Memorandum

FSK 224 - T2 (2011)

Q1.1

$$R_L = \frac{V_{cc} - V_D}{I_D} = \frac{12 - 3.7\,(V)}{20mA} = 0.415K$$

(C)

Q1.2 180° out of phase due to inverting action

(D)

Q1.3

$$F = \bar{A}\bar{B}\bar{C} + \bar{A}\bar{B}C$$

$$= \bar{A}\bar{B}(\bar{C} + C)$$

$$= \bar{A}\bar{B} \cdot 1$$

$$= \bar{A}\bar{B}$$

(C)

Q1.4 Clearly an OR-gate

(A)

Question 2

KVL(1)

$$-V_{CC} + I_B R_B + V_{BE} + I_E R_E = 0$$

$$\Rightarrow -12 + 33 I_B + 0.7 + (\beta + 1) I_B R_E = 0$$

$$\Rightarrow I_B \left[33 + 41(0.1)\right] = 12 - 0.7$$

$$\therefore I_B = \frac{11.3}{33 + 4.1}\left(\frac{V}{K\Omega}\right) = 0.305mA \quad (305\mu A).$$

$$I_C = \beta I_B = 40(0.305)mA = 12.18mA$$

(c) $V_{CE} = ?$

KVL (2)

$$-V_{cc} + I_c R_c + V_{CE} + I_E R_E = 0$$

$$\therefore -V_{cc} + \beta I_B R_c + V_{CE} + (\beta+1) R_E I_B = 0$$

$$\Rightarrow -12 + 40(0.305)1 + V_{CE} + 41(0.305)(0.1) = 0$$

$$\therefore V_{CE} = 12 - 13.45V$$

$$= -1.45V \Rightarrow V_{CE} = 0$$ since negative values won't be possible.

(d) Load-line equation

Using KVL (2),

when $I_c = 0 \quad (I_E = 0)$

$$\Rightarrow V_{CE} = V_{cc} = 12V$$

$$\Rightarrow (12V, 0mA)$$

when $V_{CE} = 0$

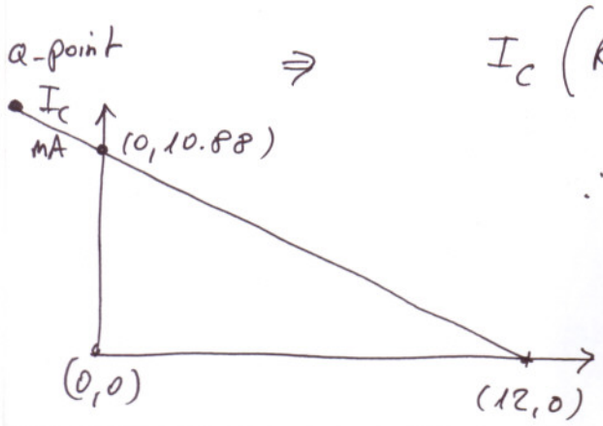
$$-V_{cc} + I_c R_c + \frac{I_c}{\alpha} R_E = 0$$

where $\alpha = \frac{\beta}{\beta+1} \therefore \frac{1}{\alpha} = \frac{\beta+1}{\beta}$

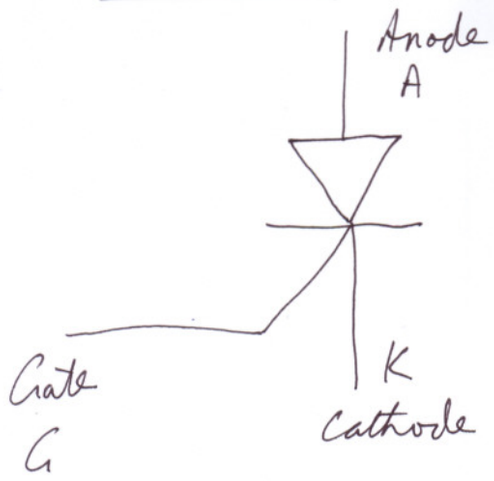
$$\Rightarrow I_c \left(R_c + \frac{\beta+1}{\beta} R_E \right) = V_{cc}$$

$$\therefore I_c \text{ (max.)} = \frac{V_{cc}}{R_c + \frac{\beta+1}{\beta} R_E} = \frac{12}{1 + \frac{41}{40}(0.}$$

$$= \underline{10.88mA} \Rightarrow \underline{(0, 10.88mA)}$$



Q2.2 Thyristor (SCR)



