that all transistors are active with \( \lambda = 0, C_{gd} = 0 \) and \( \chi = 0. \) Derive the differential-mode input impedance \( (Z_{id}) \) in terms of small-signal parameters.