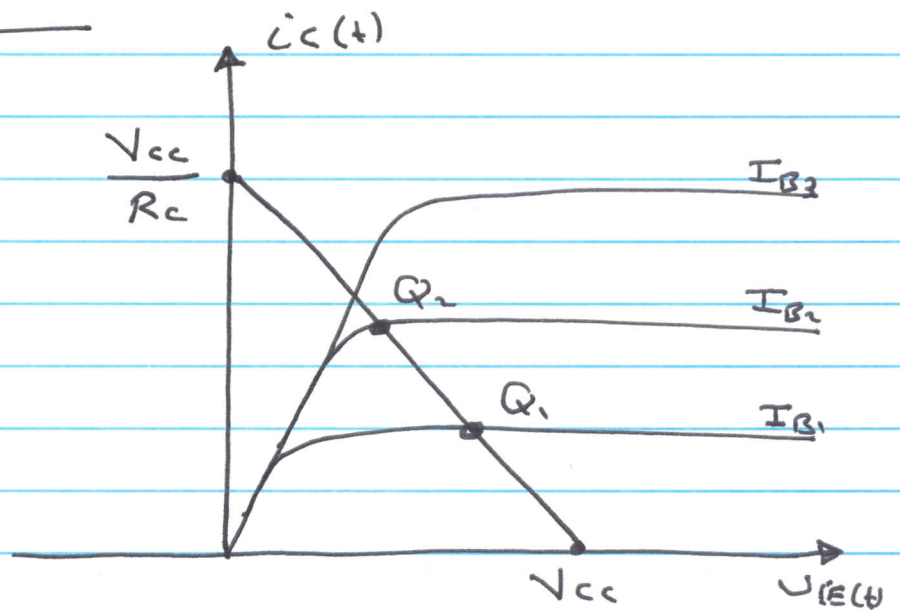
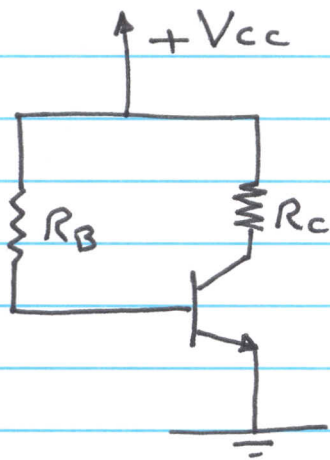
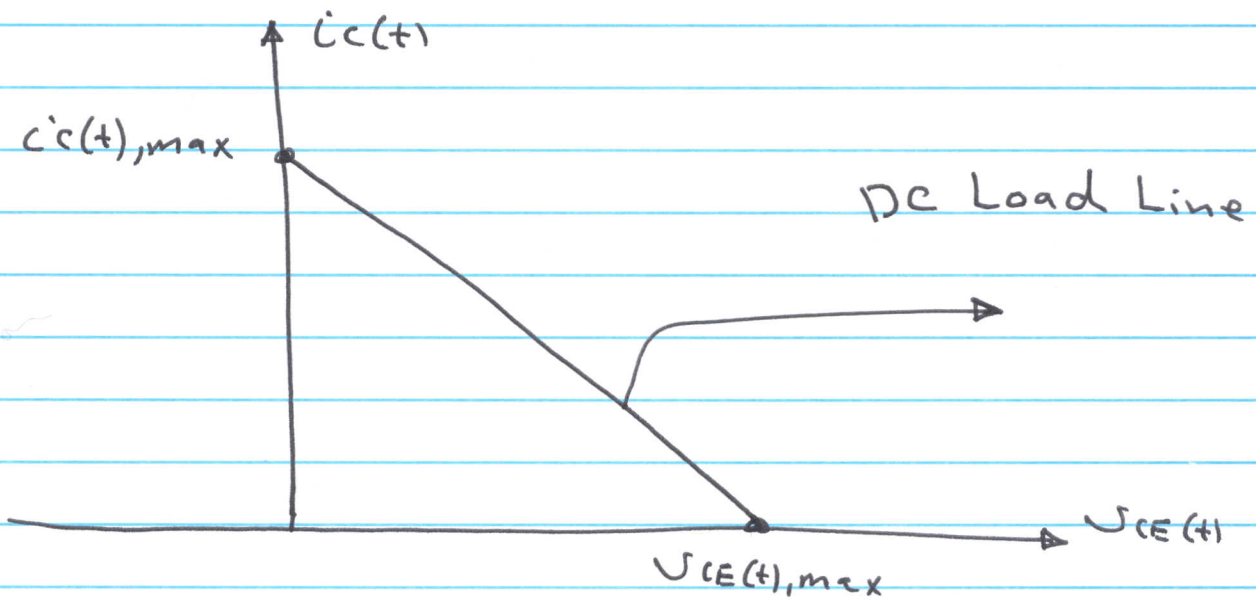


