Lecture 6 Quiz Solution

May 2020

Q1:

Question 1

V_{CC} = 12 V, R_1 = 2.7KΩ, R_2 = 16KΩ, R_E = 1KΩ, R_C = 4.7KΩ and β = 100.

a. Calculate the quiescent point of transistor Q.
b. Sketch the small signal AC equivalent circuit.
c. Find the voltage gain $A_v = v_0/v_i$.
d. Repeat question b and c if the capacitor C_E is removed.
e. Compare the gain in questions c and d and explain why they are difference.

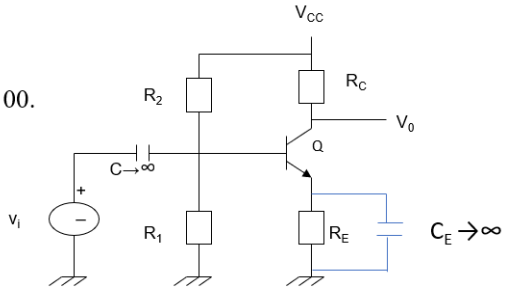
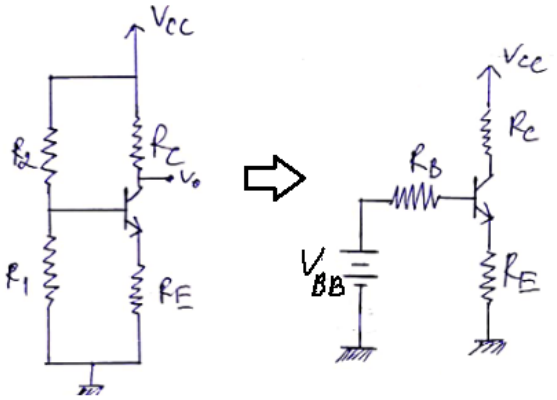


Fig.

Ans

a. DC analysis



$$R_B = R_1 // R2 = 2310\ \Omega$$

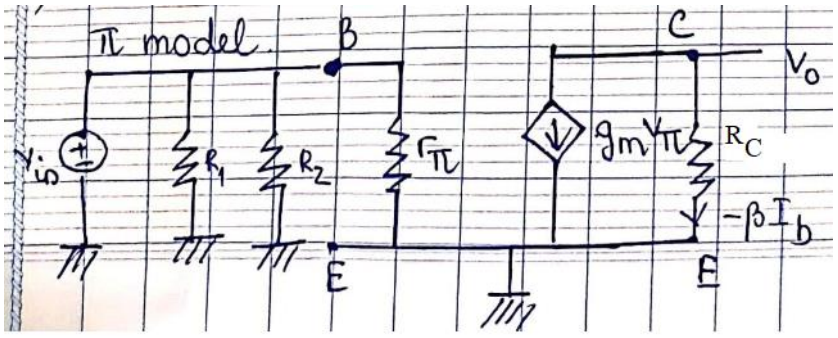
$$V_{BB} = V_{CC}\frac{R_1}{R_1 + R_2} = 1.73V$$

$$I_{EQ} = \frac{V_{BB} - 0.7}{R_E + \frac{R_B}{\beta + 1}} = 1mA$$

$$\rightarrow I_{CQ} = \alpha I_{EQ} \approx 1mA$$

$$\rightarrow V_{CEQ} = V_{CC} - I_{CQ}R_C - I_{EQ}R_E = 6.24V$$

b. AC analysis



$$r_\pi = \frac{25mV}{I_B} = 2501\ \Omega$$

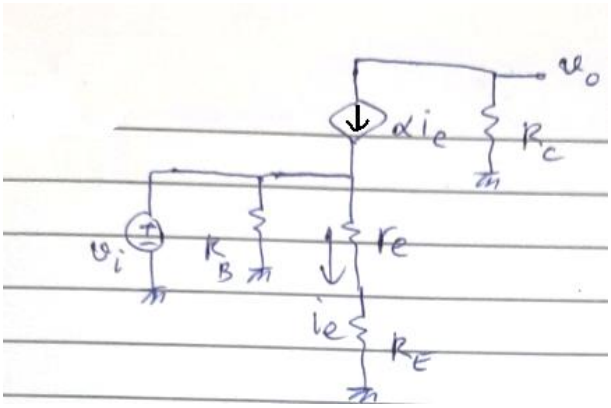
$$g_m = \frac{I_{CQ}}{25mV} = 0.04$$

c.

