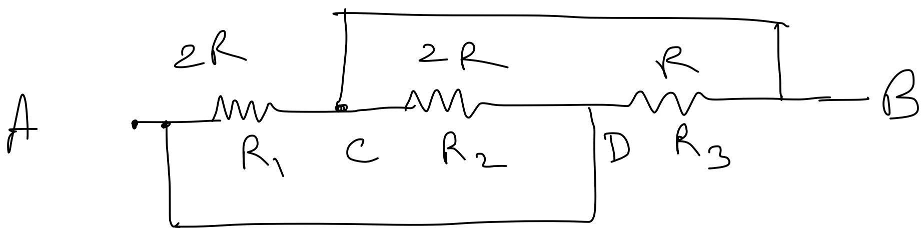
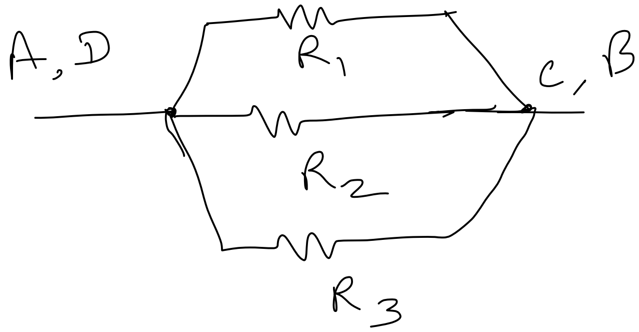
1.a. pts: 2



$\Rightarrow$



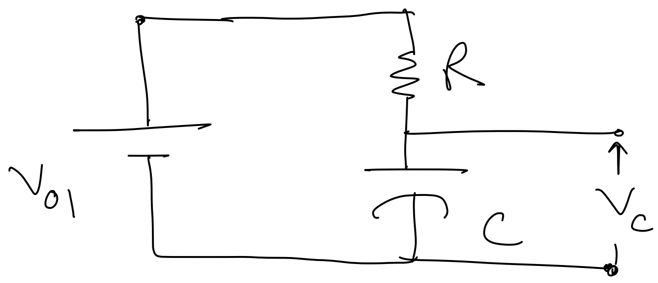
$$\therefore \quad R_{AB} = R_1 \parallel R_2 \parallel R_3$$

$$= (2R \parallel 2R) \parallel R$$

$$= R \parallel R = \boxed{\frac{R}{2}. \quad (\text{Ans})}$$

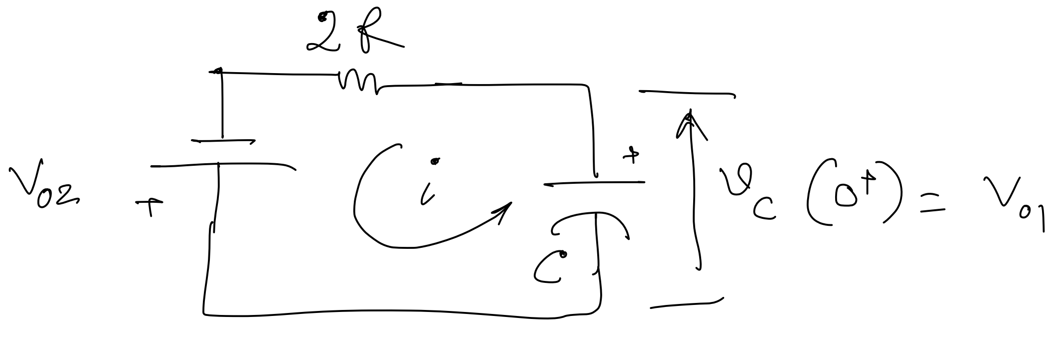
1.b. Points 3

For $t < 0$



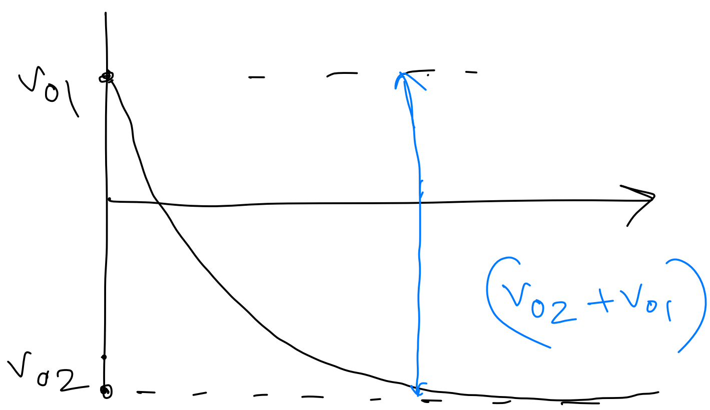
$\therefore$ At $t = 0^+$, $V_c(t) = V_{01}$