Graphical Method



KVL : $V_{cc} = R_c I_c + V_{ce}$

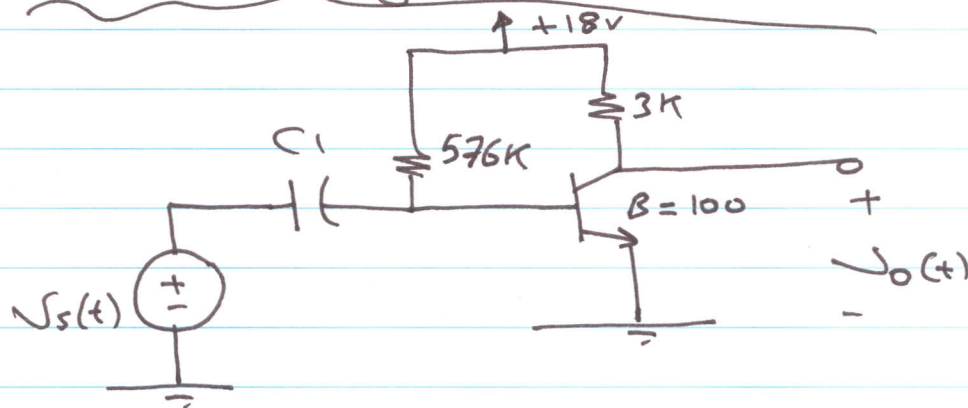
$$I_c = -\frac{1}{R_c} V_{ce} + \frac{V_{cc}}{R_c}$$



$$I_{c(max)} = \frac{V_{cc}}{R_c} \quad \text{Saturation}$$

$$V_{ce(max)} = V_{cc} \quad \text{Cutoff}$$

Small Signal BJT Amplifier



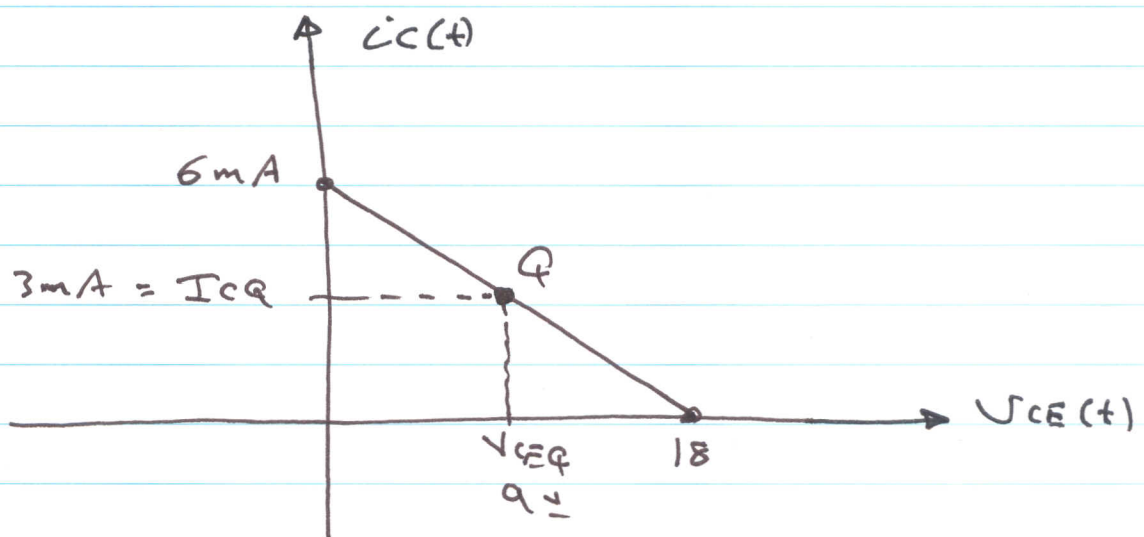
$$v_s(t) = 0.03 \sin \omega t \text{ V}$$

