جامعة بيرزيت

BIRZEIT UNIVERSITY

ANSWER BOOKLET

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Course: Department:	Number:
Division:	Instructor:
Date:	
Day	Month Year

For Instructor's Use

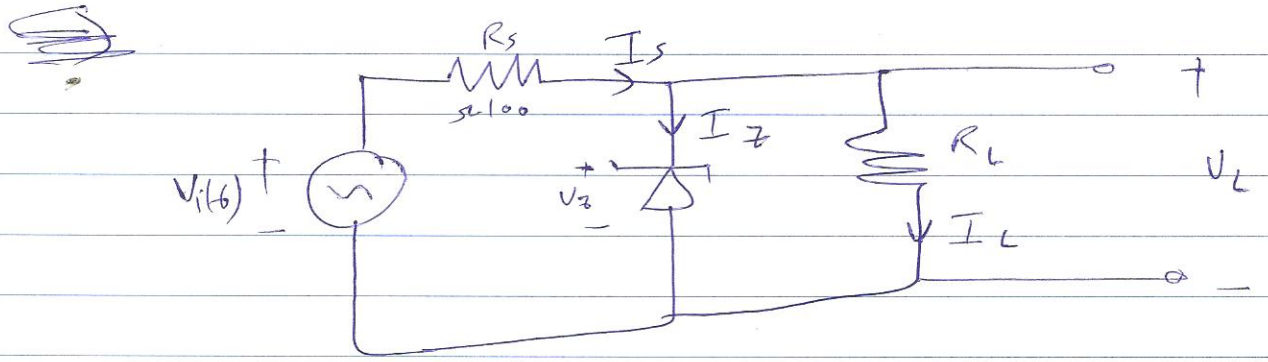
Question	Grade
1	12
2	9
3	7.5
4	13.5
5	
6	
7	
8	
9	
10	
11	
12	
Total	42 + 2

Q1) 1) $V_z = 10\,V$ @ $I_z = 25\,mA$

$P_{z(max)} = 0.5\,W = V_z * I_{z(max)}$ 12/12

$\Rightarrow I_{z(max)} = \frac{0.5}{10} = 0.05\,A = \boxed{50\,mA}$

$V_L = 10 \Rightarrow I_L = \frac{V_L}{R_L} = \frac{10}{250} = 40\,mA$



$I_{s(max)} = I_{z(max)} + I_L$

$= 50 + 40 = 90\,mA$

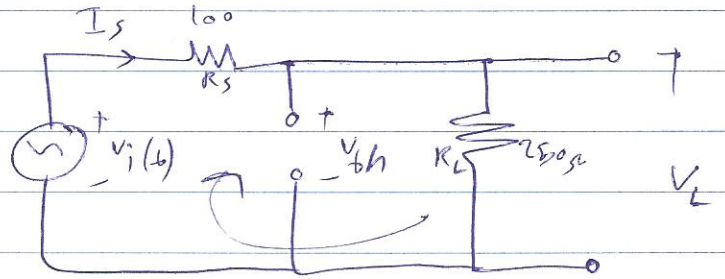
$\Rightarrow V_{i(t)(max)}$ @ $I_{s(max)}$