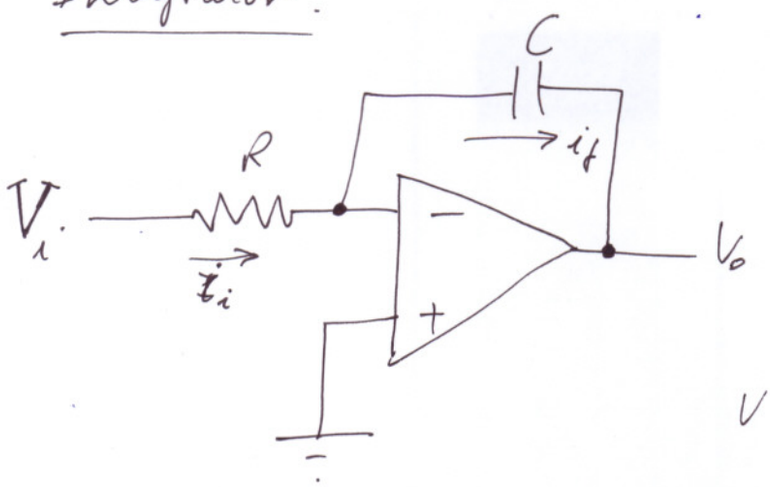
Operation:

The SCR behaves like a gated diode. When the gate voltage (V_G) is less than the threshold $V_T \approx 0.7V$ the diode does not conduct (i.e. A to K). When $V_G \geq V_T$ the diode conducts heavily and stays conducting even when V_G falls below V_T. The SCR resets ONLY when the forward bias to the A-K device is then removed.

Question 3

Q3.1.

Integrator:



$V^- = V^+ = 0$

(Virtual earth)

KCL implies that

$$i_i = i_f$$

$$\Rightarrow \frac{V_i - V^-}{R} = i_f \quad \text{— (1)}$$

$$i_f = \frac{dq}{dt} \Rightarrow \frac{V_i}{R} = i_f \quad \text{— (1)}$$

$$= C\frac{d}{dt}(V^- - V_o)$$

$$= -C\frac{dV_o}{dt} \quad \text{— (2)}$$

Equating (1) with (2)