DC Analysis

$$I_B = \frac{18 - V_{BE}}{R_B} = \frac{18 - 0.65}{576k} = 30 \mu A$$

$$I_C = \beta I_B = 3 \text{ mA}$$

$$V_{CE} = V_{CC} - R_C I_C = 9 \text{ V}$$

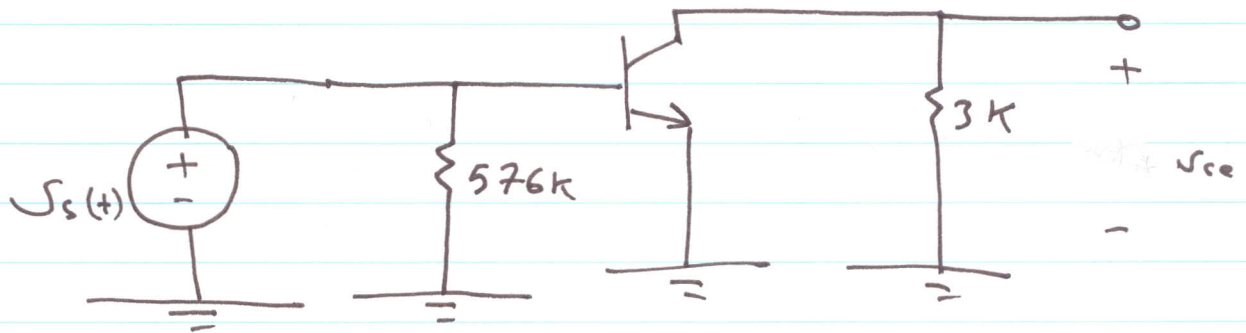


$$v_{BE}(t) = V_{BE} + v_{be}$$

$$i_C(t) = I_{CQ} + i_c$$

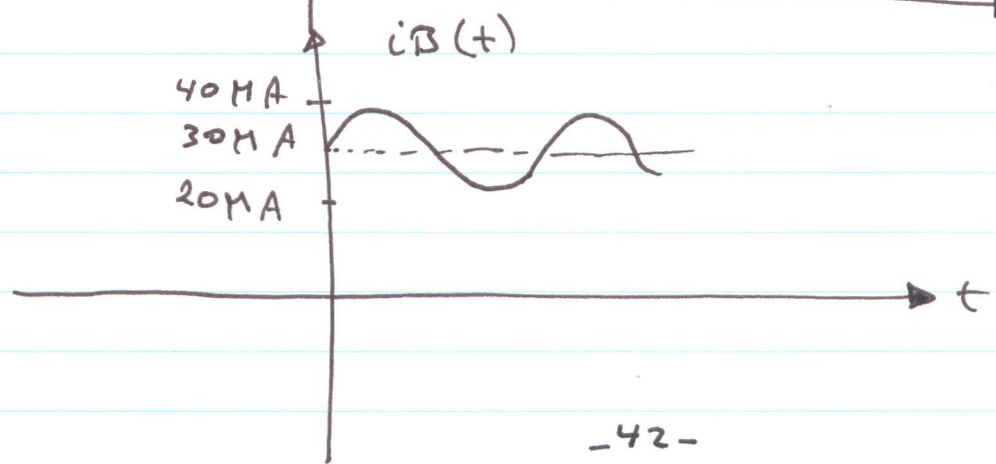
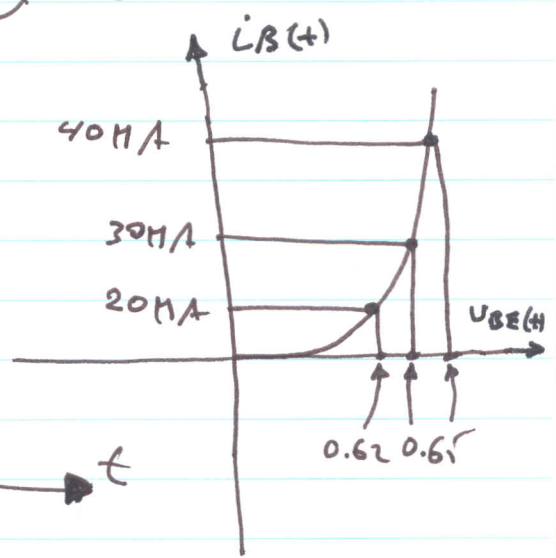
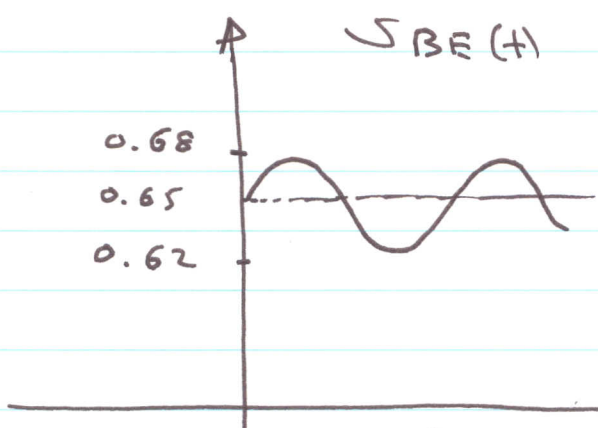
$$v_{CE}(t) = V_{CEQ} + v_{ce}$$