KVL: $-V_{i(t)_{max}} + I_{s_{max}} R_s + V_z = 0$

$\Rightarrow \boxed{V_{i(t)_{max}} = 90\,mA * 100\Omega + 10}$

$= \boxed{19\,V}$

Also: $V_{th} \geq V_z$



~~KVL V_{th}~~

~~$-V_{th} - I_s R_s + V_{i(t)} = 0$~~

~~$\Rightarrow V_{th} = V_{i(t)} - I_s R_s \geq V_z = 10$~~

~~$\Rightarrow V_{i(t)} - 40\,mA * 100\Omega \geq 10$~~

$$V_{th} = \frac{250\Omega}{250\Omega + 100\Omega} V_i(t)$$

$\Rightarrow V_{th} = 0.71\, V_i(t) \geq V_z = 10$

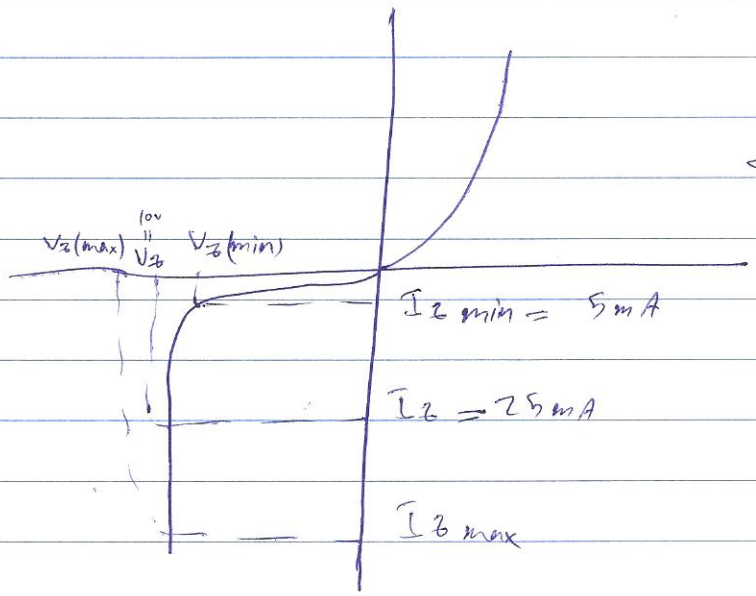
$\Rightarrow 0.71\, V_i(t) \geq 10$

$V_{th} = 0.71\, V_i(t) \Rightarrow V_z = 10$ (at least)

$\Rightarrow \boxed{V_i(t)_{min} \geq \frac{10}{0.71} = 14.08\ V \simeq 14\ V}$

$\Rightarrow$ $14mA > V_i(t) > 14mA$

2)



$V_L = V_z$

$\Rightarrow$

$V_L = V_z \Rightarrow V_L(max) \leq V_z(max)$

$V_L(min) \leq V_z(min)$

Find $\Rightarrow$ $V_z(min)$ & $V_z(max)$

~~$V_{z(max)}$~~

$V_{z(min)} = V_z - \Delta V_z$

~~r_z~~ $r_z = \frac{\Delta V_z}{\Delta I_z} \Rightarrow \Delta V_z = r_z * \Delta I_z$

$\Rightarrow \Delta I_z = I_z - I_{z(min)}$

$\Rightarrow 25 - 5 = 20mA$

~~I_z~~ $\Rightarrow \Delta V_z = 10\Omega * 20mA = 200mV$

$\Rightarrow V_{z(min)} = 10V - 200mV = 9.8V$

$= V_{L(min)}$

$V_{z(max)} = V_z + \Delta V_z$

$\Rightarrow \Delta V_z = r_z * \Delta I_z$

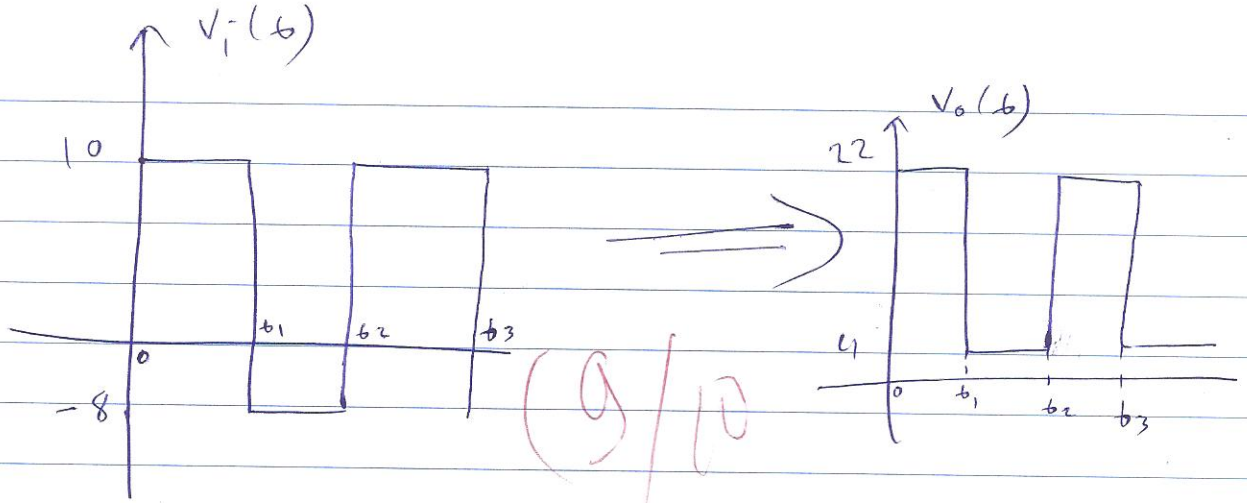
$\Rightarrow \Delta I_z = I_{z(max)} - I_z$

