DLD Solutions

1) a) o/p of 1^{st} XOR $= \overline{X}$

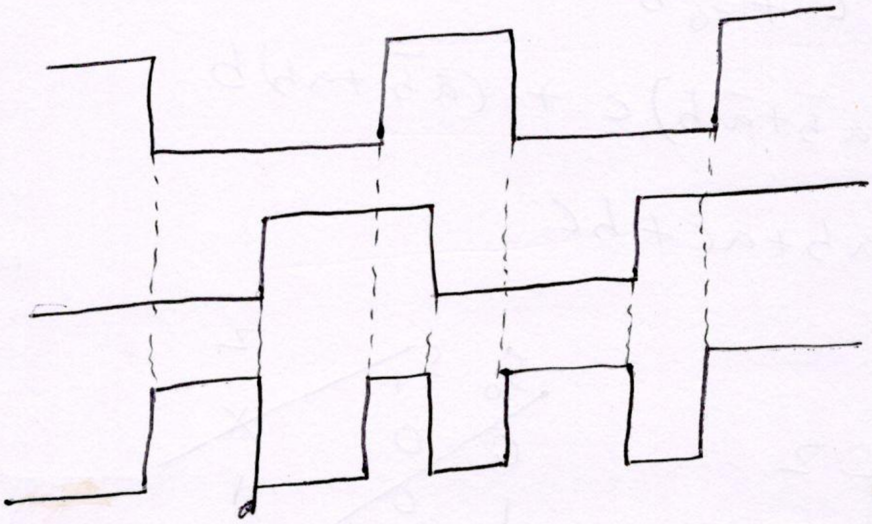
o/p of 2^{nd} XOR $= X \oplus \overline{X} = 1$

o/p of 3^{rd} XOR $= \overline{X}$

Similarly o/p of 20^{th} XOR $= 1$

b) $X = 1$ when $A = B$

$= 0$ when $A \neq B$



2) a)

$$\begin{array}{r} 11001 \\ -\ 10110 \end{array} \rightarrow \text{take 1's complement} \rightarrow \begin{array}{r} 11001 \\ 01001 \end{array}$$

Add

$$\begin{array}{r} 11001 \\ 01001 \\ \hline 00010 \end{array} \quad C = 1$$

00010 → positive number.

Add carry to LSB ⇒ $\boxed{00011}$

b)

$$\begin{array}{r} 11011 \\ -\ 11001 \\ \hline \end{array} \rightarrow \text{take 2's complement} \quad \begin{array}{r} 00110 \\ 1 \\ \hline 00111 \end{array}$$

$$\begin{array}{r} 11011 \\ 00111 \\ \hline 00010 \end{array} \quad C = 1 \text{ (discard)} \quad \boxed{00010}$$

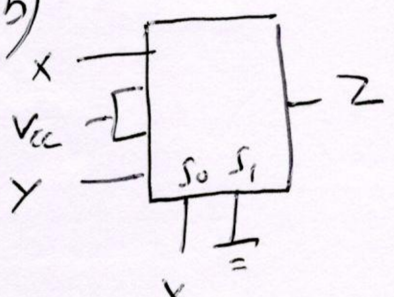
3) a) o/p of first MUX

$$\bar a \bar b + ab = \cancel{\ } a \odot b$$
$$= \overline{a \oplus b}$$

$$Z_1 = \bar c \bar S_0 + c S_0$$
$$= \bar c\,(a \oplus b) + c\,(\overline{a \oplus b}) = a \oplus b \oplus c$$

$$Z_2 = \bar S_0 c + S_0 b$$
$$= (a\bar b + \bar a b)c + (\bar a \bar b + ab)b$$
$$= ab + ac + bc.$$

b)