ac equivalent ckt



$$v_{be} = v_s(t) = 0.03 \sin \omega t \text{ V}$$

$$\therefore v_{BE}(t) = 0.65 + 0.03 \sin \omega t \text{ V}$$



$$\text{When } V_{BE}(t) = 0.65 \text{ V} ; i_B(t) = 30 \mu\text{A}$$

$$V_{BE}(t) = 0.68 \text{ V} ; i_B(t) = 40 \mu\text{A}$$

$$V_{BE}(t) = 0.62 \text{ V} ; i_B(t) = 20 \mu\text{A}$$

$$\text{using } i_C(t) = \beta i_B(t)$$

$$\text{and } V_{CE}(t) = V_{CC} - R_C i_C(t)$$

$$\text{When } i_B(t) = 30 \mu\text{A} ; i_C(t) = 3 \text{ mA}$$

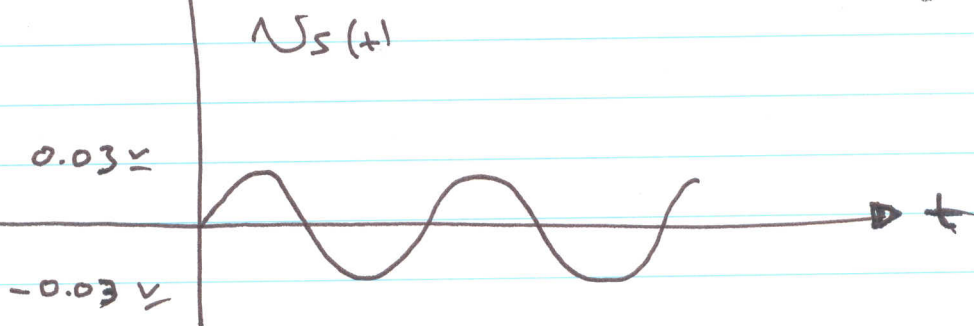
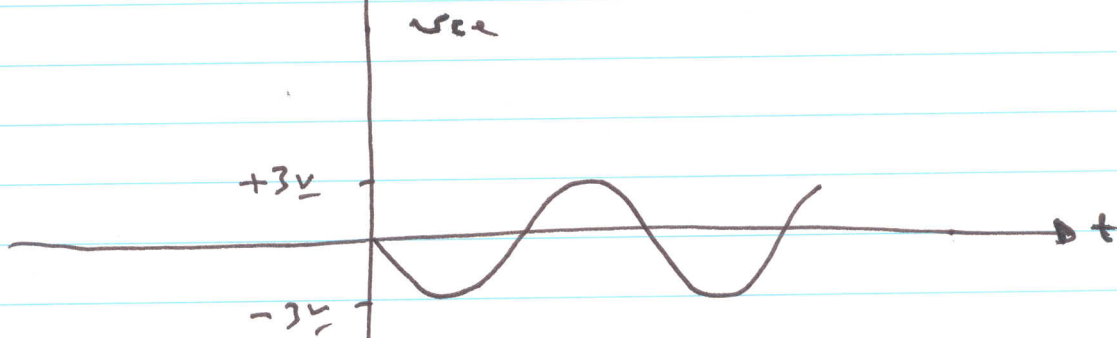
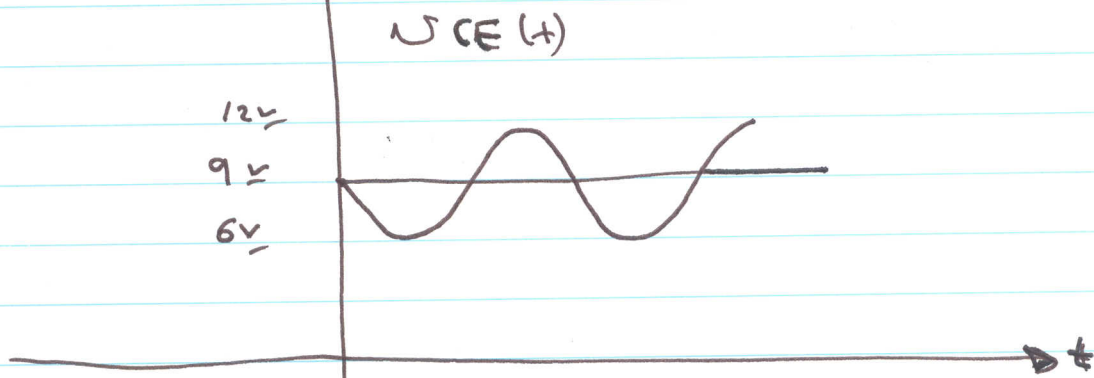
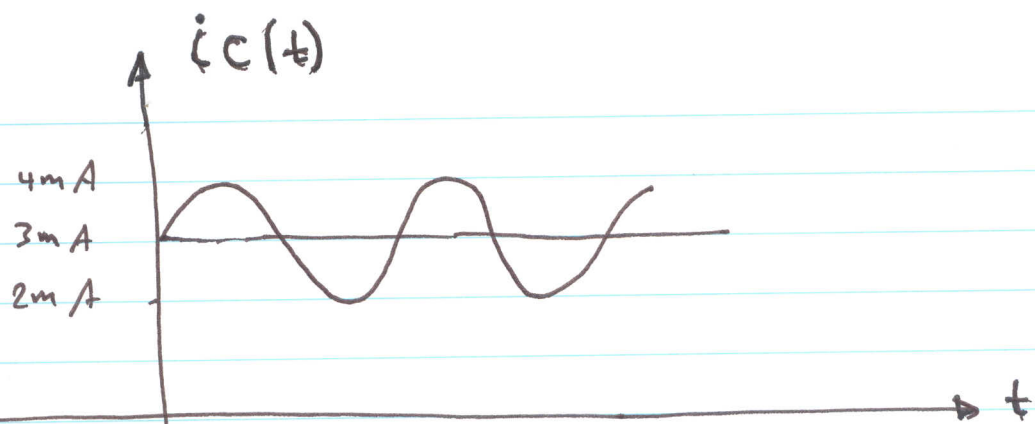
$$V_{CE}(t) = 9 \text{ V}$$