$$v_o = -g_m v_\pi R_C = -g_m v_i R_C$$

$$\rightarrow A_v = \frac{v_o}{v_i} = -g_m R_C = -188$$

d. Bypass capacitor at Emitter is removed, it is recommended that T-model should be used



$$r_e = \frac{V_T}{I_{EQ}} = 24.76\ V$$

$$v_o = -\alpha i_e R_C = -\alpha R_C \frac{v_i}{r_e + R_E}$$

$$\rightarrow A_{v1} = \frac{v_o}{v_i} = -\frac{\alpha R_C}{r_e + R_E} = -4.54\ V$$

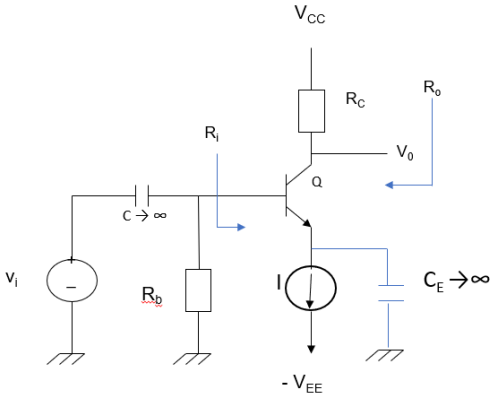
e. $A_{v1} > A_v$ beacause of negative feedback

Q2

Question 2

V_{CC} = 10 V, R_b = 10 KΩ, R_C = 4.7KΩ, I = 1mA and β = 100.

a. Calculate the quiescent point of transistor Q.
b. Sketch the small signal AC equivalent circuit.
c. Find the voltage gain $A_v = v_0/v_i$.
d. Compute input and output impedances R_i and R_o.
e. Is it possible to determine the voltage gain if the capacitor C_E removed?



ans.

a.

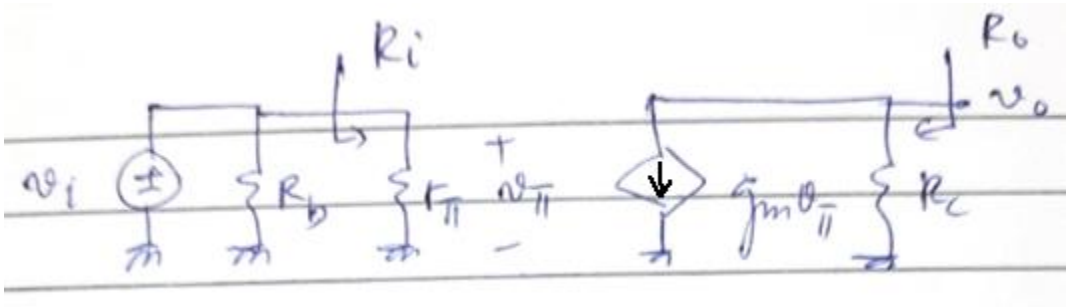
$$I_B = \frac{I}{\beta + 1} = 9.9\mu A$$

$$I_C = \alpha I = \frac{\beta}{\beta + 1} I = 0.99\ mA$$

$$V_E = V_B - 0.7 = (-I_B R_B) - 0.7 = -0.799V$$

$$\rightarrow V_{CE} = V_{CC} - I_C R_C - V_E = 6.14\ V$$

b. A bypass capacitor exists at Emitter, use π-model:



$$r_\pi = \frac{V_T}{I_B} = 2525\ \Omega; \quad g_m = \frac{I_C}{V_T} = 0.0396$$

c.

$$A_v = -g_m R_C = -186$$

d. $R_i = r_\pi = 2525\ \Omega$; $R_o = R_C = 4700\ \Omega$

e. No, because Emitter is open-circuit then no $i_e \rightarrow v_o = 0$