S_0	S_1	Z
0	0	X
1	0	1

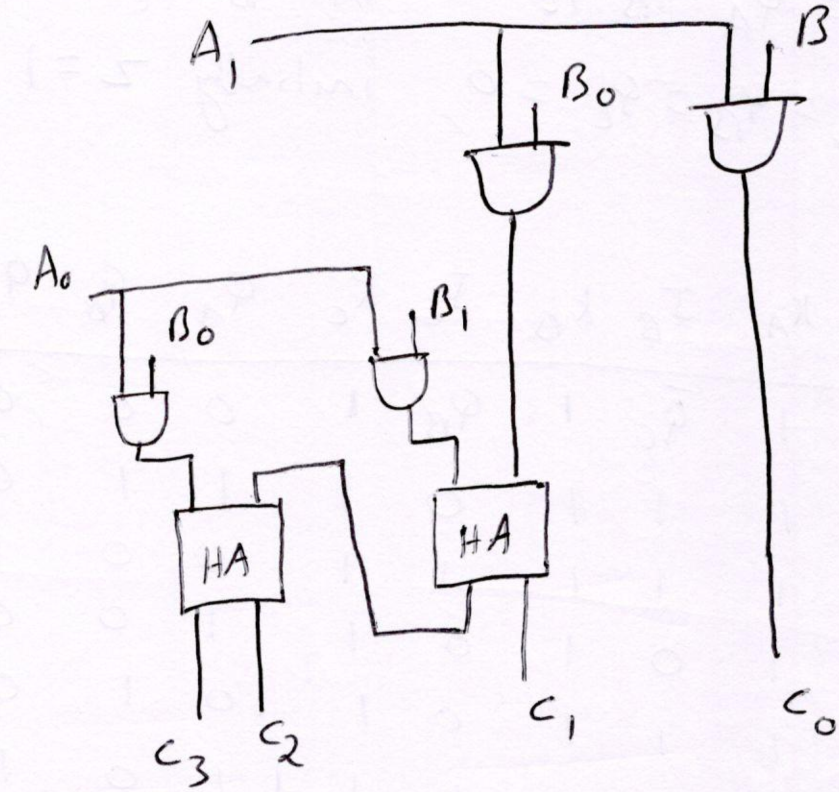
$$Z = \bar S_1 \bar S_0 X + \bar S_1 S_0 + S_1 \bar S_0 + S_1 S_0 Y$$

Subs $S_1 = 0$ in the above expression

$$Z = \bar S_1 \bar S_0 X + \bar S_1 S_0$$
$$= \bar Y X + Y$$

$$\boxed{Z = X + Y}$$

4)



		A_0	A_1
		B_0	B_1
		A_0B_1	A_1B_1
	A_0B_0	A_1B_0	
C_3	C_2	C_1	C_0

5) Expression for Z

$$Z = \bar{X}\bar{Y} I_0 + X\bar{Y} I_1 + \bar{X} Y I_2 + X Y I_3$$

$$Q_{n+1} \text{ or } Z = \bar{X}\bar{Y} Q_n + X\bar{Y} + X Y \bar{Q}_n$$

(present state) Q_n	X	Y	Q_{n+1} (next state)
0	0	0	0
0	0	1	0
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	0
1	1	0	1
1	1	1	0

6) $Z = \bar{Q}_A \cdot \bar{Q}_B \cdot \bar{Q}_C = \overline{Q_A + Q_B + Q_C}$

$Q_A = Q_B = Q_C = 0$, initially $Z = 1$

Initial (Clk)	J_A	K_A	J_B	K_B	J_C	K_C	Q_A	Q_B	Q_C	Z
-	1	1	$\bar{Q}_C$	1	Q_B	1	0	0	0	1
1	1	1	1	1	0	1	1	1	0	0
2	1	1	1	1	1	1	0	0	1	0
3	1	1	0	1	0	1	1	0	0	0
4	1	1	1	1	0	1	0	1	0	0
5	1	1	1	1	1	1	1	0	1	0
6	1	1	0	1	0	1	0	0	0	1

$Z = 1$ after 6 clock cycles $\boxed{N = 6}$

7) a) $S = \cancel{x\odot}\ \overline{x \odot q_n}$ $\quad R = x \odot q_n$

$= \overline{\bar{x}\bar{q}_n + xy}\ \cancel{= (\bar{x}\bar{q}_n)'(xy)' = (x + q_n)(\bar{x} + \bar{y})}$

