Q 2) b

d) $R_E = 0.5e3 \times 0.5R_b$ = $R_{E\,max} = 0.525K$, $R_{c\,max} = 5.25K$

$I_B = 1.332 \times 10^{-5}A$

$I_C = 1.332 \times 10^{-3}$, $I_E = 1.345 \times 10^{-3}$

$V_{CEQ} = 10 - 1.332e{-}3 \times 5.25e3 - 1.345e{-}3 \times 0.525e3$

$V_{CEQ} = 2.3V$

$R_{E\,max} = 0.525K$, $R_{c\,min} 4.25K$:-

$I_{CQ} = 1.332mA$, $I_{EQ} = 1.345mA$, $V_{CEQ} = 2.97V$

linear algebra
trigonometry
combinatorics
numirical analysis
calculus

$R_{E\,min}\ B = 0.475K$, $R_{E\,max} = 5.25K$

$I_{BQ} = 1.467 \times 10^{-5}$

$I_{CQ} = 1.467mA$ $I_{EQ} = 1.482mA$, $V_{CEQ} = 1.59V$

$R_{E\,min} = 0.475K$, $R_{c\,min} = 4.25K$

$I_{CQ} = 1.467mA$, $I_{EQ} = 1.482mA$

$V_{CEQ} = 2.33V$

Q4.) a)

$I_B R_B - 1 = 0$

$I_B R_B = 1$

$I_B = \frac{1}{500K} = 2 \times 10^{-6} A$

$I_B R_B + V_{BE(on)} + R_E I_E - 3 = 0$

$1 + I_E R_E = 2.3$

$I_E R_E = 1.3$

$I_E = \frac{1.3}{4.8K} = 2.7e-4 A$

$I_E = I_B(1+\beta)$

$\beta = \frac{I_E}{I_B} - 1 = 134$

$\alpha = \frac{\beta}{\beta+1} = 0.9926$

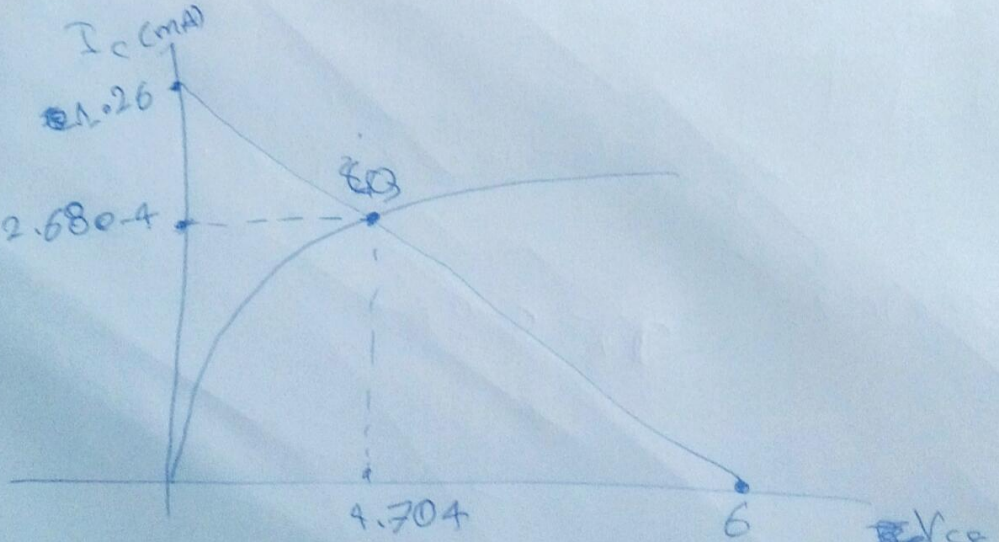
$I_C = \beta I_B = 2.68e-4 A$

$6 = V_{CE} + I_E R_E$

$V_{CE} = 6 - 1.3 = 4.704$

$6 = V_{CE} - I_E R_E \Rightarrow 6 = V_{CE} - \alpha I_e R_E$

$I_C = \frac{6 - V_{CE}}{\alpha R_E}$



Q4) b) $5-4 = I_E R_E \Rightarrow I_E = \frac{1}{R_E} = 5e-4\,A$

$-5 + I_E R_E + V_{EB(on)} + I_B R_B + I_C R_C - 5 = 0$

$I_B R_B + I_C R_C = 4.3$

$$\begin{cases} I_B R_B + I_C R_C = 4.3 \rightarrow (1) \\ I_C + I_B = .5 \times 10^{-4} \rightarrow (2) \end{cases}$$

Solve 1, 2 : get:

$I_B = 3.261 \times 10^{-5}\,A$

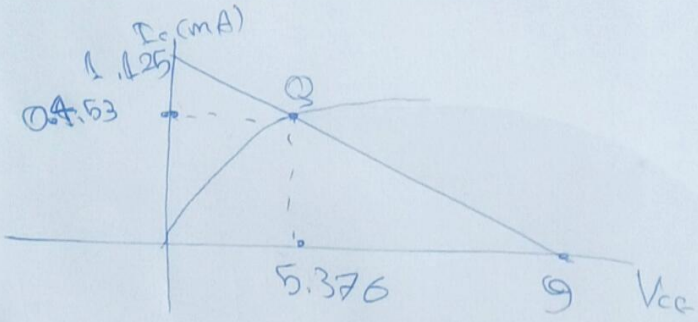
$I_C = 4.97 \times 10^{-4}\,A$

$\beta = \frac{I_C}{I_B} = 152$ | $\alpha = 0.9935$

$I_B = 4e-5\,A$
$I_C = 4.53e-4$
$\beta = 11$, $\alpha = 0.9167$

$10 = I_E R_E + V_{CE} + R_C I_C \approx$

$I_C R_C + V_{CE} = 9$



Q2)

$$V_{TH} = \left(\frac{R_2}{R_1 + R_2} \right) \times 10 - 5 = -3.571\,V$$

a)

$$R_{TH} = \frac{2e3}{12e3 + 2e3} = 1.714\,K\Omega$$

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b)

$$V_{TH} = I_B R_{TH} + V_{BE(on)} + (1+\beta) I_B R_E - 5$$

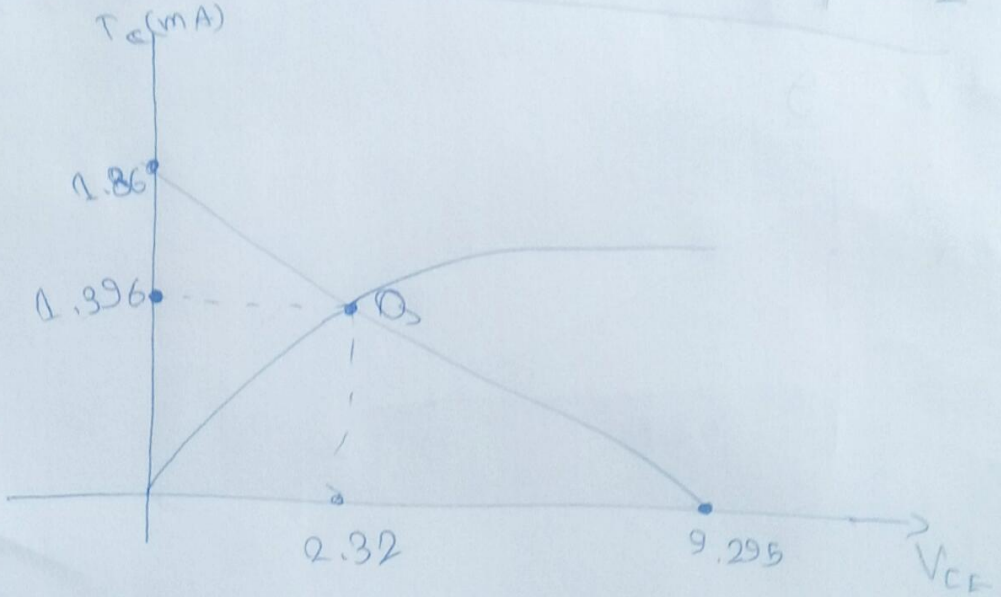
$$\Rightarrow I_B = \frac{V_{TH} - V_{BE} + 5}{R_{TH} + (1+\beta) R_E} = 1.396e-5$$

$$I_{CQ} = \beta I_B = 1.396 \times 10^{-3}\,A$$

$$V_{CEQ} = 10 - (1.396) \times 5 - 1.91 \times 0.5 = 2.32$$

---

c)



Q 3) $V_S = 5V$, $V_G = 0$ thus: $V_{SG} = 5V$

$V_{TP} = -0.5V$ thus: $V_{SD(sat)} = V_{SG} + V_{TP} = 5 - 0.5 = 4.5V$

~~$V_D = 0$ thus $V_{SD} = 5V$~~

a) $V_D = 0$ thus $V_{SD} = 5V$

$I_D = 2 \times (5 - 0.5)^2 \Rightarrow I_D = 4.05 \times 10^{-2} A$

b) $V_D = 2V$ thus $V_{SD} = 3V$

$I_D = 2 \times (2 \times (5 - 0.5) \times 3 - 3^2) \Rightarrow I_D = 3.6 \times 10^{-2} A$

c) $V_D = 4V$ thus $V_{SD} = 1V$

$I_D = 2 \times (2 \times (5 - 0.5) \times 1 - 1^2) \Rightarrow I_D = 1.6 \times 10^{-2} A$

d) $V_D = 5V$ thus $V_{SD} = 0$

thus $I_D = 0$

Q 4)

$$V_G = \frac{6}{(6+14)} \times 10 - 5 = -2V$$

$$V_G = V_{GS} + I_D R_S - 5$$

$$V_G = V_{GS} + \frac{k_n'}{2} \times \frac{W}{L} \times R_S \times (V_{GS} - V_{TN})^2 - 5$$

$$5 - 2 = V_{GS} + \frac{0.12}{5} \times 25 \times 0.5 \, (V_{GS}^2 - 0.8 V_{GS} + 0.16)$$

$$V_{GS} = 1.71$$

$$I_D = \frac{0.12}{5} \times 25 \times (1.21 - 0.4)^2 = 2.58 \times 10^{-3} A$$

$$V_{DS} = 10 - 2.58 \times (1.2 + 0.5) = 5.62 V$$