Key

EE-303 : Electronics-II EXAM-I (051)
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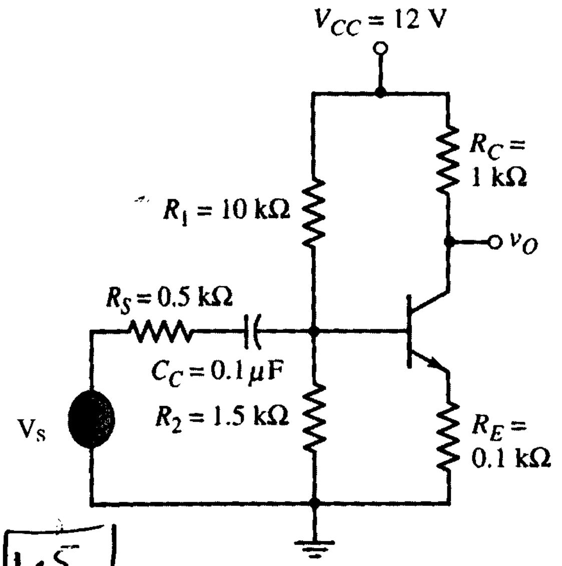
Name: ID #

Question #1: (5)
For the circuit shown below find the lower and upper corner frequencies f_L, f_H and midband gain. BJT parameters are: $\beta=100$, $C\pi = 20pF$, $C\mu = 4pF$ (ignore r_o and r_x), and $I_C=1mA$, $V_T=25mV$.



⊛ Lower Corner Frequency:

$$f_L = \frac{1}{2\pi R_{C_C} C_C}$$

$$R_{C_C} = R_S + [R_1 // R_2 // (\beta+1)(R_E + r_e)]$$

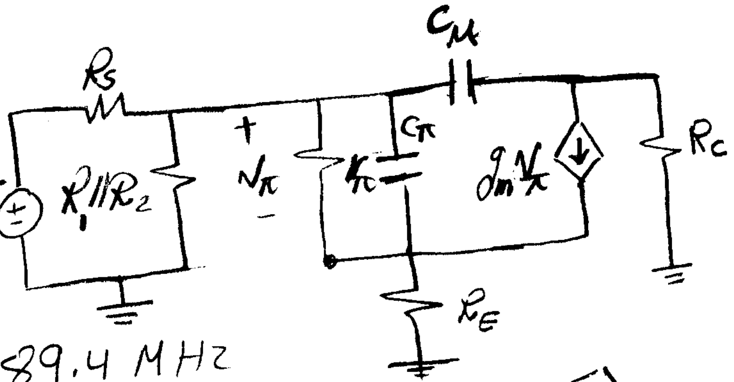
$$r_e = \frac{V_T}{I_C} = 25\Omega$$

$$f_L = \frac{1}{2\pi \times 1682 \times 0.1 \times 10^{-6}} = 946 Hz$$

[1.5]

⊛ Upper Corner Frequency:

$$f_{H_1} = \frac{1}{2\pi R_{\pi_1} C_{\pi_1}} \quad ; \quad R_x = R_S // R_1 // R_2 = 361\Omega$$



$$R_{\pi_1} = r_\pi // \frac{R_x + R_E}{1 + g_m R_E} = 89 \quad ; \quad f_{H_1} = 89.4 MHz$$

[2]

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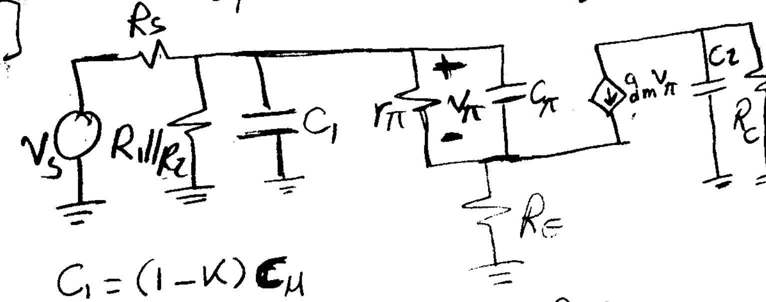


$$f_{H_2} = \frac{1}{2\pi R_{C_1} C_1} \quad ; \quad R_{C_1} = R_S // R_1 // R_2 // [(\beta+1)(r_e + R_E)]$$

$$f_{H_2} = 14 MHz$$

$$C_1 = (1-K) C_\mu = \left(1 + \frac{g_m R_C}{1 + g_m R_E + \frac{R_E}{r_\pi}}\right) C_\mu \simeq 9 C_\mu$$