$= \cancel{\bar{q}\, q_r}$

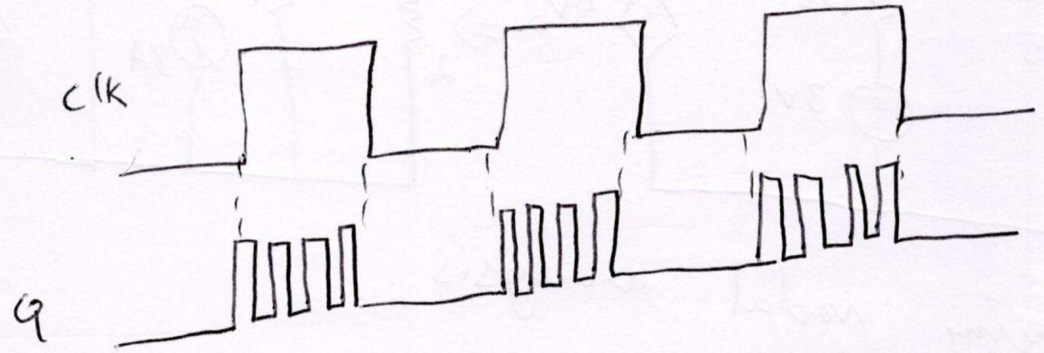
$S = \overline{\bar{x}\bar{q}_n + x q_n} = (\bar{x}\bar{q}_n)'(\overline{x q_n}) = (x + q_n)(x' + q_n')$

$S = x\bar{q}_n + \bar{x} q_n = x \oplus q_n$

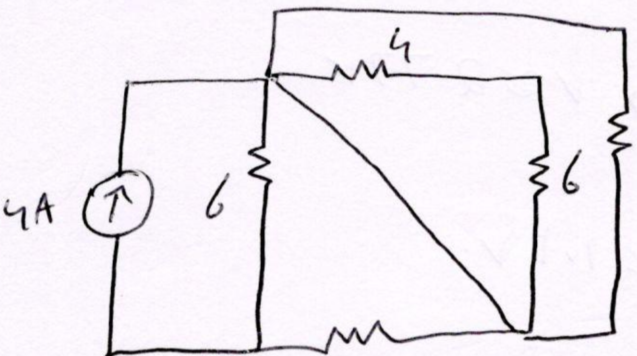
(3)

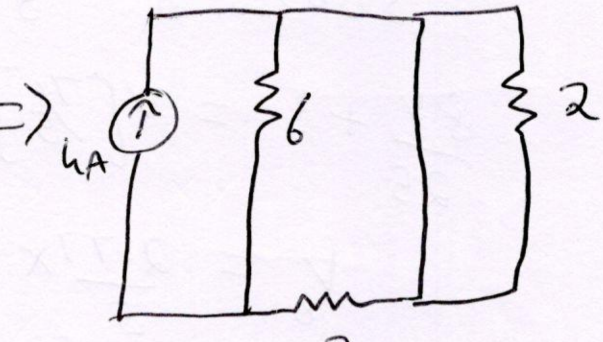
x	Q_n	S	R	Q_{n+1} (next state)
0	0	0	1	0
0	1	1	0	1
1	0	1	0	1
1	1	0	1	0

b)



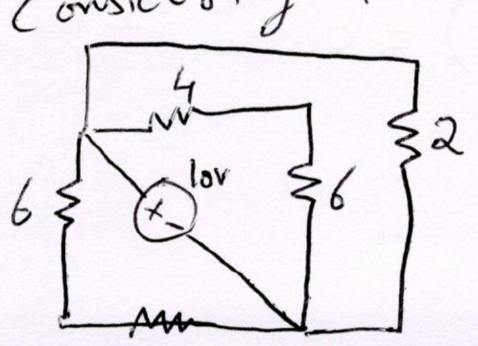
8) Considering only 4A source

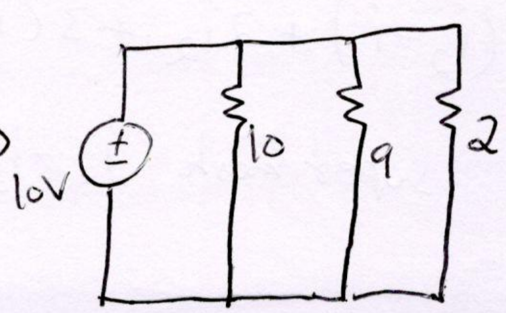


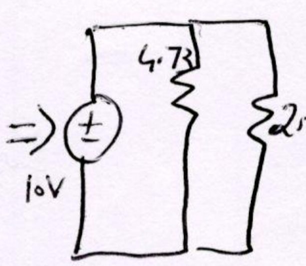


I across 2Ω resistor is 0A.