$= 50mA - 25mA = 25mA$

$\Rightarrow \Delta V_z = 10\Omega * 25mA = 250mV$

$\Rightarrow V_{z(max)} = 10V + 250mV = 10.25V$

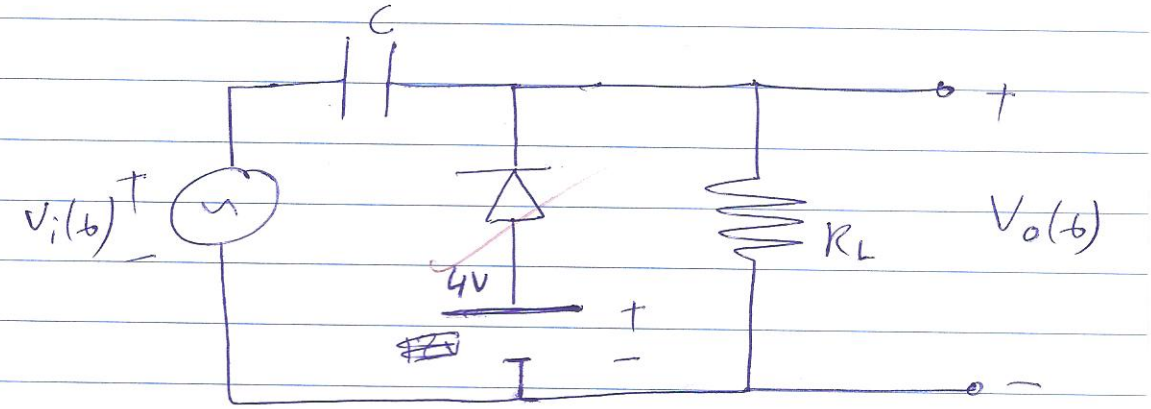
Q2)



(9/12)

⇒ shifts up by 12 V

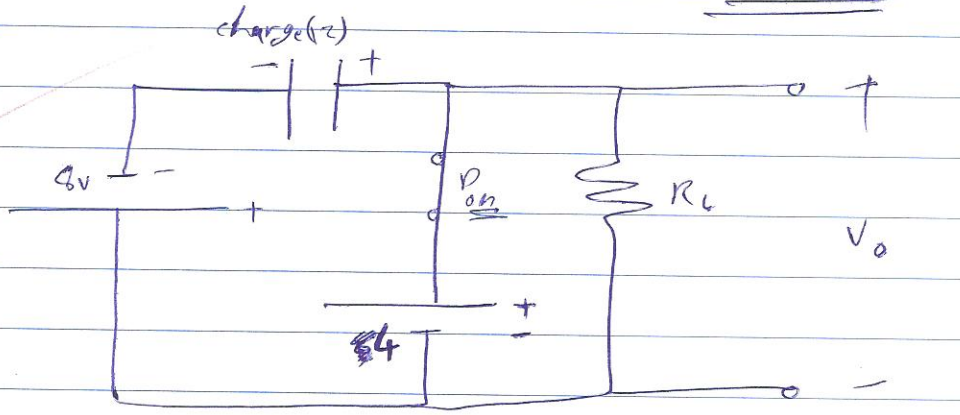
⇒ Design :



⇒ Analysis : $2 < t < 4$:

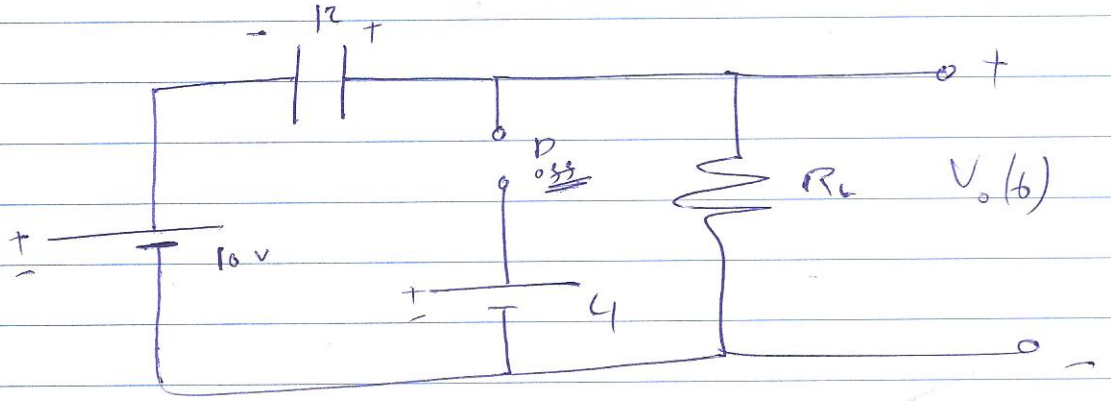
when ⇒ $V_i(t)$ ⇒ from $t_1 \rightarrow t_2$:

⇒ $V_o = 4$



~~when~~ ~~when~~ ⇒ ~~$t_1 < t < t_2$~~

@ $4 < t < 6$:



$\Rightarrow$ $-V_o + 12 + 10 = 0$

$\Rightarrow$ $\boxed{V_o = 22}$

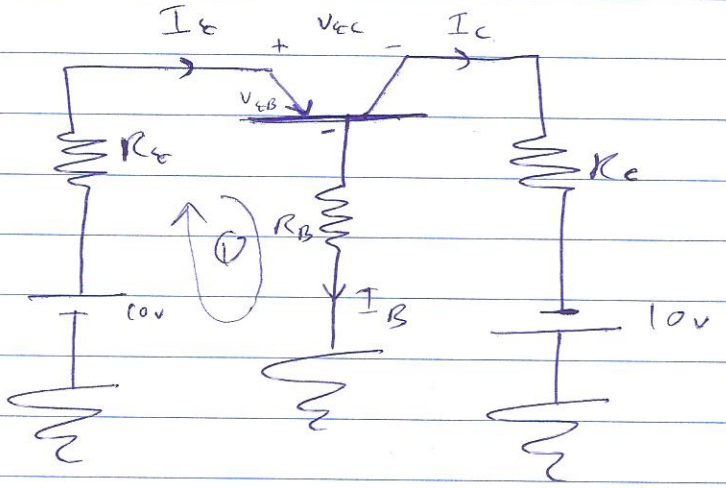
$f = ?$

0

Q3) 1) DC analysis $\Rightarrow h_{ib} = \frac{V_T}{I_{EQ}}$

- Caps open
- $AC_s = 0$

PnP



$V_{EB} \approx 0.7$

KVL @ 2 $\quad -10 + R_E I_E + V_{EB} + R_B I_B = 0$

$\Rightarrow -10 + R_E I_E + V_{EB} + \frac{R_B I_E}{\beta+1}$

$I_E = (\beta+1) I_B \Rightarrow I_B = \frac{I_E}{\beta+1}$

$I_B \beta = I_C$

$\beta = \frac{I_C}{I_B}$

$\Rightarrow -10 + 1k * I_B$

$\Rightarrow -10 + 1k * I_E + 0.7 + 10k$

$\alpha = \frac{I_C}{I_E} \Rightarrow I_C = \alpha I_E$

$\alpha I_E = (I_C + I_B) \Rightarrow I_E = I_C + I_B$

$\Rightarrow I_C = I_E - I_B \Rightarrow I_E - I_B = \alpha I_E$

$\Rightarrow -I_B = \alpha I_E - I_E \Rightarrow I_B = (I_E - I_E \alpha)$

$\Rightarrow \boxed{I_B = I_E (1-\alpha)} \Rightarrow$ KVL-Q

$\Rightarrow -10 + 1k * I_E + 0.7 + 10k(1-\alpha) I_E = 0$

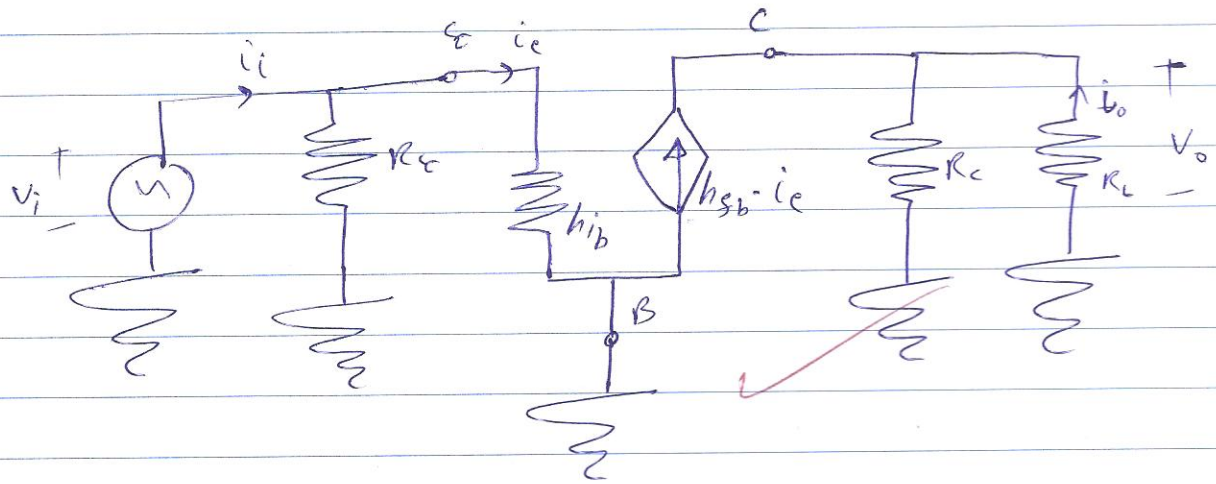
$\Rightarrow -9.3 + 1k * I_E + 10k * 0.01 * I_E = 0$