$$f_{H_3} = \frac{1}{2\pi R_{C_2} C_2} = \frac{1}{2\pi R_C C_2} = 39.8 MHz$$

$$C_2 = \left(1 - \frac{1}{K}\right) C_\mu \simeq C_\mu$$

$$f_H \simeq 14 MHz$$

$$R_i = R_1 // R_2 // (\beta+1)(R_E + r_e) = 1182\,\Omega$$

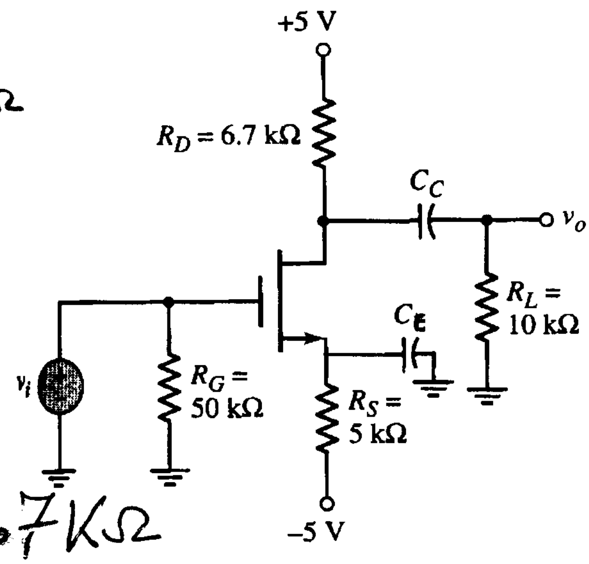
$$\text{Midband Gain} = \frac{R_i}{R_i + R_S}\left(\frac{R_C}{R_E + r_e}\right) = -5.6$$

[1.5]

Question #2: (4)

For the circuit shown below, design the audio amplifier circuit such that the lower corner frequency f_L is 20Hz and find midband gain. MOSFET g_m = 1mA/V (ignore r_o).

$f_{L_1} = \frac{1}{2\pi R_{C_E} C_E}$; $R_{C_E} = R_S // \frac{1}{g_m} = 833\Omega$



$f_{L_1} = \frac{1}{2\pi \times 833 \times C_E}$ [1]

$f_{L_2} = \frac{1}{2\pi R_{C_C} C_C}$; $R_{C_C} = R_D + R_L = 16.7 K\Omega$

$f_{L_2} = \frac{1}{2\pi \times 4011 \times C_C}$ [1]

Different approches can be used here to design f_L. One way: [0.5]

$f_L = f_{L_1} + f_{L_2} = 16 + 4$

$\Rightarrow C_E = \frac{1}{2\pi \times 833 \times 16} = 11.9\ \mu F$

$C_C = \frac{1}{2\pi \times 4011 \times 4} = 9.91\ \mu F$

Midband Gain $= -g_m (R_D // R_L) = -4.01$ V/V [1.5]

Question # 3: (6)

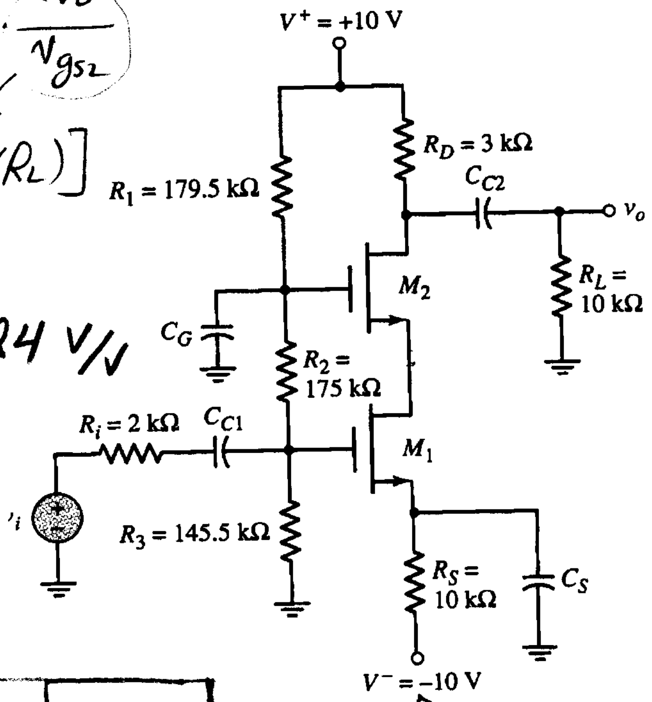
For the Cascode circuit shown below find the upper corner frequency f_H and midband gain. MOSFETs are identical and have the following parameters are: $g_{m1} = g_{m2} = 1\,mA/V$, $C_{gs} = 5pF$, $C_{gd} = 1pF$ (ignore ro).

