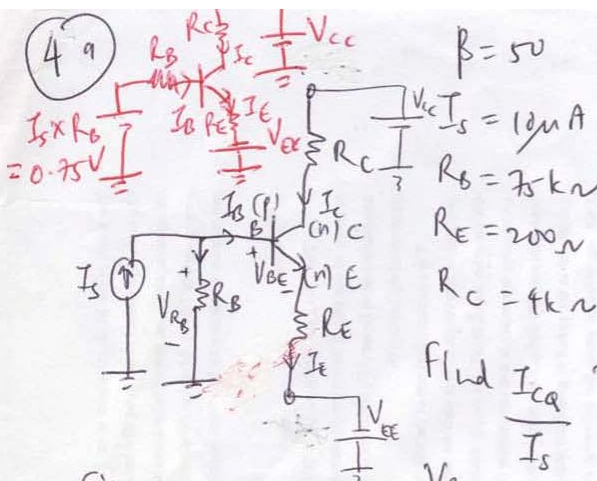


**ANSWER TO TEST 2**

**QUESTION 1**



(i)  $V_{CC} = 18, V_{EE} = 4$   
 $-0.7 + I_B(75k) + V_{BE} + I_E(200) = 0$   
 $-0.7 + \frac{I_E}{51}(75k) + 0.7 + I_E(200) - 4 = 0$   
 $-\frac{I_E}{51}(75k) + 0.7 + I_E(200) - 4 = 0$   
 $I_E = 2.4243 \text{ mA}$

$V_{RB} = (I_s - I_B)R_B$   
 $I_E = \frac{I_B}{1-\beta} = (\beta+1)I_B$

$V_{RB} = \left(I_s - \frac{I_E}{51}\right)R_B$   
 $-\left(I_s - \frac{I_E}{51}\right)R_B + 0.7 + I_E(200) - 4 = 0$

$-I_s R_B + \frac{I_E R_B}{51} + 0.7 + 200 I_E - 4 = 0$   
 $I_E \left(\frac{R_B}{51} + 200\right) = 10 \mu(75k) - 0.7 + 4$

$I_E (1670.5882) = 4.05$   
 $I_E = 2.4243 \text{ mA}$   
 $I_B = \frac{I_C}{\beta} = \frac{2.3768 \text{ mA}}{50} = 47.54 \mu\text{A}$

$I_C = \beta I_B = 50(47.54 \mu\text{A}) = 2.3768 \text{ mA}$   
 $\frac{I_C}{I_s} = \frac{2.3768 \text{ mA}}{10 \mu\text{A}} = 237.68$

$V_E = V_B - V_{BE} = -0.7 = -3.5155 \text{ V}$   
 $V_C = V_{CC} - I_C R_C = 18 - (2.3768 \text{ mA})(4k) = 8.4928 \text{ V}$   
 $V_B = I_B R_B = (10 \mu - 47.54 \mu) 75k = -2.8155 \text{ V}$

(ii)  $V_{CC} = 22 \text{ V}, V_{EE} = 0 \text{ V}$

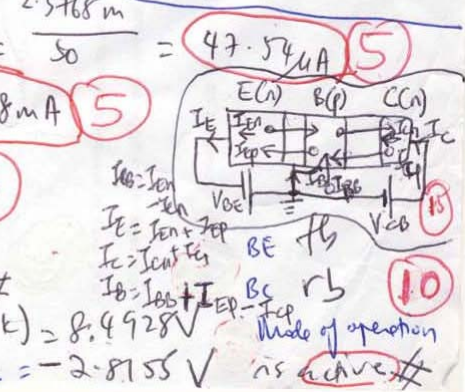
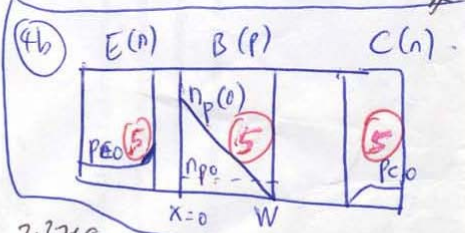
$I_E \left(\frac{75k}{51} + 200\right) = 10 \mu(75k) - 0.7$   
 $I_E (1670.5882) = 0.05$

$I_E = 2.993 \times 10^{-5} \text{ A}$   
 $I_C = \frac{50}{51} (2.993 \times 10^{-5}) = 2.9343 \times 10^{-5} \text{ A}$

$\frac{I_C}{I_s} = \frac{2.9343 \times 10^{-5}}{10 \mu} = 2.9343$   
 $I_B = I_E - I_C = 5.87 \times 10^{-7} \text{ A}$

$V_B = V_{RB} = I_B R_B = (10 \mu - 5.87 \mu) 75k = 0.706 \text{ V}$   
 $V_C = V_{CC} - I_C R_C = 22 - (2.9343 \times 10^{-5}) \times 4k = 21.88 \text{ V}$   
 $V_E = V_B - V_{BE} = 0.706 - 0.7 = 0.006 \text{ V}$