$$\Rightarrow \frac{V_i}{R} = -C\frac{dV_o}{dt}$$

$$\therefore V_o = -\frac{1}{RC}\int_0^t V_i(t)\,dt$$

Q3.2

$V_{in} = 6V$

$R = 100K$

$C = 2200\mu F$

$\Rightarrow RC = 10^5 \Omega \times 2.2 \times 10^3 \times 10^{-6} F$

$= 2.2 \times 10^2$ seconds $= 0.22 \times 10^3 s$

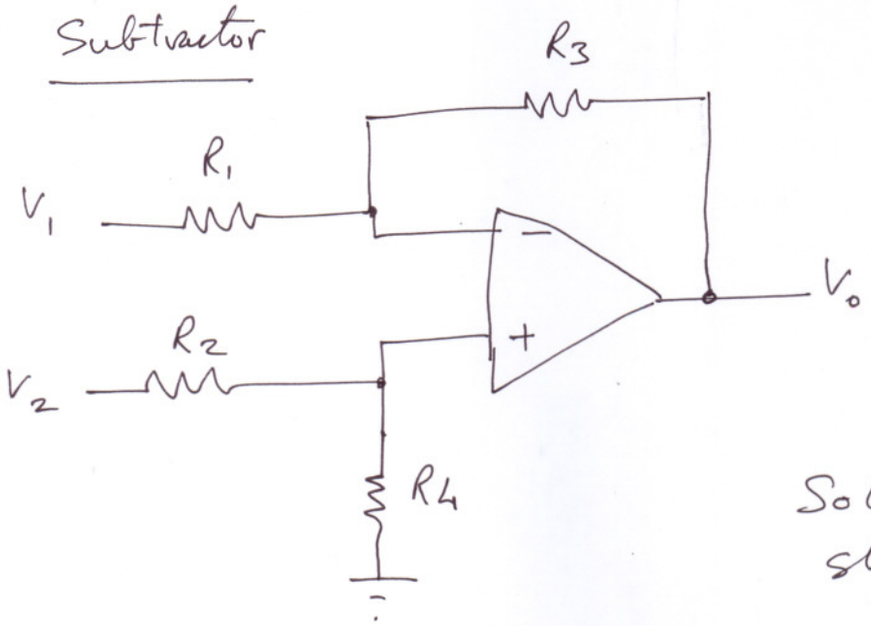
$$\therefore V_o = -\frac{10^{-3}}{0.22}\int_0^{100} 6\,dt = -4.545 \times 10^{-3} \times 6\, t\Big|_0^{100}$$