For $t \geq 0^+$



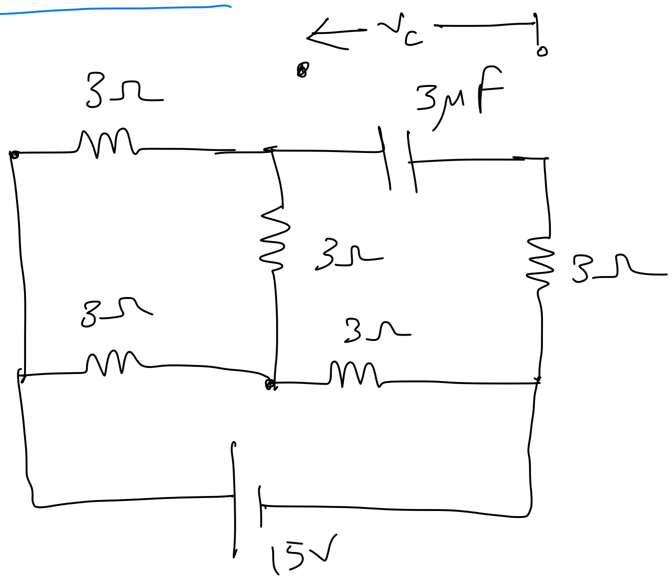
$\therefore$ Initial value of voltage across $C \Rightarrow V_{01}$

