

Problem 1

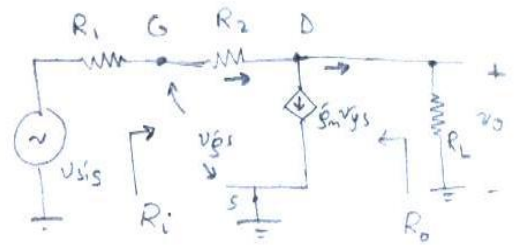
(c)

$$\frac{v_{sig} - v_o}{R_2} = g_m v_{gs} + \frac{v_o}{R_L}$$

$$v_{gs} = v_{sig}$$

$$v_{sig} \left(\frac{1}{R_2} - g_m \right) = v_o \left(\frac{1}{R_2} + \frac{1}{R_L} \right)$$

$$\frac{v_o}{v_{sig}} = \frac{1/R_2 - g_m}{1/R_2 + 1/R_L} = \frac{1 - R_2 g_m}{1 + R_2/R_L}$$



"Common Source"

(d)
$$i_i = \frac{v_i - v_o}{R_2}$$

$$\frac{i_i}{v_i} = \frac{1 - v_o/v_i}{R_2} = \frac{1 - AV}{R_2}$$

$$R_i = \frac{R_2}{1 - AV}$$

(e) $v_{gs} = 0 \Rightarrow R_o = R_2$

(f) R_i reduces overall gain

Problem 2

KVL :

$$(a) \quad 9 - 2.7k I_E - 0.7 - \frac{I_E}{\beta+1} (2.7k) = 0$$

$$I_E = 2.8 \text{ mA} \quad I_C = 2.77 \text{ mA} \quad I_B = 27.7 \mu\text{A}$$

$$V_B = 27.7 \mu (2.7k) = 0.748 \text{ V}$$

$$V_E = 1.448 \text{ V}$$

$$V_C = 2.77 \text{ m} (2.7k) - 9 = -1.521 \text{ V}$$

(b) $V_B > V_C \Rightarrow$ Active mode

(c) At the boundaries $V_B = V_C$

$$(2.77 \text{ mA})(2.7k) + V_{CC} = V_B = 0.748 \text{ V}$$

$$\Rightarrow V_{CC} = -6.73 \text{ V}$$

Problem 3

(b) $I_C = 0.5 \text{ mA} \Rightarrow \beta_m = 20 \text{ mA/V} ; r_m = 5.05 \text{ k}\Omega ; r_e = 50 \Omega$

(d) $v_o = -\alpha i_e 30k$ (from the T-model circuit)

$$v_i = (r_e + R_E) i_e$$

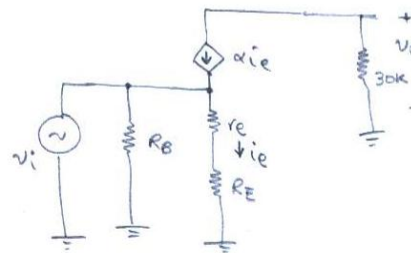
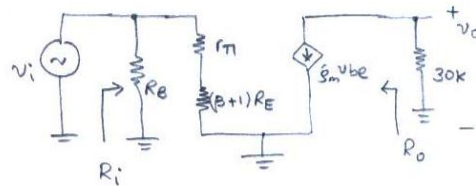
$$\frac{v_o}{v_i} = \frac{-\alpha 30k}{r_e + R_E}$$

(e) $-10 = \frac{-\alpha 30k}{50 + R_E} \Rightarrow R_E = 2.9 \text{ k}$

(f) $R_i = R_B \parallel [r_m + (\beta+1) R_E]$

(g) By shorting $v_i \Rightarrow i_e = 0$

$$\Rightarrow R_o = \infty$$



" Common Emitter with R_E "