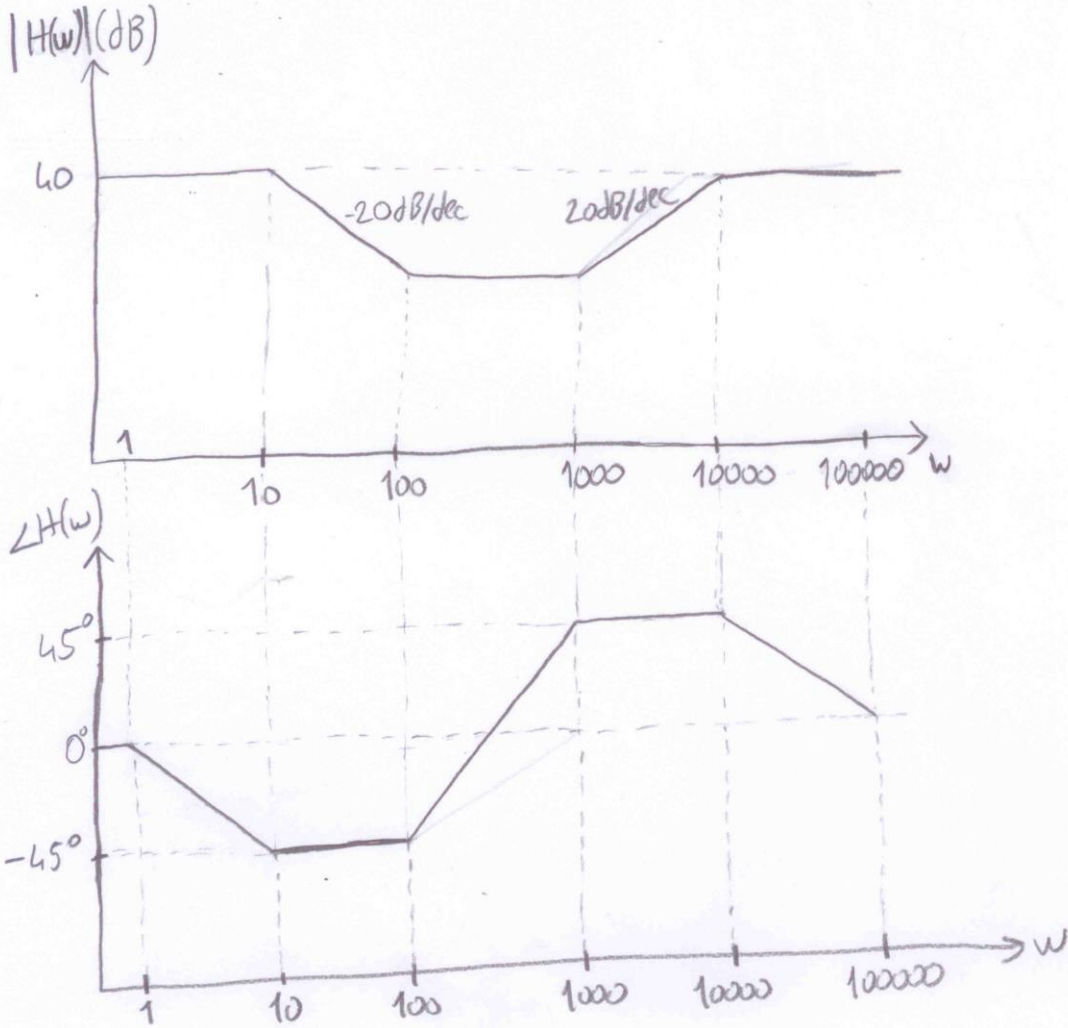


①

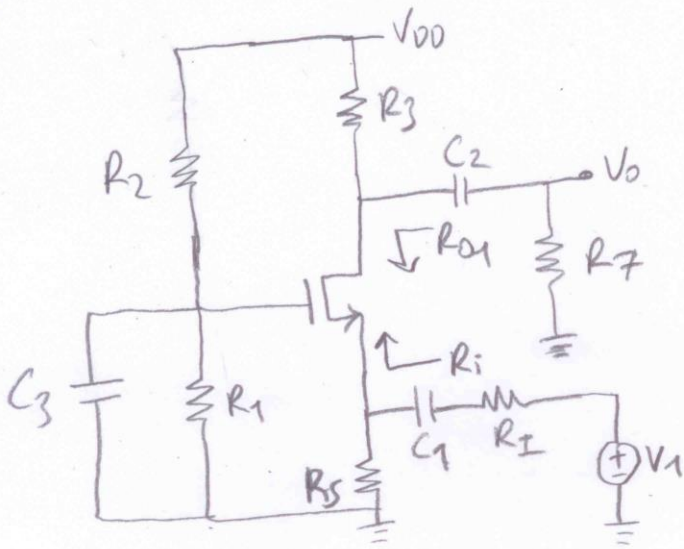
$$H(s) = \frac{100(100+s)(1000+s)}{(10+s)(10000+s)} = \frac{100 \left(1 + \frac{s}{100}\right) \left(1 + \frac{s}{1000}\right) \cdot \cancel{100} \cdot \cancel{1000}}{\left(1 + \frac{s}{10}\right) \cdot \cancel{10} \cdot \left(1 + \frac{s}{10000}\right) \cdot \cancel{10000}}$$

$$\omega_{z1} = 100, \quad \omega_{z2} = 1000, \quad \omega_{p1} = 10, \quad \omega_{p2} = 10000$$

$$\text{At } \omega_0 = 0, \Rightarrow A_0 = H(0) = 100 = 40 \text{ dB}$$