final value of the vol across $C \Rightarrow -V_{02}$

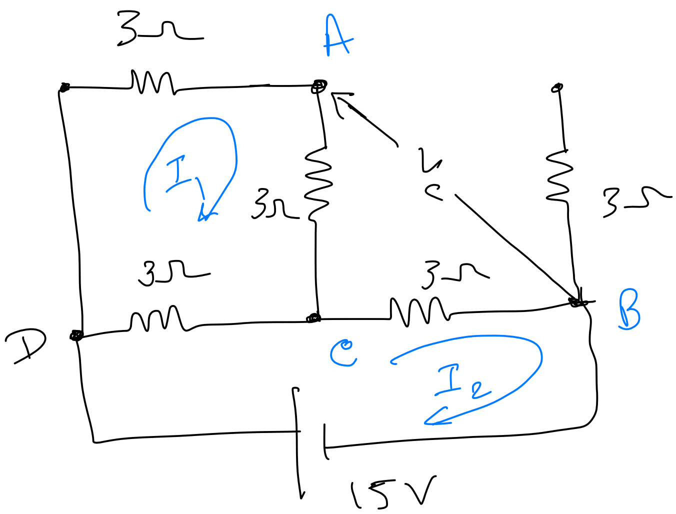


$$v_c(t) = \left(V_{02} - V_{01}\right)\left(1 - e^{-t/2RC}\right) + V_{01}$$

1. c. points 3



At steady state, no current will flow through the capacitor, ∴ the ckt becomes,



Loop-1

$$-3I_1 - 3I_1 - 3(I_1 - I_2) = 0$$

$$\Rightarrow -9I_1 + 3I_2 = 0$$

$$\Rightarrow -3I_1 + I_2 = 0 \quad \text{---} \; (1)$$

Loop-2

$$15 - 3I_2 - 3(I_2 - I_1) = 0$$

$$\Rightarrow 15 - 6I_2 + 3I_1 = 0$$

$$\Rightarrow 15 - 6I_2 + I_2 = 0 \quad [\text{using } (1)]$$

$$\Rightarrow I_2 = 3\,A.$$

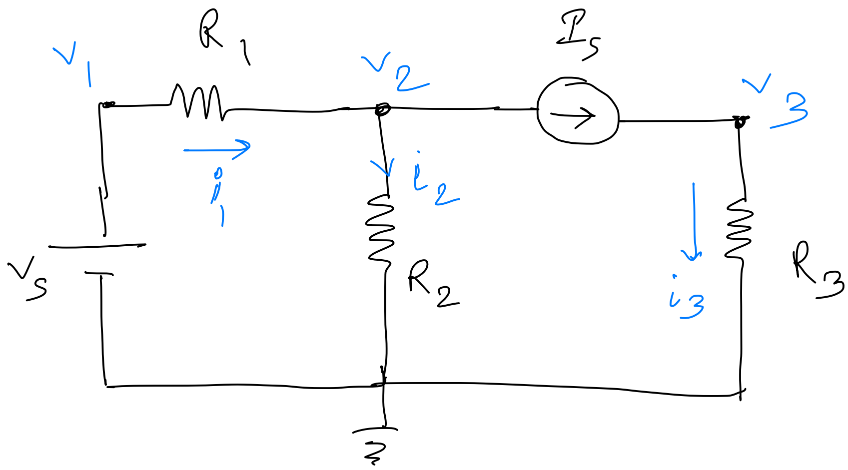
$$I_1 = 1\,A.$$

$$V_c = V_{AB} = V_{Ac} + V_{cB}$$

$$= 3I_1 + 3I_2$$

$$= 3 + 9 = \boxed{12V}$$ Ans.

1.d. points 2



$\boxed{v_1 = V_s. \quad \text{Ans.}}$

Node 2

$$i_1 = i_2 + i_3$$

$$\frac{v_1 - v_2}{R_1} = \frac{v_2}{R_2} + I_s \qquad i_3 = I_s$$

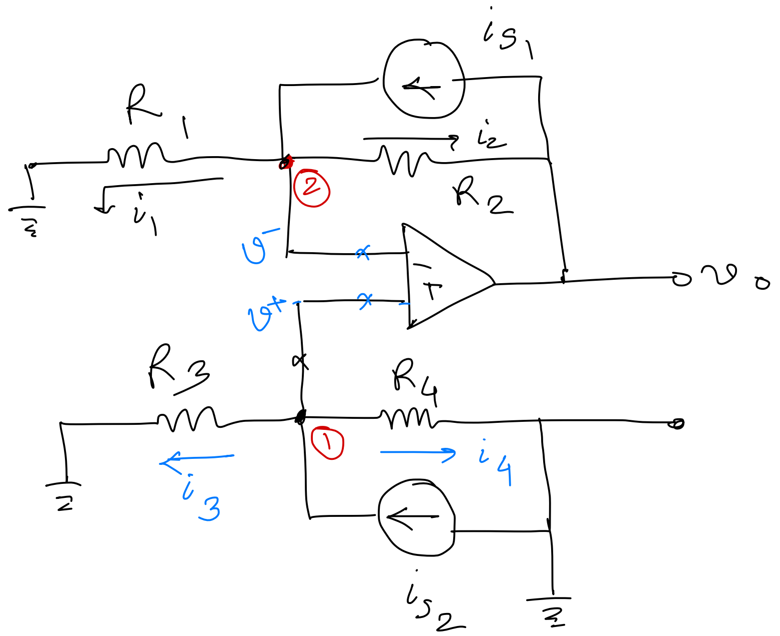
$$\Rightarrow \frac{V_s}{R_1} - \frac{v_2}{R_1} = \frac{v_2}{R_2} + I_s$$

$$\Rightarrow v_2\left(\frac{1}{R_1} + \frac{1}{R_2}\right) = \frac{V_s}{R_1} - I_s$$

$$\Rightarrow \boxed{v_2 = \left(\frac{V_s}{R_1} - I_s\right)\frac{R_1 R_2}{R_1 + R_2} \quad \text{Ans}}$$

$\boxed{v_3 = I_s R_3 \quad \text{Ans.}}$

2.a. points 7



At Node 1

$$i_{s_2} = i_3 + i_4$$

$$\Rightarrow \quad i_{s_2} = \frac{v^+}{R_3} + \frac{v^+}{R_4}$$

$$\Rightarrow \quad v^+ = \left(\frac{R_3 R_4}{R_3 + R_4}\right) i_{s_2} = v^- \quad \text{--- (1)}$$