BE fb  
 BC rb  
 Mode of operation is active

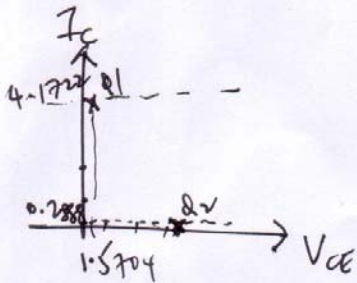
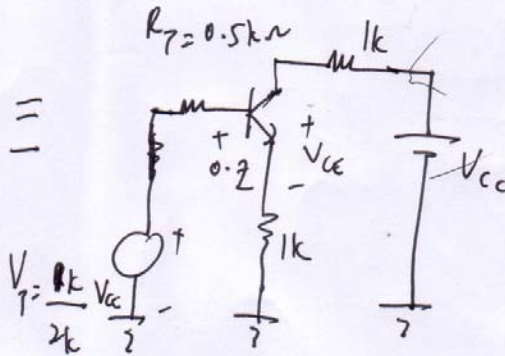
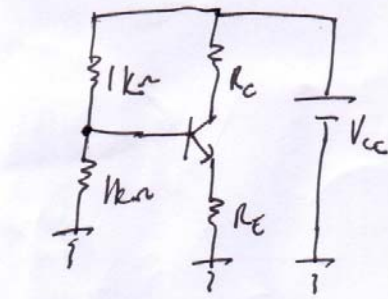


QUESTION 2

③  $\alpha = 0.98$   $I_{B0} = 0$   $V_{BE} = 0.7V$

$I_B?$   $I_C?$   $V_{CE}?$

$R_1 = R_2 = R_C = R_E = 1k\Omega$



$= 0.5V_{cc}$

$-V_T + I_B(500) + 0.7 + I_E(1000) = 0$

$-0.5V_{cc} + 500I_B + 0.7 + (1000)50(I_B)_{20}$

$-0.5V_{cc} + 50,500I_B + 0.7 = 0$

$I_B = \frac{0.5V_{cc} - 0.7}{50,500}$

$= 8.5148 \times 10^{-5}$

$I_C = \beta I_B$

$I_E = 2I_B$

$\beta I_B = 2I_E$

$I_E = \frac{\beta I_B}{2}$

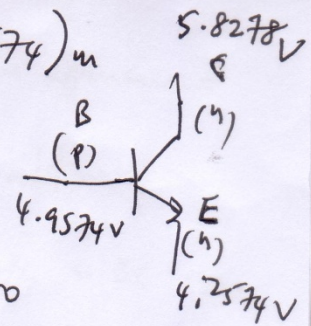
$= \frac{\beta I_B}{2}$

$(1-\alpha)I_C$

$= \frac{I_C}{1-\alpha} = 50I_B$

$I_C = \beta I_B = \frac{\beta}{1-\alpha} I_B = 4.1722mA$   
 $I_E = 50(8.5148 \times 10^{-5}) = 4.2574mA$   
 $V_{CE} = V_{cc} - I_C(1k) - I_E(1k)$

$$V_{CE} = 10 - 1k(4.1722 + 8.2574)m = 1.5704 V \#$$



If  $R_1$  is  $9k \sim$

$$V_T = \frac{1k(10)}{10k} = 1V$$

$$R_T = 900$$

$$-1 + I_B(900) + 0.7 + (1000)50I_B = 0$$

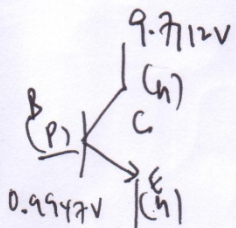
$$-1 + I_B(900 + 50000) + 0.7 = 0$$

$$I_B = \frac{1 - 0.7}{50900} = 5.8939 \mu A \#$$

$$I_C = 49(5.8939 \mu) = 0.2888 mA \#$$

$$I_E = 50(5.8939 \mu) = 0.2947 mA \#$$

BC is rb



$$V_{CE} = 10 - I_C(1k) = 10 - (0.2888 + 0.2947)m = 9.4165V \#$$

$$V_C = V_{CE} + I_E R_E = 9.4165 + I_E(1k) = 9.7112V$$

$$V_B = V_{BE} + I_E(1k) = 0.9947V$$

BE is

$$V_E = I_E(1k) = 0.2947V$$

$\therefore$  Transistor is still in the active mode. Although  $R_1$  has been changed, transistor is still in active.

## Comment

When all ~~resistors~~ resistors are  $1k\Omega$ , the quiescent point is close to the saturation region although it is still in the active region as  $BE$  is  $+BC$  is  $rb$ .

When  $R_1$  is  $9k\Omega$ , the Q-point is close to the cut-off region although the mode of operation is still active.