$\Rightarrow 1100\, I_E = 9.3$

$\Rightarrow I_E = \frac{9.3}{1100} = 8.45mA$

$\Rightarrow h_{ib} = \frac{26\,mV}{8.45mA} = 3.08 \simeq 3$

2) Common Base PnP :
AC analysis :



$A_V = \frac{V_o}{V_i}$

$\Rightarrow V_o = -i_o * R_L \Rightarrow \frac{V_o}{i_o} = R_L$

$\Rightarrow i_o = \frac{R_C}{R_C + R_L}(-h_{fb} \cdot i_e)$

$\Rightarrow \frac{i_o}{i_e} = \frac{-h_{fb} R_C}{R_C + R_L}$

$$i_e = \frac{v_i}{h_{ib}} \Rightarrow \frac{i_e}{v_i} = \frac{1}{h_{ib}}$$

$$\Rightarrow A_v = \frac{v_o}{i_o} * \frac{i_o}{i_e} * \frac{i_e}{v_i}$$

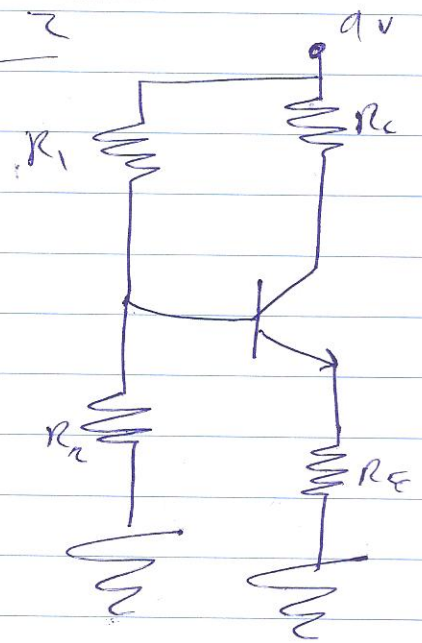
$$= R_L * \frac{\alpha R_c}{R_c + R_L} * \frac{1}{h_{ib}}$$

$$= !$$

$$-0.5$$

(Q4) a) $h_{ie} = \frac{V_T}{I_B}$ ✓

DC analysis :



13.5/20

$R_{dc} = R_c + R_E$

$= 220 + 100$

$= 320$

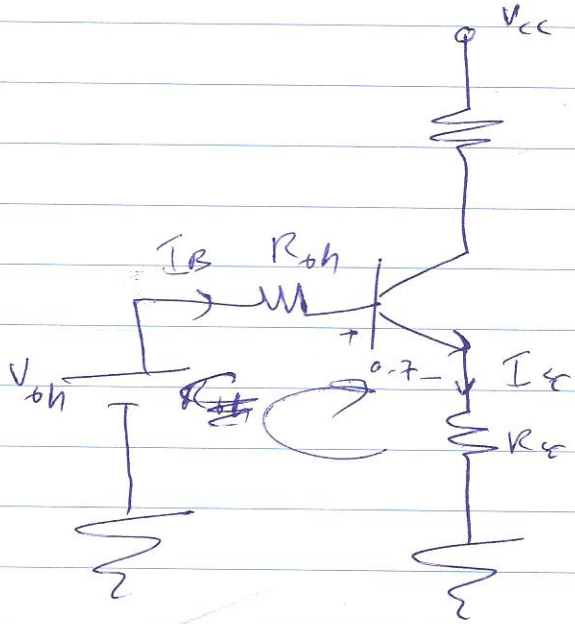
$\Rightarrow$ Find I_B

3/4

(1)