At Node 2

$$i_{s_1} = i_1 + i_2$$

$$\Rightarrow \quad i_{s_1} = \frac{v^-}{R_1} + \frac{v^- - v_o}{R_2}$$

$$\Rightarrow \quad i_{s_1} = v^-\left(\frac{1}{R_1} + \frac{1}{R_2}\right) - \frac{v_o}{R_2}$$

$$\Rightarrow \quad \frac{v_o}{R_2} = \frac{R_1 + R_2}{R_1 R_2} \cdot v^- - i_{s_1}$$

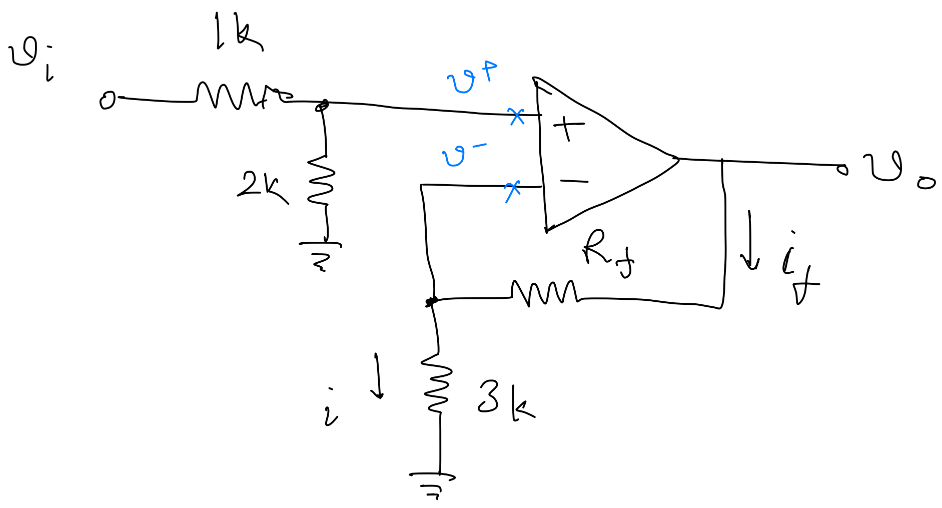
$$\Rightarrow \quad v_o = \frac{R_1+R_2}{R_1} \cdot v^- - i_{s_2}$$

$$\Rightarrow \quad \boxed{v_o = \left(\frac{R_1+R_2}{R_1}\right) \cdot \left(\frac{R_3 R_4}{R_3+R_4}\right) i_{s_2} - R_2 i_{s_1}}$$

Ans.

Eq ① used.

2.b. points 3



$$v^+ = \frac{2}{2+1} \cdot v_i = \frac{2}{3} v_i = v^- \quad \text{-- ①}$$

$$i_f = i$$

$$\Rightarrow \quad \frac{v_o - v^-}{R_f} = \frac{v^-}{3}$$

$$\Rightarrow \quad \frac{v_o}{R_f} = v^-\left(\frac{1}{R_f}+\frac{1}{3}\right)$$

$$\Rightarrow \quad v_o = v^-\left(1+\frac{R_f}{3}\right)$$

$$= \frac{2}{3}\cdot v_i\left(1+\frac{R_f}{3}\right)$$

① used

$$\frac{v_o}{v_i} = 5 \quad \text{(given)}$$

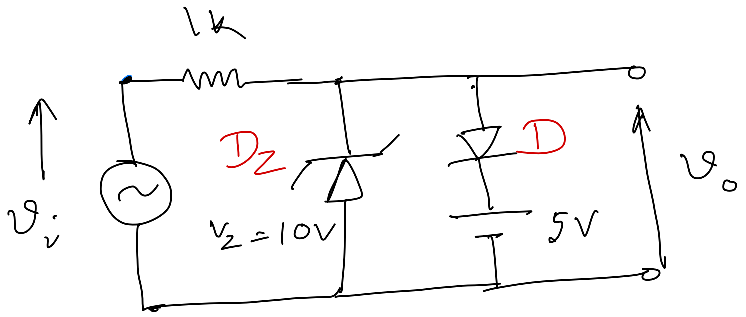
$$\therefore \quad \frac{2}{3}\left(1+\frac{R_f}{3}\right) = 5$$

$$\Rightarrow \quad 1+\frac{R_f}{3} = \frac{15}{2}$$

$$\Rightarrow \quad R_f = 3\left(\frac{15}{2}-1\right) = \frac{39}{2} = \boxed{19.5\,k\Omega}$$

Ans.