$$\text{When } i_B(t) = 40 \mu\text{A} ; i_C(t) = 4 \text{ mA}$$

$$V_{CE}(t) = 6 \text{ V}$$

$$\text{When } i_B(t) = 20 \mu\text{A} ; i_C(t) = 2 \text{ mA}$$

$$V_{CE}(t) = 12 \text{ V}$$

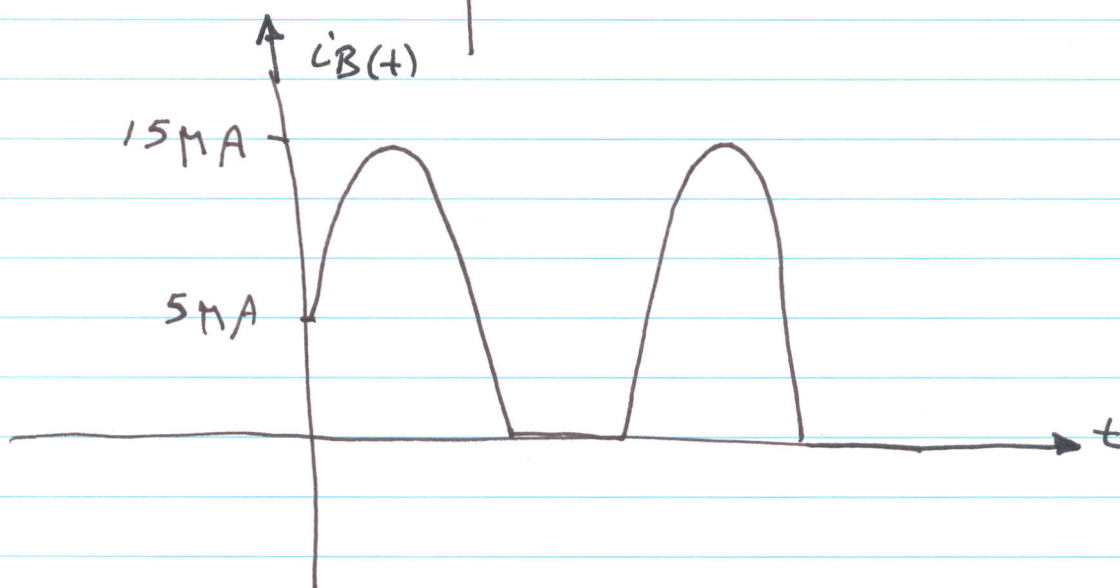
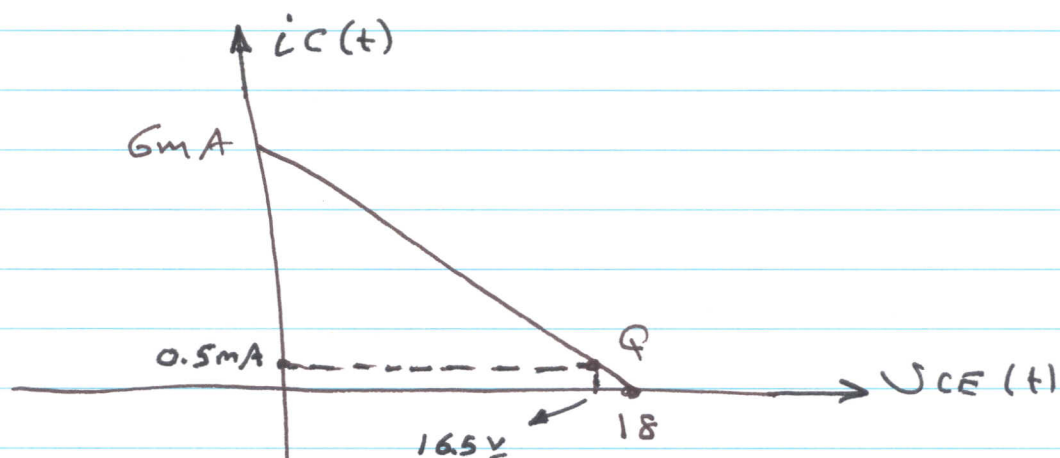


