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Exercises for Tutorial 3: Frequency Response

1) Problem 6.6. in the course book.

a) $Z_{in} = \frac{g_{m1}+sC_1}{sg_{m1}C_1}$

b) $Z_{in} = \frac{sC_1C_2r_o+C_1+C_2+g_mr_oC_2}{sC_1C_2(1+g_mr_o)}$ $\quad (g_m = g_{m1} + g_{m2}, r_o = r_{o1} \parallel r_{o2})$

c) $Z_{in} = \frac{sC_2+g_{m1}}{sC_2(g_{m1}+g_{mb1})}$

2) Problem 6.8(e) in the course book.

We define $C_1 = C_{gs1} + C_{sb1} + C_{db2} + C_{gd2}, C_2 = C_{gs2} + C_{sb2} + C_{db1} + C_{gd1}$

$$H(s) = \frac{V_{out}}{V_{in}} = \frac{g_{m1}}{s^2C_1C_2R_S + s\big((1 + g_{m1}R_S)C_2 + g_{m2}C_1R_S\big) + g_{m2}}$$

$$Z_{in} = \frac{g_{m2} + sC_2}{s^2C_1C_2 + s(g_{m1}C_2 + g_{m2}C_1)}$$

3) Problem 6.9(b) in the course book.

At low frequencies: $A_V \approx -g_{m1}r_{o3} \rightarrow \infty$ if $\lambda = 0$

At high frequencies: $A_V \approx -g_{m1}(r_{o1} \parallel r_{o3}) \rightarrow \infty$ if $\lambda = 0$

4) Problem 6.10(b) in the course book. Assume $r_{03} \gg R_2$.

At low frequencies: $A_V \approx -g_{m1}R_2$

At high frequencies: $A_V \approx -\frac{g_{m1}g_{m6}R_1R_2}{2+g_{m6}R_1}$

5) Figure 6 shows an amplifier schematic. For simplicity we can ignore all parasitics of M_1 and M_2 and we assume that the dominant pole occurs at the output node. Also, we assume $g_m \gg 1/r_0$. Find the product $|A_0|\omega_{-3dB}$, where A_0 is the DC gain and ω_{-3dB} is the 3 dB cut-off frequency. Assume $\gamma = 0$.

$$|A_0| \times \omega_{3dB} = \frac{g_{m2}}{C}$$

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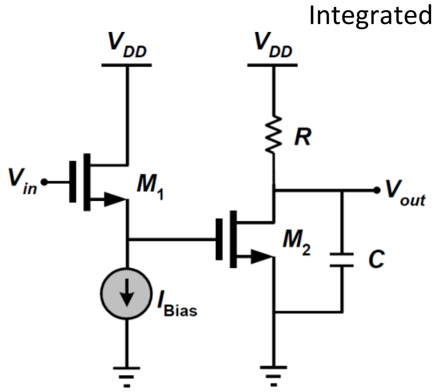

Figure 6 An amplifier schematic.

6) Figure 7 shows an amplifier schematic. For simplicity we can ignore all parasitics of $M_1 - M_4$ and we assume that the dominant pole occurs at the output node. If the input signal has an angular frequency of $\omega_i = 10^9\ rad/s$, determine the AC gain of the amplifier. Assume $g_{m1} = g_{m3} = 4\ mA/V$, $g_{m2} = g_{m4} = 1\ mA/V$, $C = 1\ pF$, $g_m \gg 1/r_0$ and $\gamma = 0$.

$$|\mathrm{A_{ac}}| = 2\sqrt{2}$$

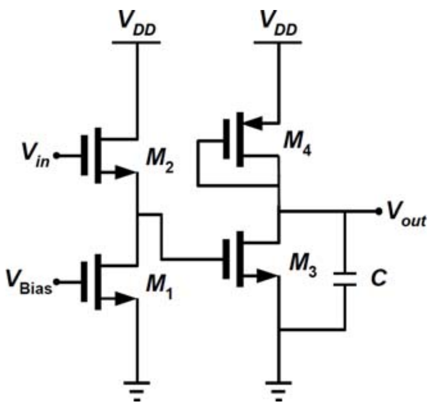

Figure 7 An amplifier schematic.