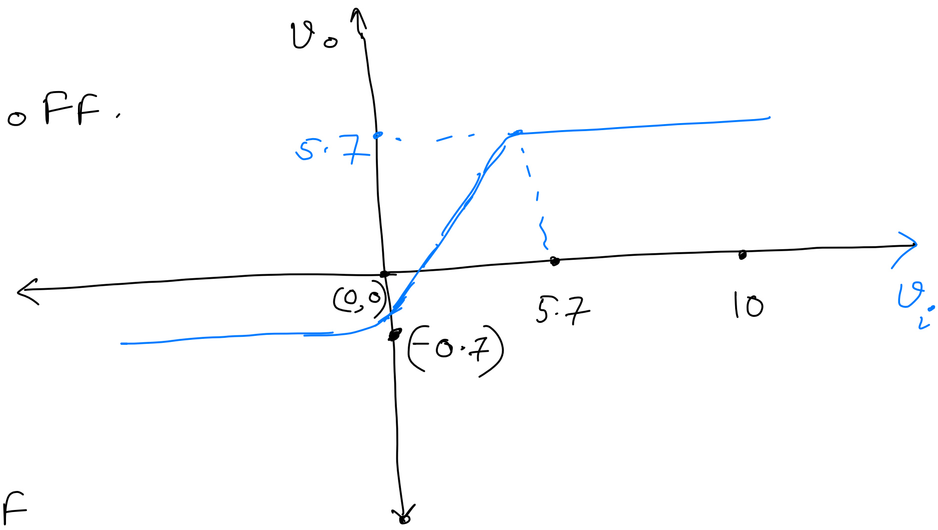
3.a point 3



$v_i < 0V$

D_Z ON, D OFF.

$v_o = -0.7V$



$5.7 > v_i \geq 0$

D_Z OFF, D OFF

$v_o = v_i$

$10 > v_i \geq 5.7$

D_Z OFF, D ON

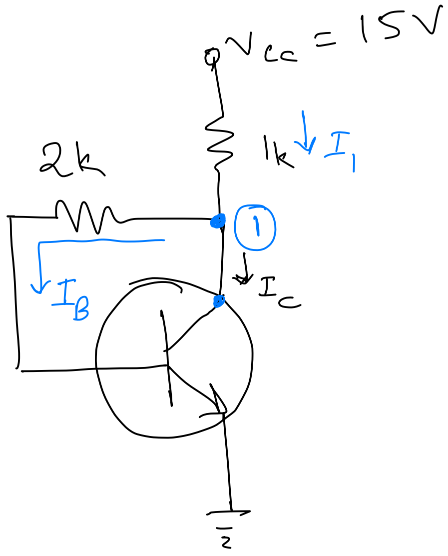
$v_o = 5.7V$

$v_i \geq 10$

D ON, ∴ D_Z off.

$v_o = 5.7V$

3.b. point 3



path Vcc → 1k → 2k → B → E → Ground.

$$15 - 1 I_1 - 2 I_B - 0.7 = 0 \quad \text{-- } (1)$$

Assume Active region,

$$I_1 = I_B + I_C$$

$$I_1 = I_B + \beta I_B$$

$$15 - I_B - \beta I_B - 2 I_B - 0.7 = 0$$

$$\Rightarrow \quad 83 I_B = 14.3$$

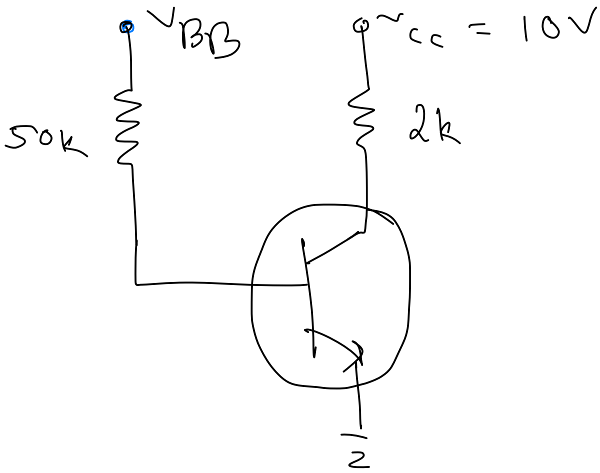
$$\Rightarrow \quad I_B = 0.1723 \text{ mA.}$$