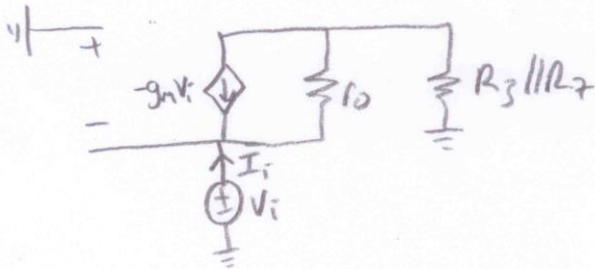


②



$$R_{o1} = g_m r_o R_S \parallel R_I + r_o + R_S \parallel R_I$$

$$f_{p1} = \frac{1}{2\pi C_2 (R_3 \parallel R_{o1} + R_7)}$$



$$V_i - (I_i - g_m V_i) r_o - I_i R_3 \parallel R_7 = 0$$

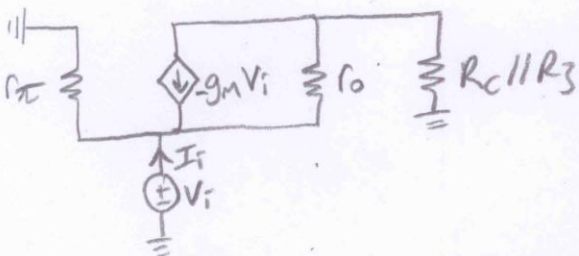
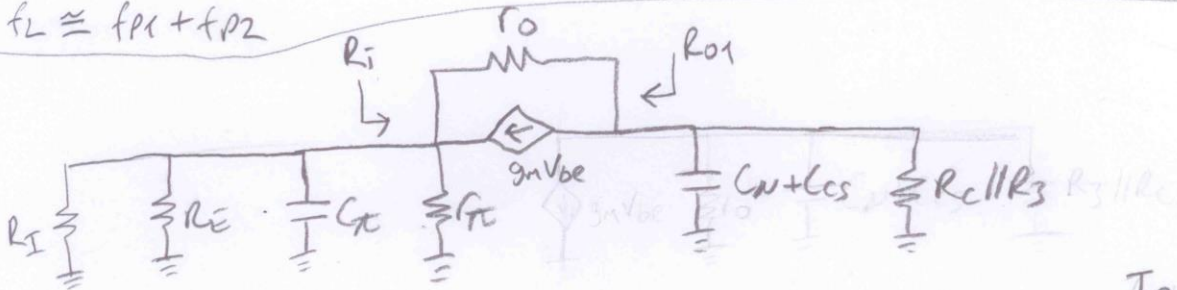
$$R_i = \frac{V_i}{I_i} = \frac{r_o + R_3 \parallel R_7}{1 + g_m r_o}$$

$$f_{p2} = \frac{1}{2\pi C_1 (R_S \parallel R_i + R_I)}$$

Since C_3 is not in signal path, it does not create any pole.