$V_{th} = \frac{R_2}{R_2 + R_1} V_{cc}$

$R_{th} = \frac{R_1 \cdot R_2}{R_1 + R_2}$



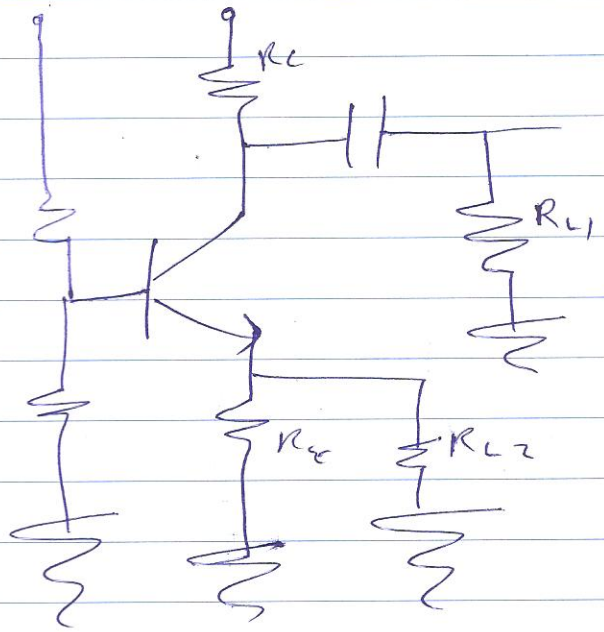
$V_{BE} = 0.7$

KVL : $-V_{th} + I_B R_{th} + V_{BE} + I_E R_E = 0$

$\Rightarrow -V_{th} + I_B R_{th} + V_{BE} + (1+\beta) I_B R_E = 0$

$\Rightarrow$ Find I_B

From AC domain :



$$\Rightarrow R_{ac} = (R_E // R_{L2}) + (R_C // R_{L1}) \quad (2/4)$$

$$\Rightarrow I_{CQ} = \frac{V_{CC}}{R_{ac} + R_{dc}} \quad (2)$$

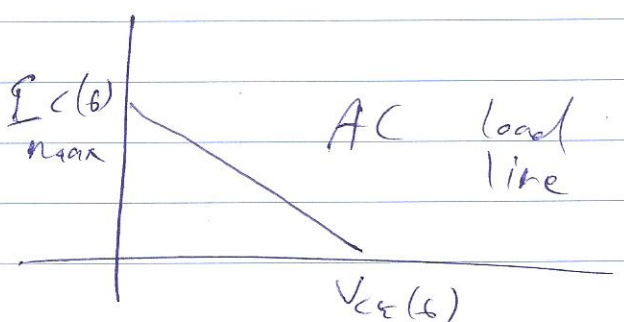
$$V_{CEQ} = \frac{V_{CC}}{1 + \frac{R_{dc}}{R_{ac}}}$$

$$\Rightarrow V_{CE}(t)_{max} = 2\, V_{CEQ}$$

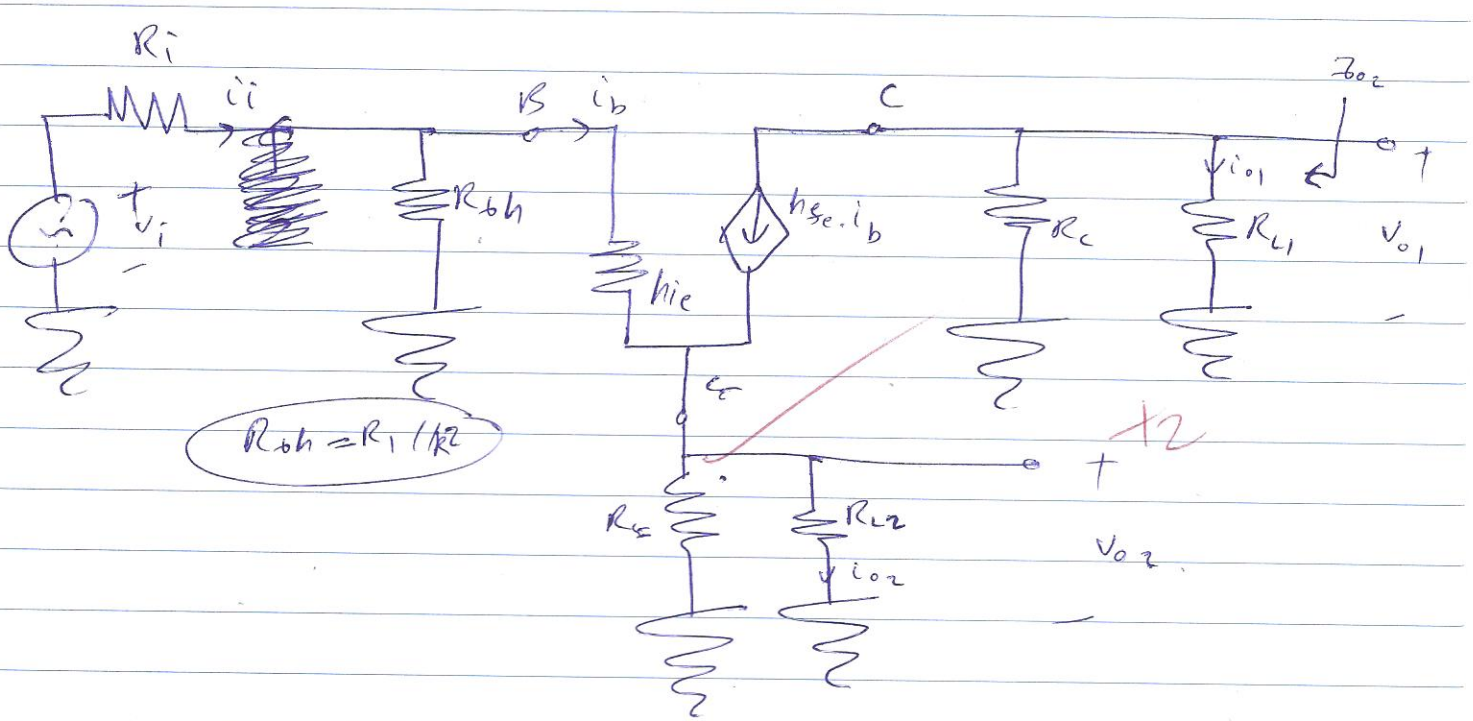
$$\Rightarrow I_C(t)_{max} = 2\, I_{CQ}$$