$$\boxed{I_C = \beta I_B = 13.78 \text{ mA.} \quad \text{Ans}}$$

$$\frac{15-0.7}{2+80\times 1}\times 80 = \frac{14.3}{82}\times 80$$

$$\boxed{= 13.95 \quad \text{Ans}}$$

3. C. point 4



In saturation $V_{CE} = 0.2V$ or $0V$, (assume)

& $\boxed{I_C < \beta I_B.}$, just $I_c \rightarrow \beta I_B.$

$$I_c = \frac{V_{CC} - V_{CE}}{2} = \frac{10-0.2}{2} \approx 5\,mA$$

$$I_B = \frac{5}{\beta} = 0.025\,mA$$

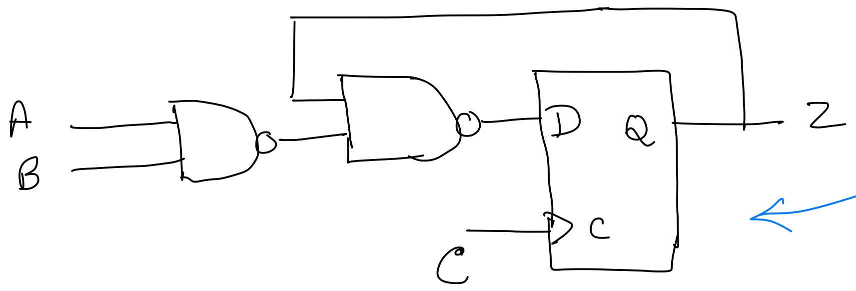
$$V_{BB} - 50 I_B - 0.7 = 0$$

$$V_{BB} = 0.7 + 50 \times 0.025$$

$$= 1.95\,V$$

$$\therefore \boxed{V_{BB} \geq 1.95\,V \quad \text{Ans.}}$$

4.a. point 2



+ve edge triggered

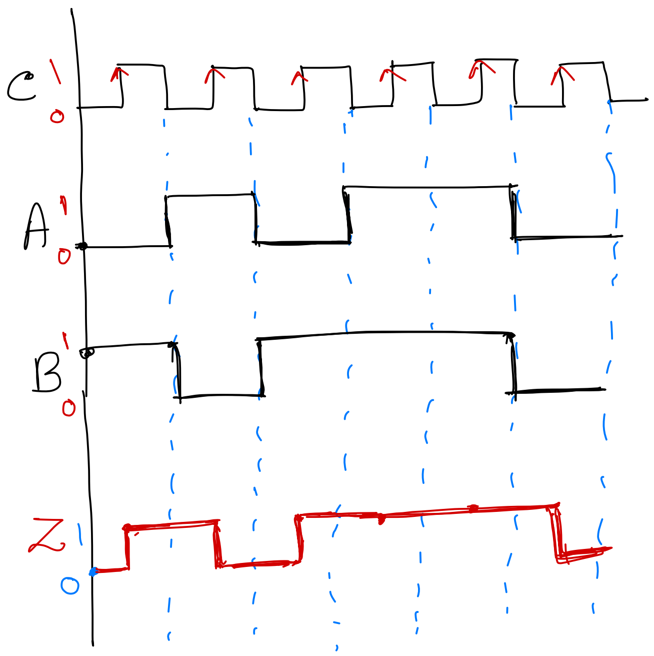
$\therefore$ Z = D at +ve edge.