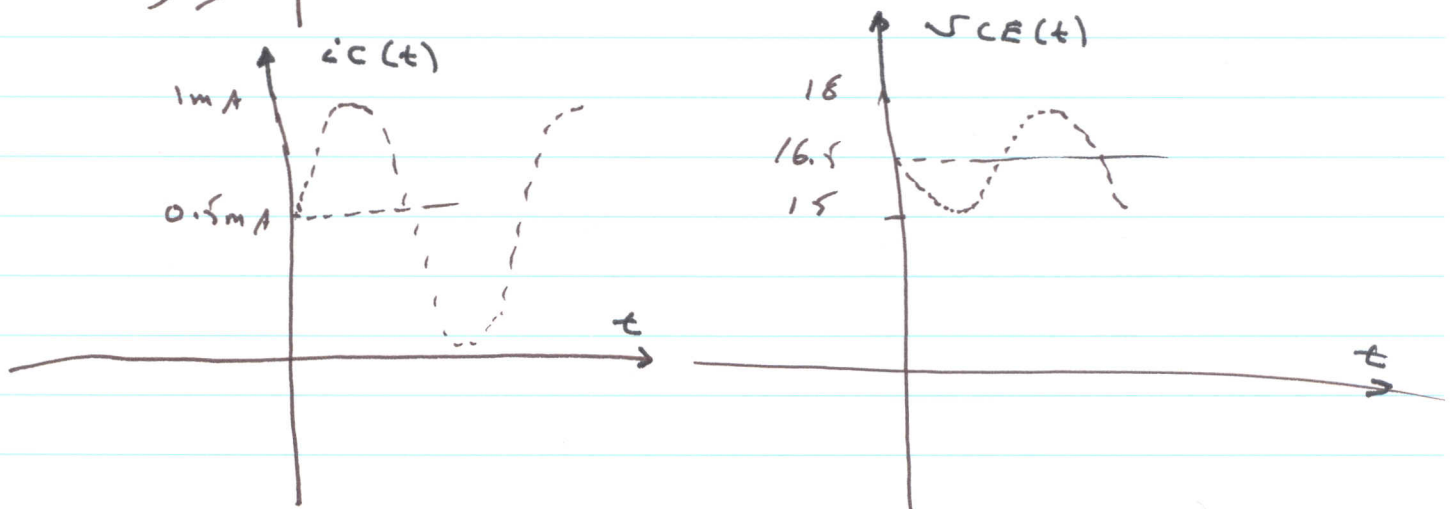
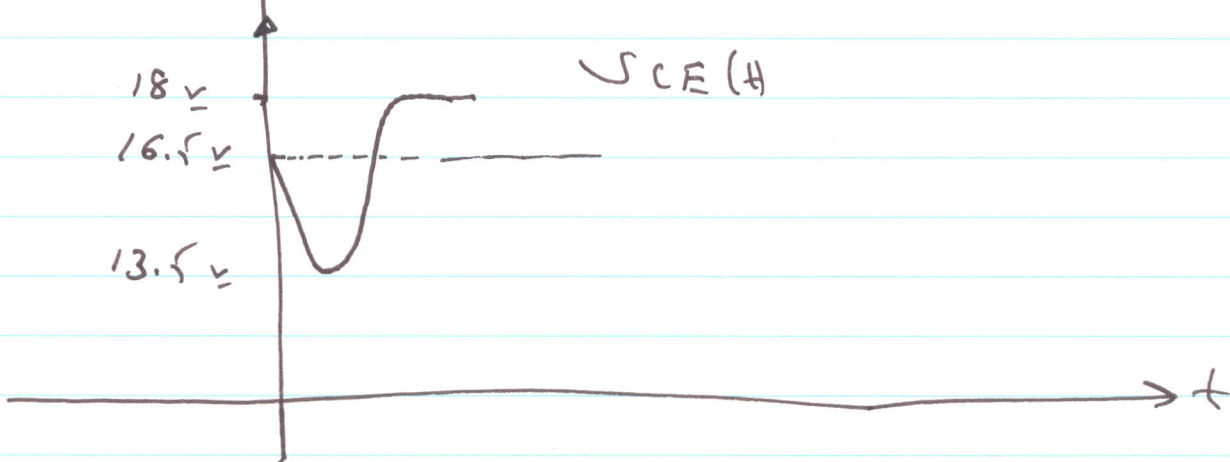
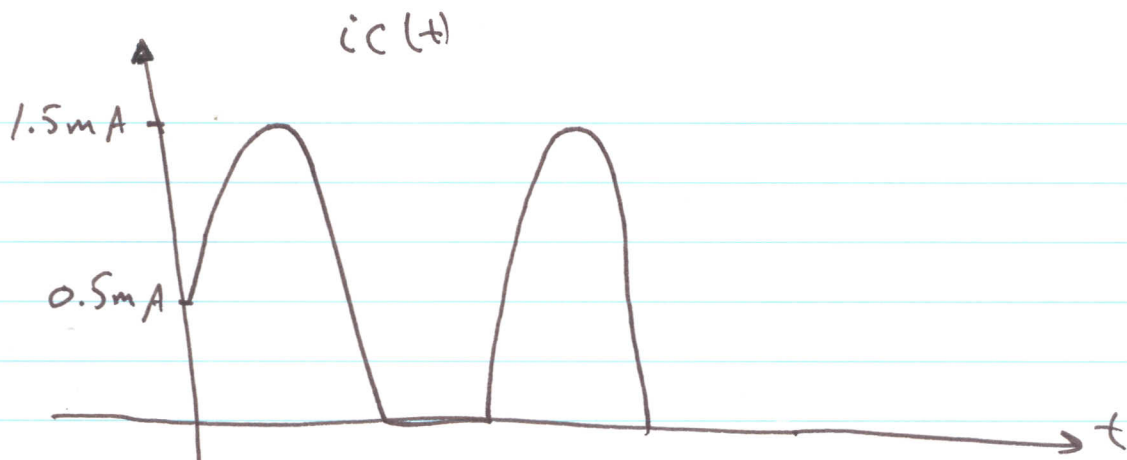
$$\text{let } R_B = 3.47 \text{ m}\Omega$$