Considering 10V source





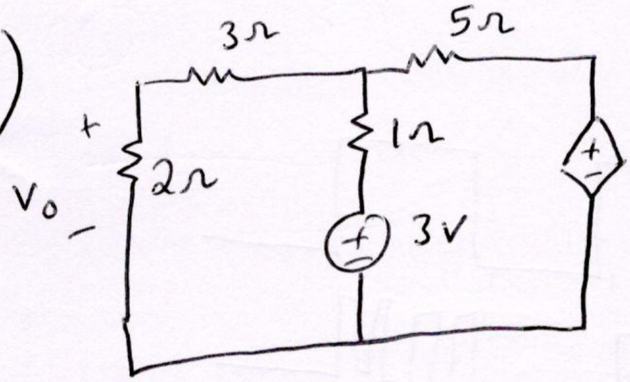


Current across 2Ω resistor is approx 5A.

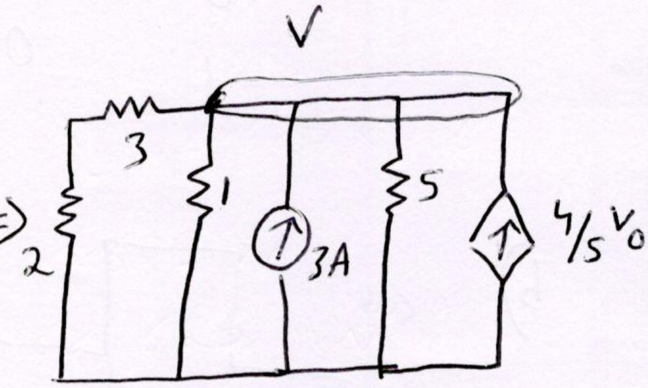
Total current $= 0 + 5 \approx 5A$

$V_{2\Omega} = 5 \times 2 = 10V$.

9)



$\Rightarrow$



Applying nodal analysis

$$\frac{4}{5}V_0 + 3 = \frac{V}{5} + \frac{V}{1} + \frac{V}{5}$$

Subs $V_0 = \frac{V}{5} \times 2$

$$\frac{8V}{25} + 3 = V\left[\frac{7}{5}\right] \Rightarrow V \approx 2.77V.$$

$$V_0 = \frac{2.77 \times 2}{5} \approx 1.1V.$$

10) a) $-7 + (i_1 - i_3) + 3(i_3 - i_2) + i_3 = 0$

$(i_2 - i_1) + 2i_2 + 3(i_2 - i_3) = 0$

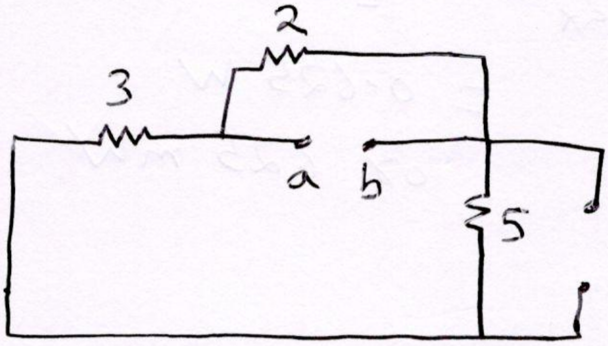
for super mesh $i_1 - i_3 = 7$

b) $\frac{V_1-V_2}{3}+\frac{V_1-V_3}{4}=8+3$

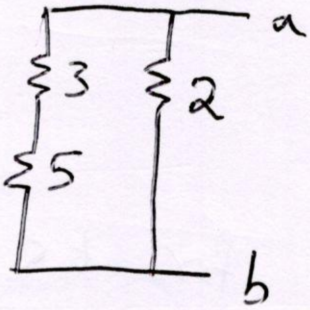
$\cancel{\frac{V_3}{5}+\frac{V_3}{4}}+\frac{V_2}{1}+\frac{V_2-V_1}{3}+\frac{V_3-V_1}{4}+\frac{V_3}{5}=-28$

for super node $V_2-V_3=22$

ii)