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

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

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

A	B	Z	D
0	0	0	1
0	1	0	1
1	0	0	1
1	1	0	1
0	0	1	0
0	1	1	0
1	0	1	0
1	1	1	1



4.b. point 1

$$Y = A + \overline{B}C + A(B + \overline{C})$$

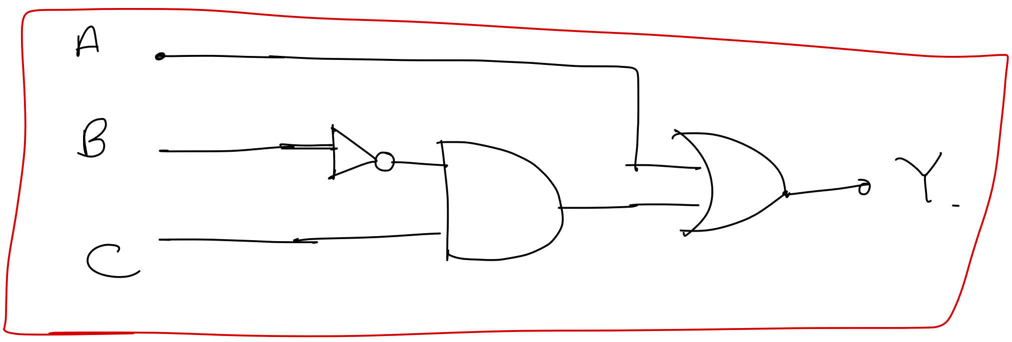
$$= A + AB + \overline{B}C + A\overline{C}$$

$$= A(1 + B) + A\overline{C} + \overline{B}C$$

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

$$= A(1 + \overline{C}) + \overline{B}C$$

$$\boxed{Y = A + \overline{B}C}$$



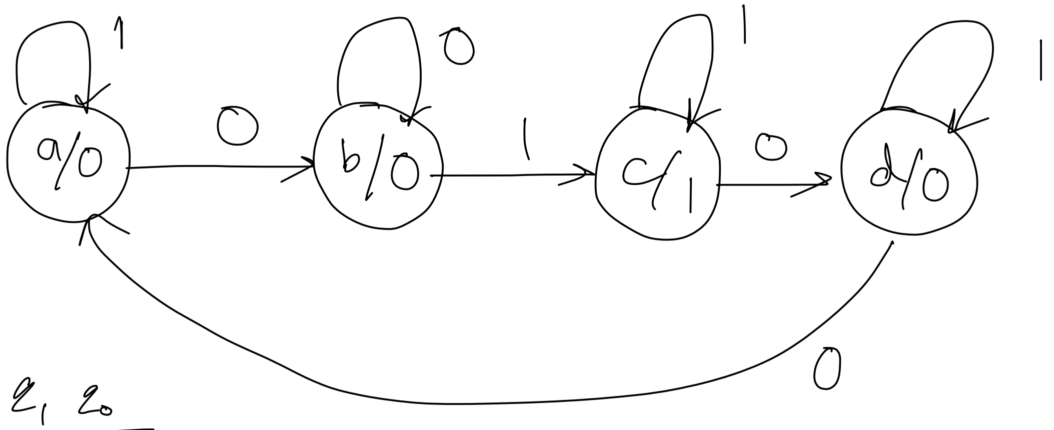
4.C. point 3

AB \ CD	00	01	11	10
00	1 [0]	1 [1]	1 [3]	[2]
01	[4]	[5]	1 [7]	[6]
11	[12]	[13]	[15]	[14]
10	[8]	[9]	1 [11]	[10]

$$\boxed{Y = \bar{A}\bar{B}\bar{C} + \bar{A}CD + \bar{B}CD}$$

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

4. d . point 4



	q_1	q_0
a	0	0
b	0	1
c	1	0
d	1	1

i/p $\Rightarrow$ x

o/p $\Rightarrow$ y.