true for design but we must find actual values which may be different for

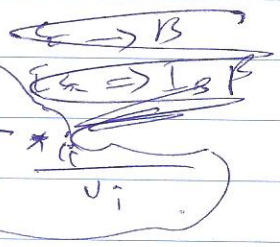
for most cases



AC analysis2



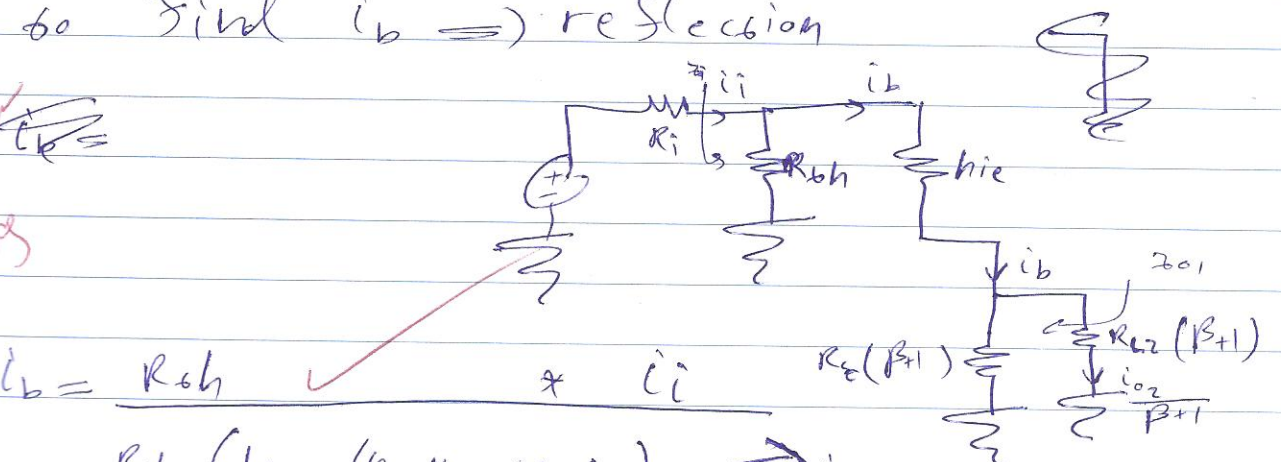
1) $A_{v_1} = \frac{V_{o1}}{V_i} = \frac{V_{o1}}{i_{o1}} * \frac{i_{o1}}{i_b} * \frac{i_b}{i_i} * \frac{i_i}{V_i}$



$V_{o1} = i_{o1} R_{L1} \Rightarrow \frac{V_{o1}}{i_{o1}} = R_{L1}$

$i_{o1} = \frac{R_c}{R_c + R_L}(-h_{fe} \cdot i_b) \Rightarrow \frac{i_{o1}}{i_b} = \frac{-h_{fe} R_c}{R_c + R_L}$ (x2.5)

to find $i_b \Rightarrow$ reflection



$i_b = \frac{R_{bh}}{R_{bh} + \left(hie + \left((R_c // R_{L2})(\beta+1)\right)\right)} * i_i \Rightarrow \frac{i_b}{i_i} =$

$$\Rightarrow \frac{i_b}{i_i} = \frac{R_{bh}}{R_{bh} + h_i}$$

$$i_i = \frac{V_i}{Z_i + R_i}$$

$$i_i = \frac{V_i}{\left(\left(h_{ie} + (R_E // R_{L2})(\beta+1)\right) // R_{bh}\right) + R_i}$$

+2

Para 6 (E)

$$\Rightarrow \frac{i_i}{V_i} = \frac{1}{\left(\left(h_{ie} + (R_E // R_{L2})(\beta+1)\right) // R_{bh}\right) + R_i}$$

why

$$5) \; A_{i2} = \frac{i_{o2}}{i_i} \Rightarrow \frac{i_{o2}}{\beta+1} = \frac{R_E(\beta+1)}{(R_E + R_{L2})(\beta+1)} \cdot i_b$$