$$= -4.545 \times 10^{-3} \times 6 * (100 - 0)$$

$$= -2.73V$$

Q3.3

Subtractor

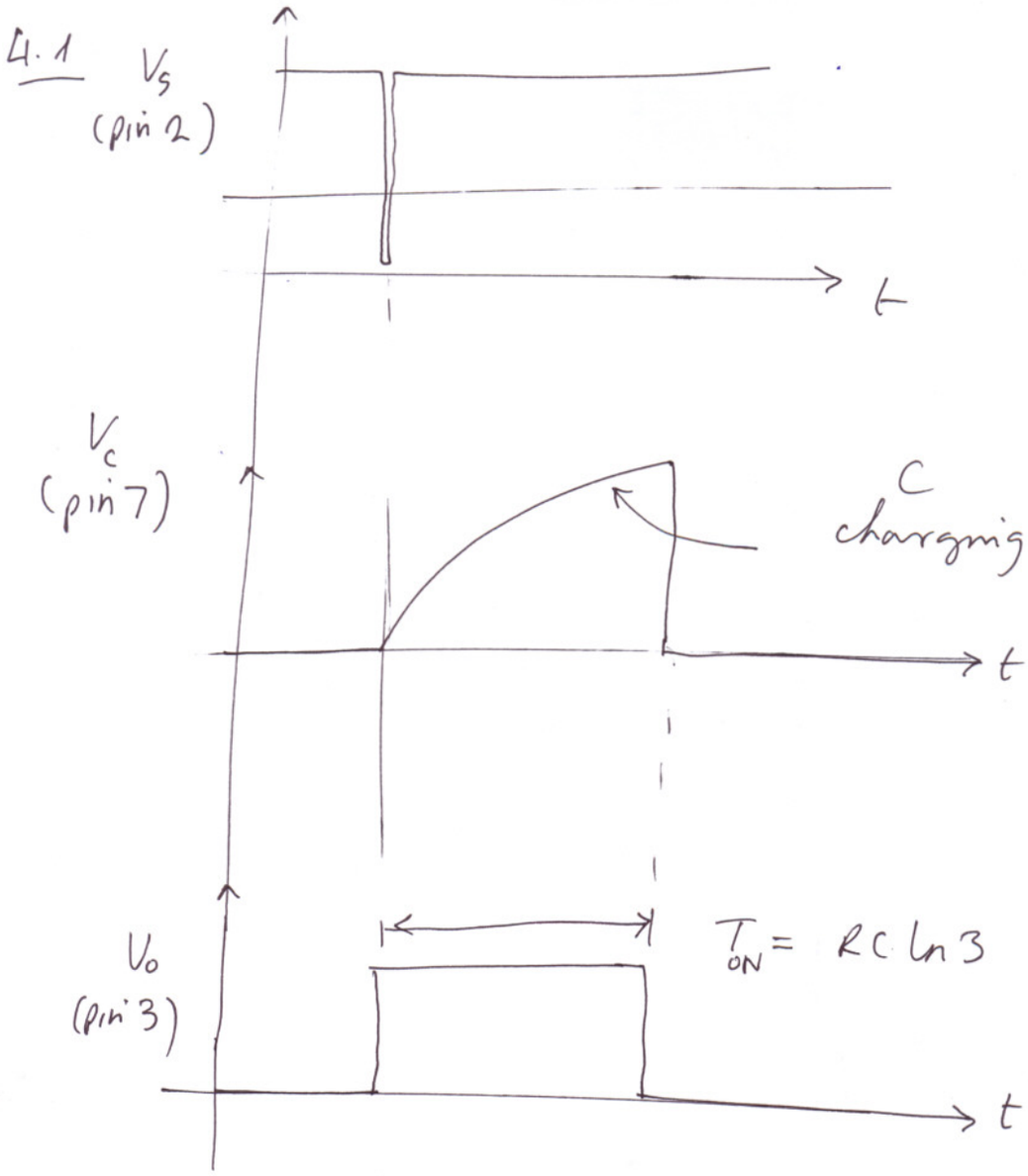


Solve and show that

$V_o =$

Question 4

4.1



Use

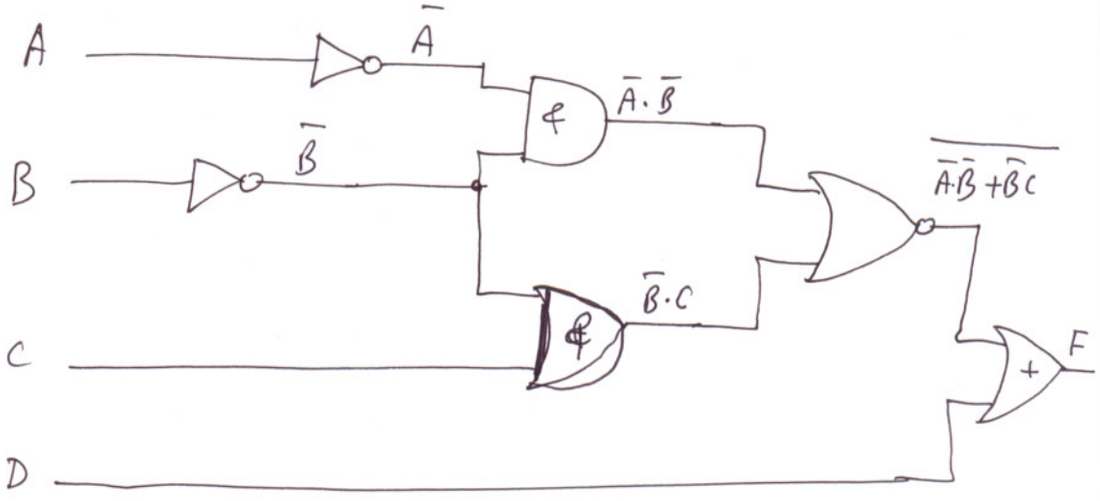
$V_c(t) = E(1 - e^{-\frac{t}{RC}})$

to show that

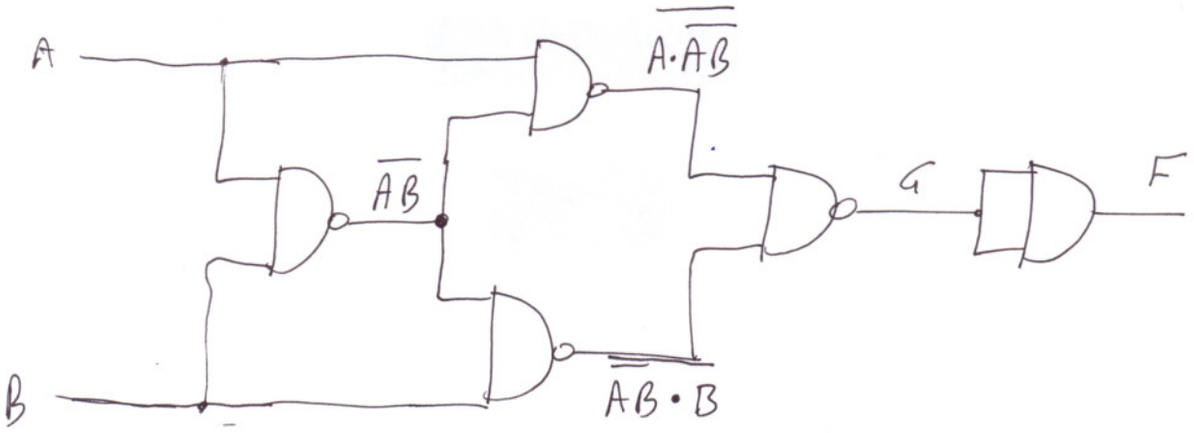
$T_{ON} = RC\ln 3$

Question 5

(5.1)



(5.2)



$$F = G.G = G$$

$$F = G = \overline{\overline{(A\cdot\overline{AB})}\cdot\overline{(\overline{AB}\cdot B)}}$$

Simplification

$$\overline{AB} = \overline{A} + \overline{B}$$

$$\therefore A\cdot\overline{AB} = A\cdot(\overline{A}+\overline{B})$$

$$= A\cdot\overline{A} + A\cdot\overline{B}$$

$$= A\cdot\overline{B} = \overline{\overline{A}+\overline{\overline{B}}} = \overline{\overline{A}+B}$$

and $\overline{AB}\cdot B = (\overline{A}+\overline{B})\cdot B$

$$= \overline{A}\cdot B + \overline{B}\cdot B$$