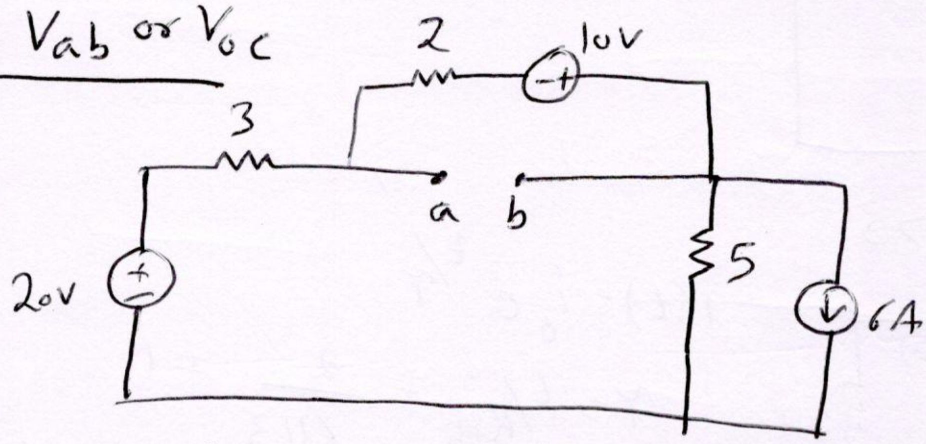


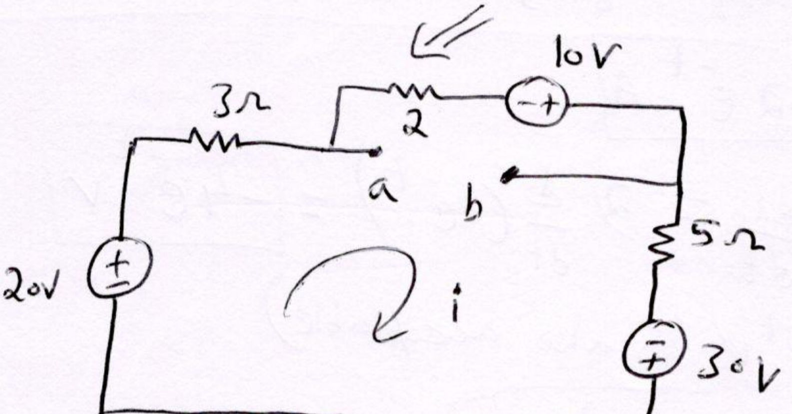
$\Rightarrow$



$R_{ab}=8\,||\,2=1.6\,\Omega=R_{th}$

find V_{ab} or V_{oc}





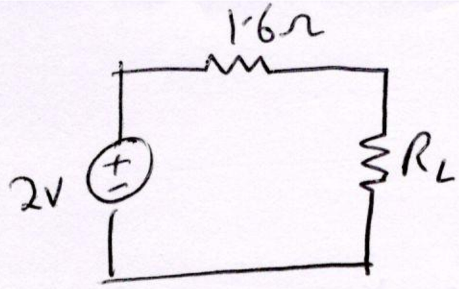
Applying KVL to the loop

$-20+10i-10-30=0$

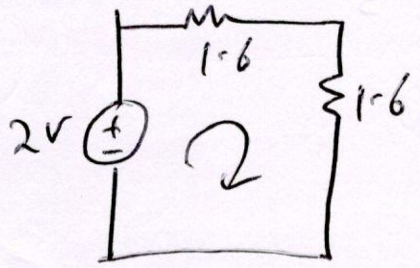
$i=6A$

$V_{ab}=6\times 2-10$

$=12-10=2V$



$R_L = 1.6\Omega$ for P_{max}



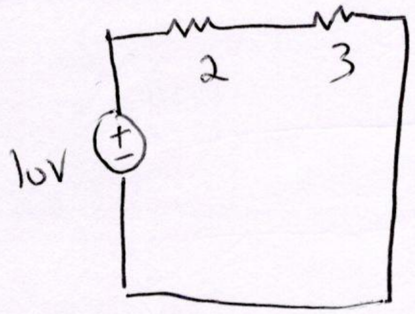
$$i = \frac{2}{3.2} = 0.625A$$

$$P_{max} = i^2 R_L = 0.625 \times 1.6$$

$$= 0.625\ W$$

or 625 mW

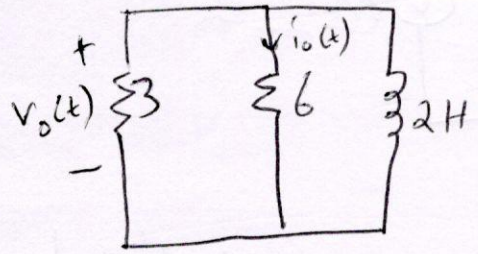
12) for $t < 0$



$$i = \frac{10}{5} = 2A$$

$$i(0^-) = 2A = i(0)$$

for $t > 0$



$$i(t) = i_0 e^{-t/\tau}$$

$$\tau = L/R_{th} = \frac{2}{6 \| 3} = 1$$

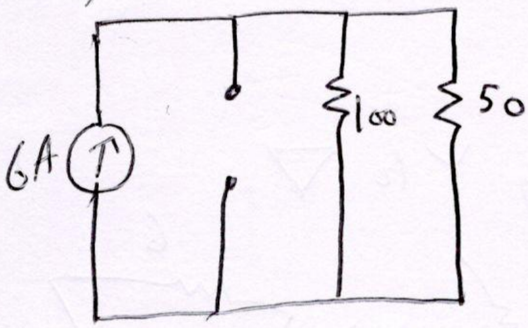
$$\boxed{i(t) = 2e^{-t}\ A}$$

$$V_o(t) = V_L(t) = L\frac{di}{dt} = 2\frac{d}{dt}(2e^{-t}) = \boxed{-4e^{-t}\ V}$$

($V_o(t) = +4e^{-t}V$ is also acceptable)