$$f_L \approx f_{p1} + f_{p2}$$

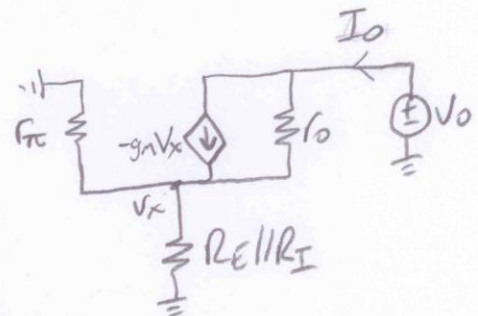
③



$$V_i - (I_i - \frac{V_i}{r_\pi} - g_m V_i) r_o - (I_i - \frac{V_i}{r_\pi}) R_C \parallel R_3 = 0$$

$$R_i = \frac{V_i}{I_i} = \frac{r_\pi r_o + R_C \parallel R_3 \cdot r_\pi}{g_m r_\pi r_o + r_o + r_\pi + R_C \parallel R_3}$$

$$f_{p1} = \frac{1}{2\pi C_1 (R_E \parallel R_I \parallel R_i)}$$



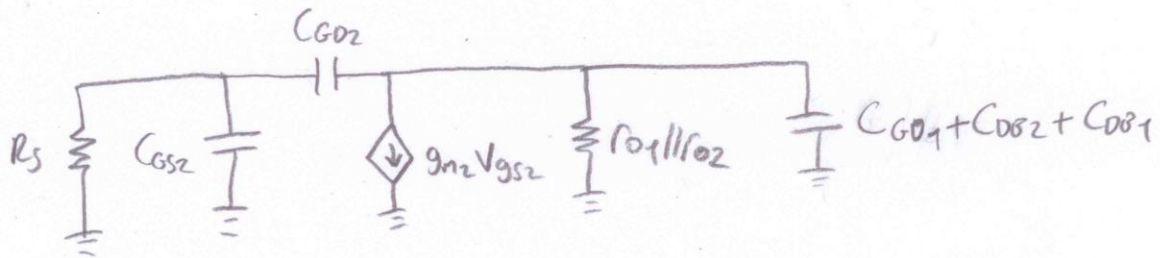
$$V_o - I_o r_o - g_m V_x r_o = V_x$$

$$R_x = R_E \parallel R_I \parallel r_\pi$$

$$V_x = I_o \cdot R_x$$

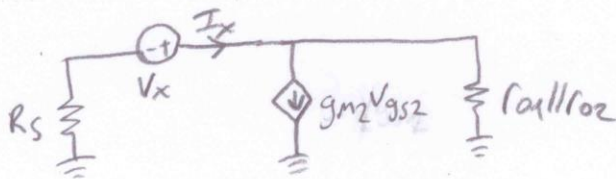
$$R_{o1} = \frac{V_o}{I_o} = g_m r_o R_x + r_o + R_x$$