$$= \overline{A}\cdot B$$

$$= \overline{\overline{\overline{A}+\overline{B}}}$$

$$= \overline{A+\overline{B}}$$

$$\therefore \overline{A\cdot\overline{AB}} = \overline{\overline{\overline{A}+B}} = \overline{A}+B = Q$$

$$\therefore \overline{\overline{AB}\cdot B} = \overline{\overline{A+\overline{B}}} = A+\overline{B} = P$$

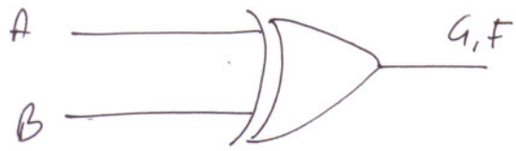
Then $F = \overline{Q\cdot P} = \overline{Q} + \overline{P} = \overline{\overline{A}+B} + \overline{A+\overline{B}}$

$$= \overline{A}+B+A+\overline{B} \qquad = \overline{\overline{A}+B} + \overline{A+\overline{B}}$$

$$\therefore F = \overline{\bar{A} + B} + \overline{A + \bar{B}}$$

$$= (A \cdot \bar{B}) + (\bar{A} \cdot B)$$

$$= A \oplus B$$



Truth-table

$A \cdot \bar{B}$	$\bar{A} \cdot B$	A	B	$\bar{A}$	$\bar{B}$	$A \oplus B$	$A\bar{B} + \bar{A}B$
0	0	0	0	1	1	0	0
0	1	0	1	1	0	1	1
1	0	1	0	0	1	1	1
0	1	1	1	0	0	0	0