$$i_o(t) = \frac{V_o(t)}{6} = \boxed{-\frac{2}{3}e^{-t}\ A}$$

13) for $t<0$



$i_L(0^-) = 6 \times \frac{50}{150} = 2A$

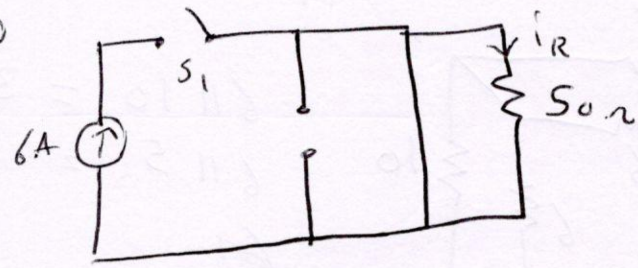
$i_L(0^+) = 2A$

$V_C(0^-) = 2 \times 100 = 200V$

$V_C(0^+) = 200V$

$i_R(0^-) = 6 \times \frac{100}{150} = 4A$

for $t>0$

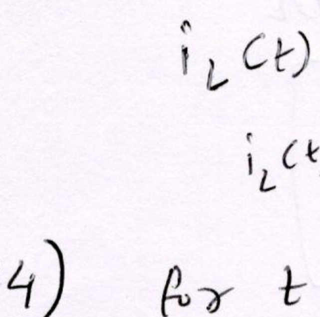


$i_R(0^+) = 0A$

$i_L(t) = i_L(0)e^{-t/\tau}$ $\quad \tau = L/R = 5/50 = 0.1$

$i_L(t) = 2e^{-t/0.1}\,A$ for $t>0$

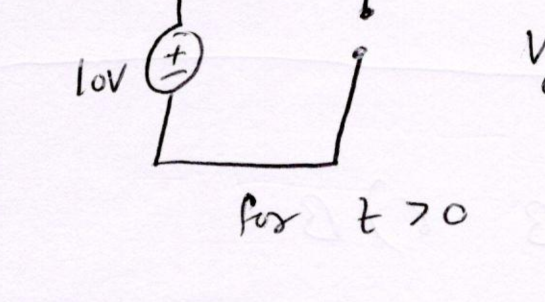
14) for $t<0$



$V_C(0^-) = V_C(0^+) = 10V$

$V_C(t) = V_f + (V_i - V_f)e^{-t/\tau}$

for $t>0$



Apply KVL

$-10 + 2i + 6i - 50 = 0$

$i = 7.5A$