$$f_{p2} = \frac{1}{2\pi (C_C + C_{CS}) (R_C \parallel R_3 \parallel R_{o1})}$$



$$\tau_I = R_S \cdot C_{GS2}$$

$$\tau_O = r_{O1} || r_{O2} \cdot (C_{GD1} + C_{DB2} + C_{DB1})$$



$$-I_X \cdot R_S + V_X - (I_X - g_m2 V_{GS2}) r_{O1} || r_{O2} = 0$$

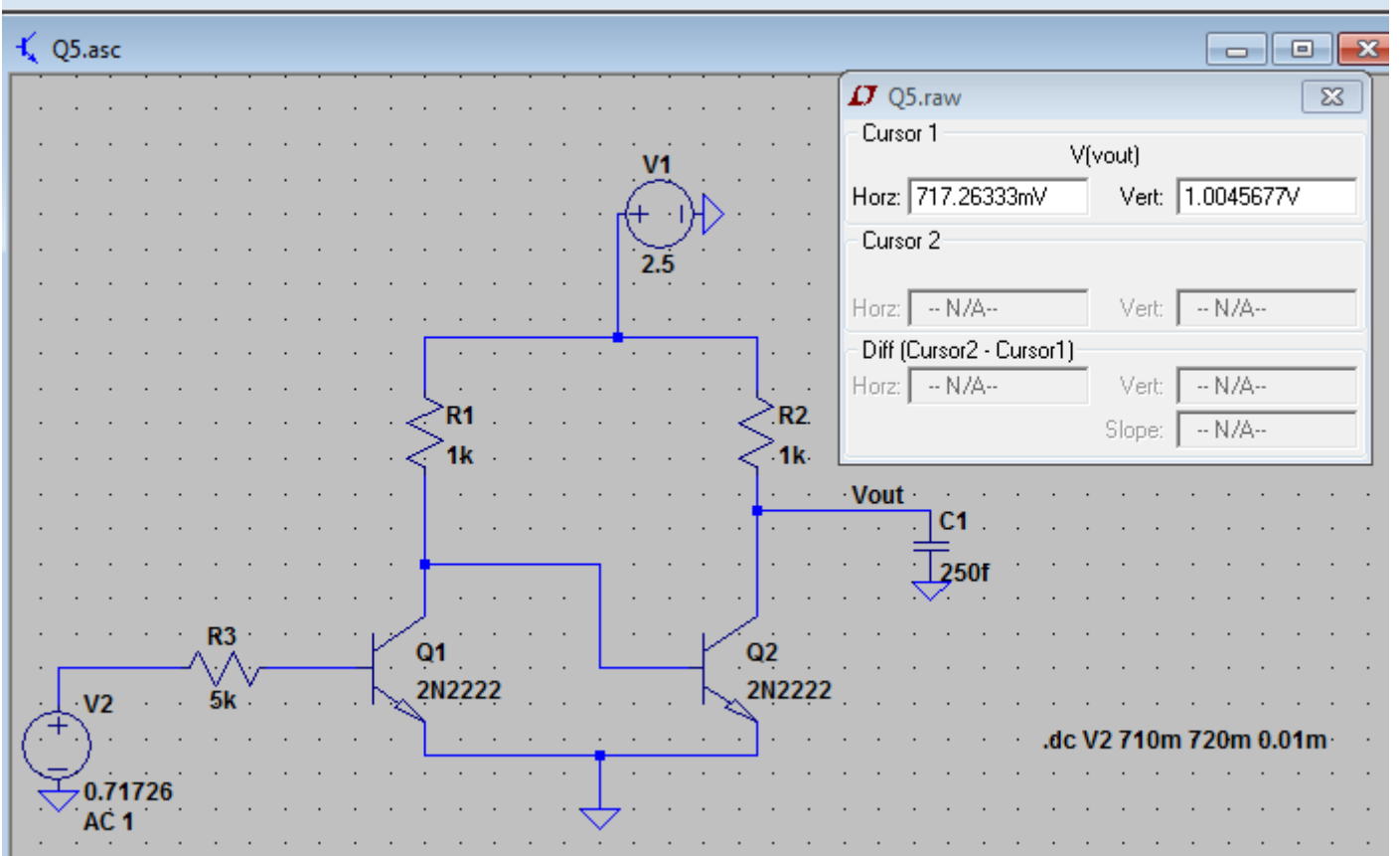