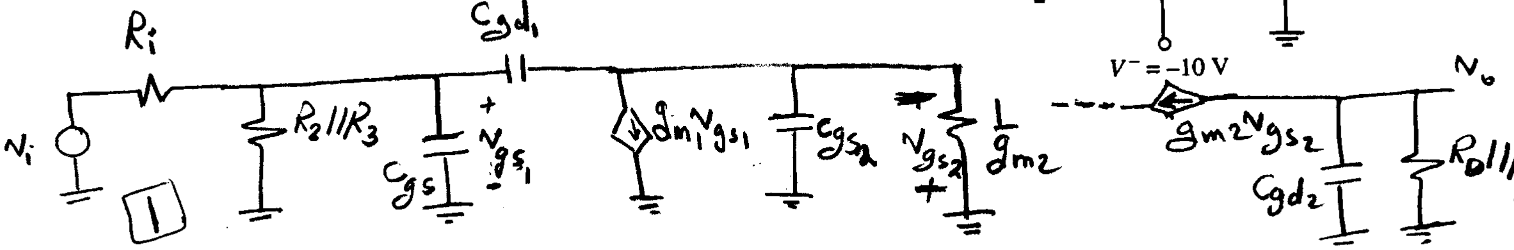
$$\text{Midband Gain} = \frac{V_o}{V_i} = \frac{V_{gs1}}{V_i} \cdot \frac{V_{gs2}}{V_{gs1}} \cdot \frac{V_o}{V_{gs2}}$$

$$= \frac{R_2 // R_3}{R_i + R_2 // R_3} \cdot \frac{g_{m1}}{g_{m2}} \left[-g_{m2}(R_D // R_L)\right]$$

$$= 0.97\,(1)\,(-2.3) \simeq -2.24\ V/V$$

[1.5]





[1]

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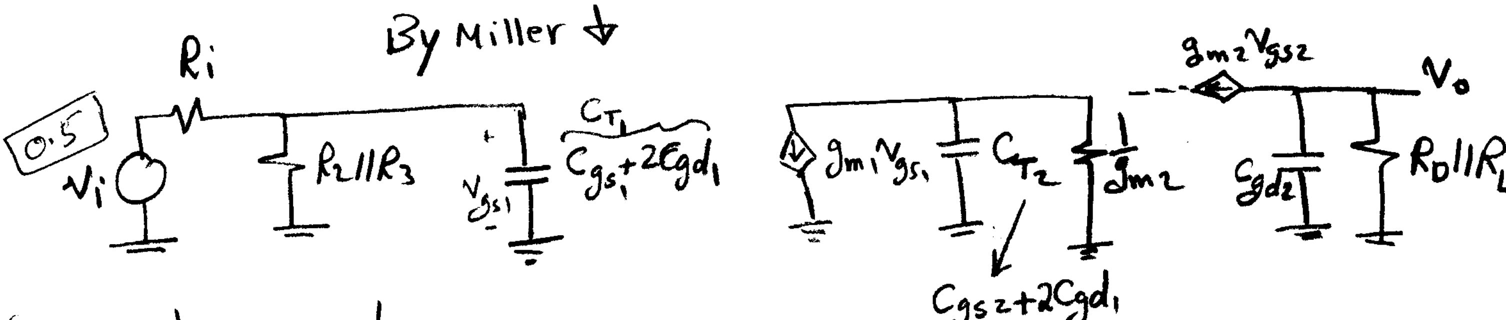

[0.5]

$$W_{H1} = \frac{1}{R_{CT1} C_{T1}} = \frac{1}{(R_i // R_2 // R_3)(C_{gs1} + 2C_{gd1})} = 73.226\ M\ rad/s \Rightarrow f_{H1} = 11.65\ MHz$$

[1]

$$W_{H2} = \frac{1}{R_{CT2} C_{T2}} = \frac{}{\frac{1}{g_{m2}}(C_{gs2} + 2C_{gd1})} = 142.857\ M\ rad/s \Rightarrow f_{H2} = 22.73\ MHz$$

[1]

$$W_{H3} = \frac{1}{(R_D // R_L)\,C_{gd2}} = 433.3\ M\ rad/s \Rightarrow f_{H3} = 68.9\ MHz$$

[1]

$$W_H \simeq \frac{1}{\tau_1 + \tau_2 + \tau_3} \Rightarrow f_H \simeq 6.928\ MHz$$