$V_f = 10 - 2(7.5) = -5$

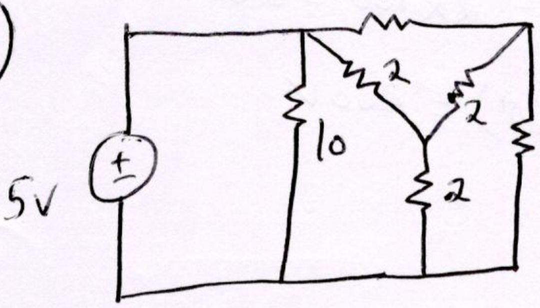
$R_{th} = 2 \parallel 6 = 1.5, \quad \tau = 1.5 \times 0.33$

$\approx 0.5\,s$

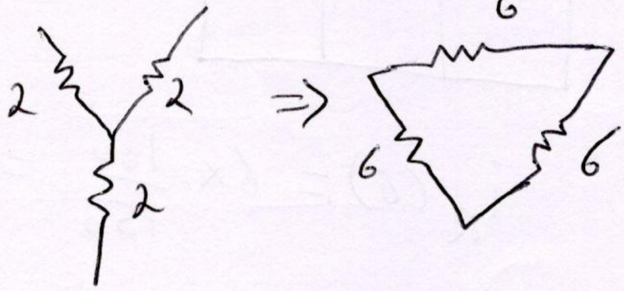
$$V_c(t) = -5 + [10 - (-5)]e^{-t/0.5}$$

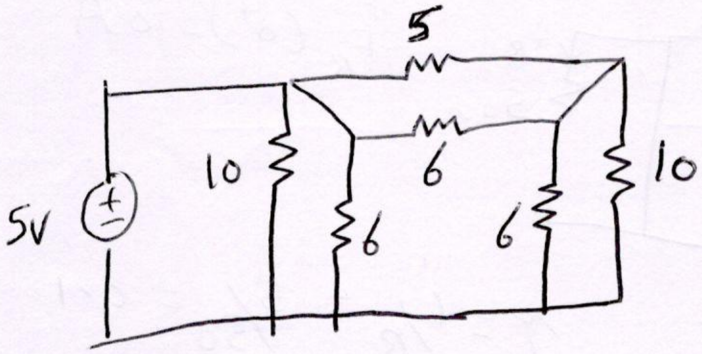
$$\boxed{V_c(t) = -5 + 15e^{-2t}}\ \text{v}$$

15)



Apply Y to ∇

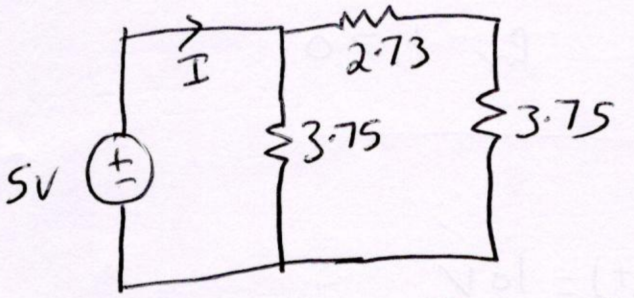




$6 \parallel 10 = 3.75$

$6 \parallel 5 = 2.72$

$6 \parallel$



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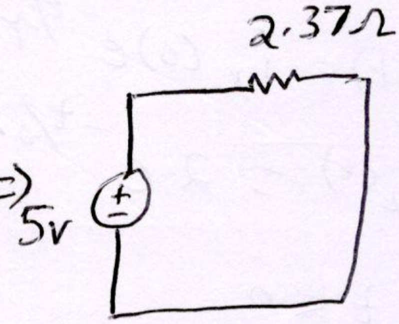

$$I = \frac{5}{2.37} = 2.1\ A$$

MCQ

1) D 2) A 3) B 4) B 5) B 6) B

7) C 8) D 9) C 10) B