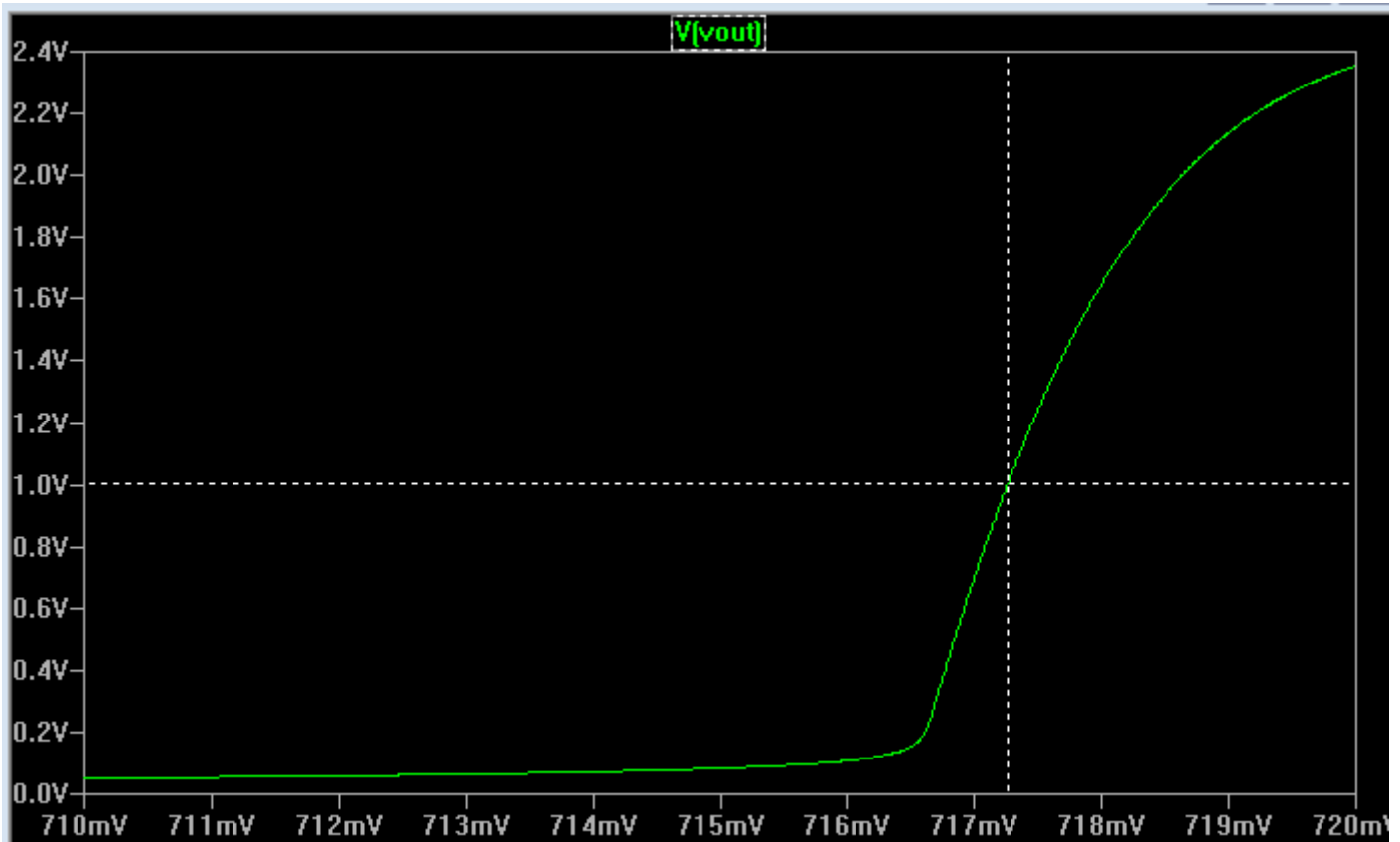
$$V_{GS2} = -I_X \cdot R_S$$

$$R_X = \frac{V_X}{I_X} = g_m2 \cdot R_S \cdot r_{O1} || r_{O2} + R_S + r_{O1} || r_{O2}$$

$$\tau_X = C_{GD2} \cdot R_X$$

$$f_H \approx \frac{1}{2\pi(\tau_I + \tau_O + \tau_X)}$$

5) a)



b)

