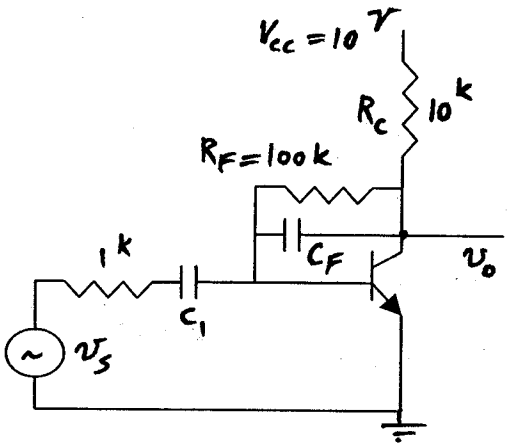
5-30 points) In the common emitter amplifier shown, beta=100 and $V_{BE(on)}$=0.7 [V] and V_A=infinity.

a) Find I_{CQ}, r_π and g_m.
b) Find C1 so that the lower cut-off frequency is 200 Hz. (CF is open in this case)
c) Find CF so that the higher cut-off frequency is 20 Khz. (C1 is short in this case)

Note: C_π and C_μ of the BJT are not effective in this frequency range.



Solution:

(a) First we find the I_{CQ}

$$R_c[I_C + I_B] + R_F I_B + 0.7 = V_{cc} \qquad I_B = \frac{I_C}{100}$$

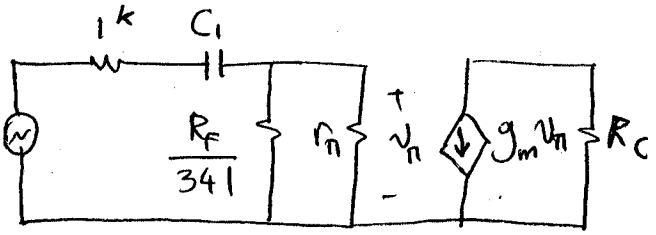
$$I_C = I_{CQ} = 0.84 \text{ mA}$$

$$r_\pi = 3 \text{ k}\Omega \qquad g_m = 34 \text{ m}\mho$$

(b)
$$R'_F = \frac{R_F}{1 + g_m R'_L}$$

$$R'_L = R_C$$

$$1 + g_m R'_L = 1 + 34 \times 10 = 341$$



$$R'_F = \frac{100}{341} = 0.293 \text{ k}\Omega \approx 0.3 \text{ k}\Omega$$

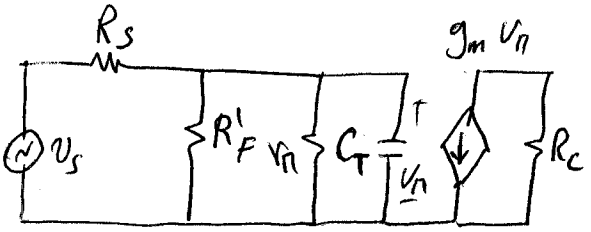
$$R_i = R'_F \,//\, r_\pi = 0.3^k \,//\, 3^k = 0.27 \text{ [k}\Omega\text{]}$$

Resistance seen by C_1 is $R_{C1} = R_S + R_i = 1 + 0.27 = 1.27$ kΩ

$$f_L = \frac{1}{2\pi R_{C1} C_1} = \frac{1}{2\pi \times 1.27 \times C_1} = 200$$

$$\boxed{C_1 = 0.626 \ \mu F}$$

(c)
$$R_T = 1^k \,//\, R'_F \,//\, r_\pi = 1 \,//\, 0.3 \,//\, 3 = 0.214 \text{ k}\Omega$$



$$f_H = \frac{1}{2\pi C_T R_T} = \frac{1}{2\pi \times 0.214 C_T} = 20000$$

$$C_T = 37.18 \text{ nF}$$

$$C_F = \frac{C_T}{1 + g_m R_C} = \frac{37.18}{341} = 0.1 \text{ nF}$$