$$I_B = \frac{18 - 0.65}{3.47 \text{ m}} \approx 5 \text{ mA}$$

$$I_C = 0.5 \text{ mA}$$

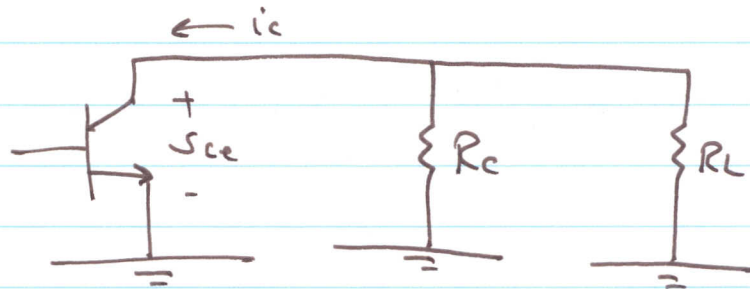
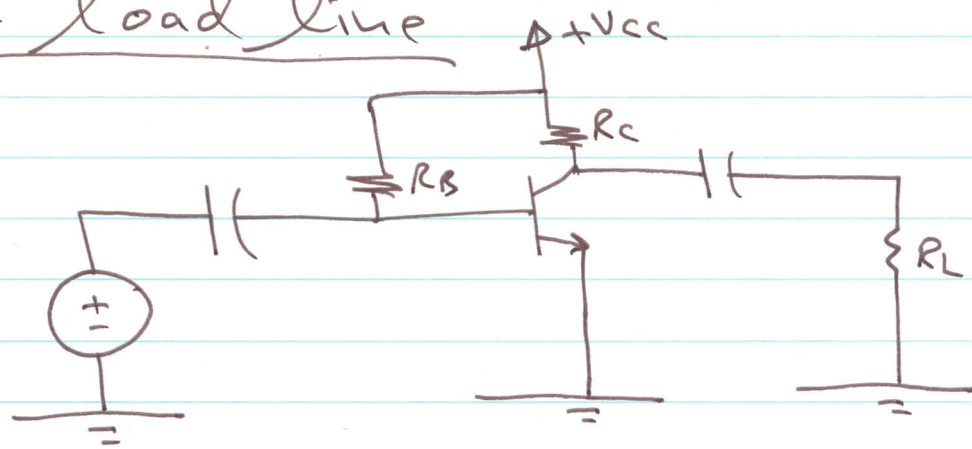
$$V_{CE} = 16.5 \text{ V}$$





maximum possible swing -46-

ac load line



$$v_{ce} = - (R_C \parallel R_L) i_c$$

$$v_{ce} = - R_{ac} i_c$$

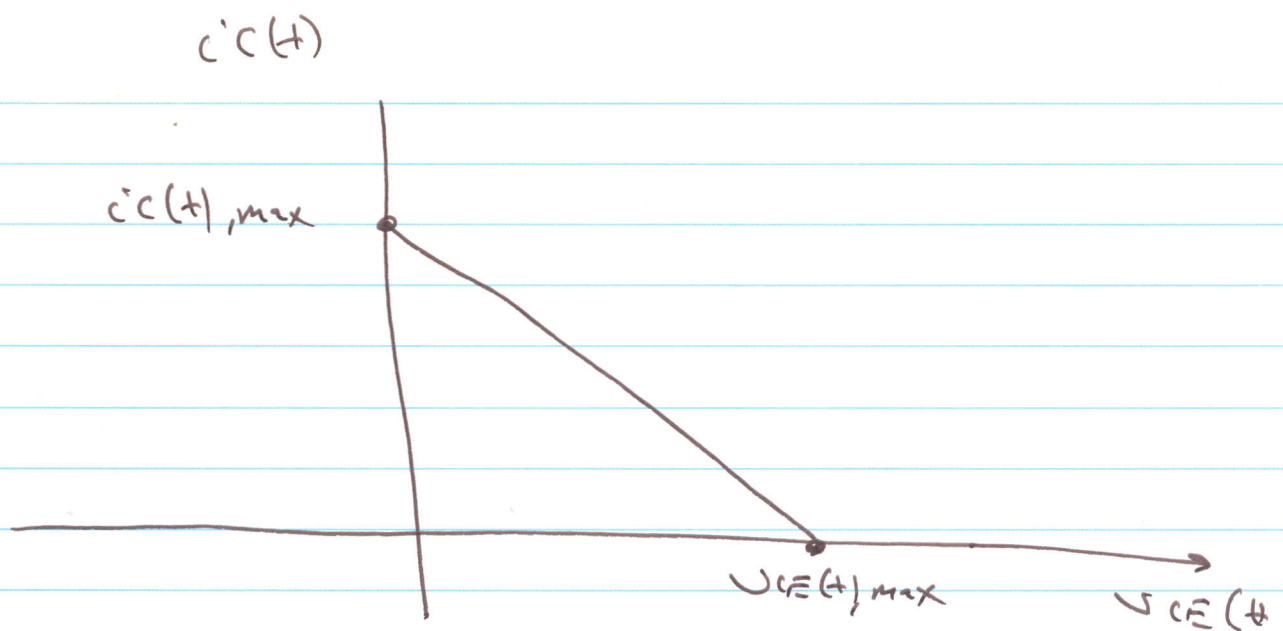
$$v_{ce}(t) - v_{ceQ} = - R_{ac} (i_c(t) - I_{CQ})$$