من فيديو ( ) = 2

$$\frac{i_b}{i_i} = \frac{R_{bh}}{R_{bh} + (R_E // R_{L2})(\beta+1) + h_{ie}}$$

+2

$$i_{o2} = i_e \frac{R_E}{R_E + R_{L2}} = \frac{1}{2} i_e$$

$$i_e = (1+h_{fe}) i_b$$

i_i & i_b known from previous step

$$\Rightarrow A_{i2} = \frac{i_{o2}}{i_b} \cdot \frac{i_b}{i_i}$$

$$\frac{R_E(\beta+1)(\beta+1)}{(R_E + R_{L2})(\beta+1)} \cdot \downarrow$$

0.5 / 2.5

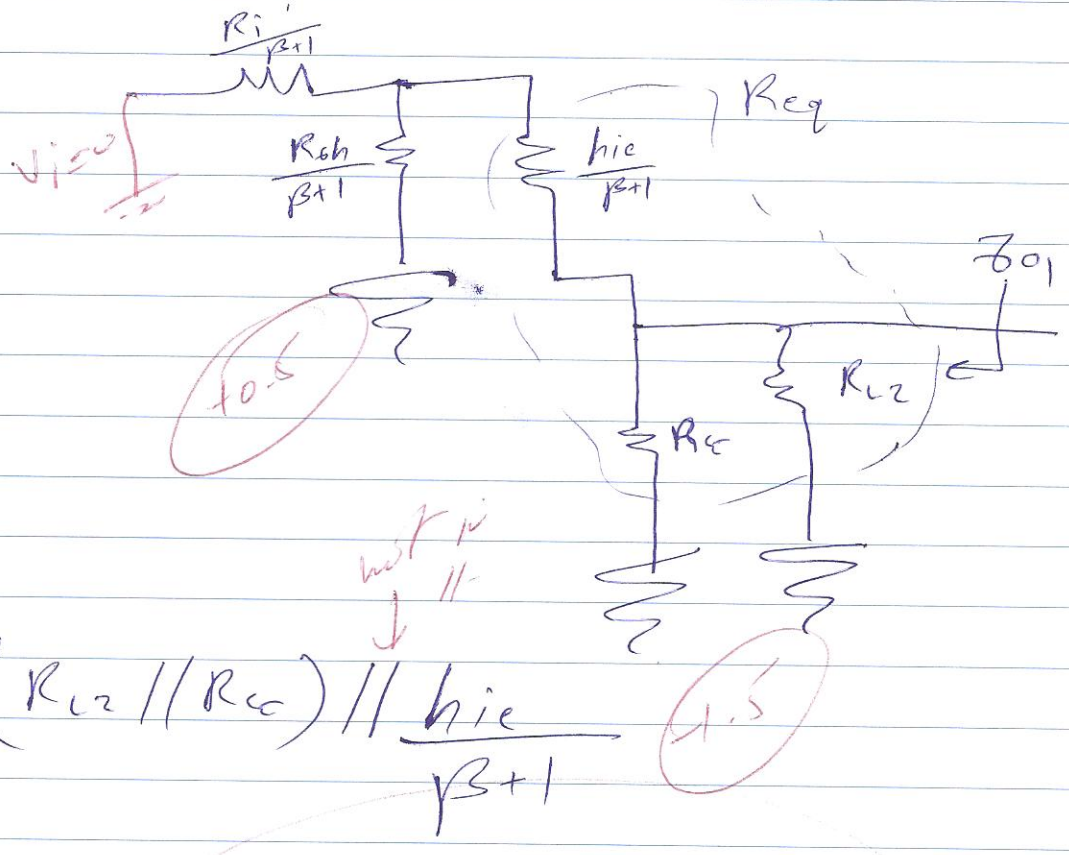
$$6) \; Z_i = h_{ie} + R$$

+2

~~5) $Z_{o1} = (R_{L2} // R_c)(\beta+$~~

5) $Z_{o1} = R_{L1} // R_c$ ✓ ×1

to find Z_{o2} ⟹ reflects from Base to emitter



R_i' // R_{th}

$$R_{eq} = (R_{L2} // R_c) // \frac{hie}{\beta+1}$$

$$\Rightarrow Z_{o2} = \left(R_{eq} // \frac{R_{th}}{\beta+1}\right) + \frac{R_i}{\beta+1}$$

$R_{L2} // R_E$

$$Z_{o2} = \left(\frac{R_i}{\beta+1} // \frac{R_{th}}{\beta+1} + \frac{hie}{\beta+1}\right) //$$