To find $i_c(t)_{max}$, set $v_{ce}(t) = v_{ce,sat} \approx 0$

$$\therefore i_c(t)_{max} = I_{CQ} + \frac{v_{ceQ}}{R_{ac}}$$

To find $v_{ce}(t)_{max}$, set $i_c(t) = 0$

$$\therefore v_{ce}(t)_{max} = v_{ceQ} + R_{ac} I_{CQ}$$



For Maximum symmetrical Swing

$$I_{CQ} = \frac{1}{2} i_c(t), \max$$

$$i_c(t), \max = I_{CQ} + \frac{v_{CEQ}}{R_{ac}} = 2 I_{CQ}$$

$$\therefore I_{CQ} = \frac{v_{CEQ}}{R_{ac}}$$

For DC Condition

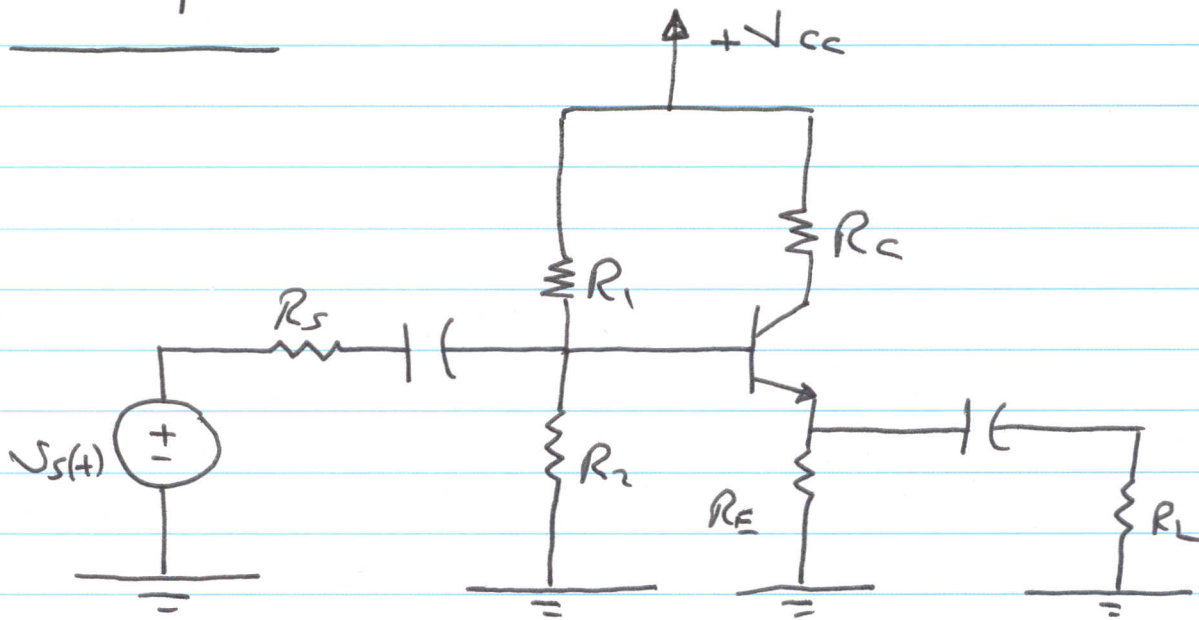
$$V_{CC} = R_c I_c + v_{CE}$$

$$V_{CC} = R_{dc} I_c + v_{CE}$$

$$V_{CC} = R_{dc} I_c + R_{ac} I_c$$

$$\therefore I_{CQ} = \frac{V_{CC}}{R_{ac} + R_{dc}}$$

Example



For maximum symmetrical swing

$$I_{CQ} = \frac{V_{CC}}{R_{ac} + R_{dc}}$$

$$R_{dc} = R_c + R_E$$

$$R_{ac} = R_c + R_E \parallel R_L$$

$$V_{CEQ} = R_{ac} I_{CQ}$$