	q_1	q_0	x	q_1^+	q_0^+	
a	0	0	0	0	1	b
b	0	1	0	0	1	b
c	1	0	0	1	1	d
d	1	1	0	0	0	a
a	0	0	1	0	0	a
b	0	1	1	1	0	c
c	1	0	1	1	0	c
d	1	1	1	1	1	d

	q_1	q_0	y
a	0	0	0
b	0	1	0
c	1	0	1
d	1	1	0

q_1^+

x \ $q_1 q_0$	00	01	11	10
0	(0)	(1)	(3)	1 (2)
1	(4)	1 (5)	1 (7)	1 (6)

$$q_1^+ = x q_0 + q_1 \bar{q}_0$$

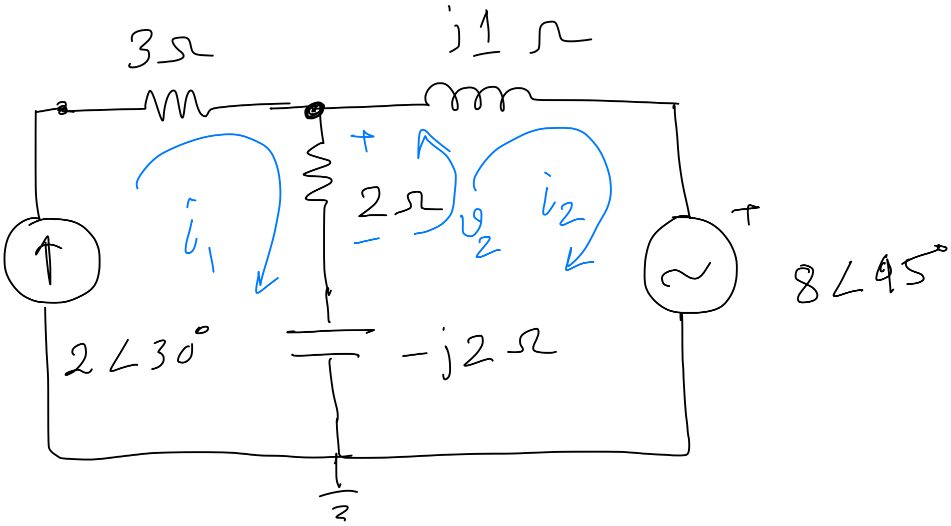
q_0^+

x \ $q_1 q_0$	00	01	11	10
0	1 (0)	1 (1)	(3)	1 (2)
1	(4)	(5)	1 (7)	(6)

$$q_0^+ = \bar{x} \bar{q}_1 + \bar{x} \bar{q}_0 + x q_1 q_0$$

$$y = q_1 \cdot \bar{q}_0$$

5. a. points 3



Loop 2

$$j1 \cdot I_2 + (2-j2)(I_2 - I_1) + 8\angle 45^\circ = 0$$

& $I_1 = 2\angle 30^\circ$

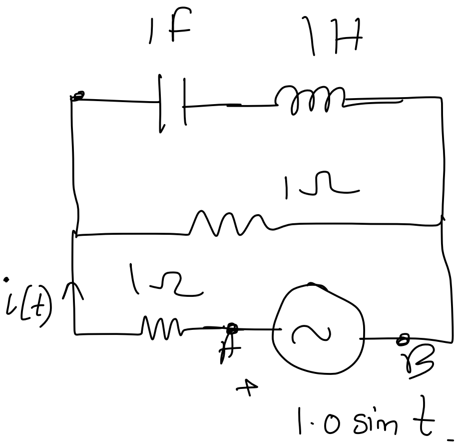
$$\therefore \quad jI_2 + (2-2j)I_2 - 2\angle 30^\circ (2-2j) = -8\angle 45^\circ$$

$$\therefore \quad I_2 = 3.18\angle -65^\circ \text{ A.}$$

$$\therefore \quad V_2 = 2(I_1 - I_2) = 2(2\angle 30^\circ - 3.18\angle -65^\circ)$$

$$\boxed{V_2 = 7.8\angle 84.41^\circ} \quad \text{Ans.}$$

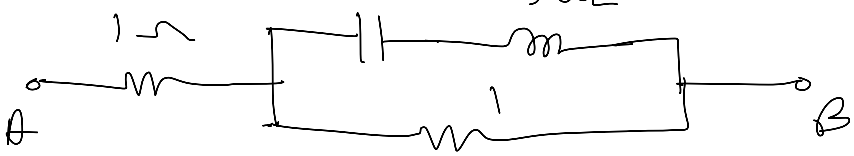
5.b point : 2



$\omega = 1$ rad/sec.

$\frac{1}{j\omega C} = -j1$

$j\omega L = j1.$

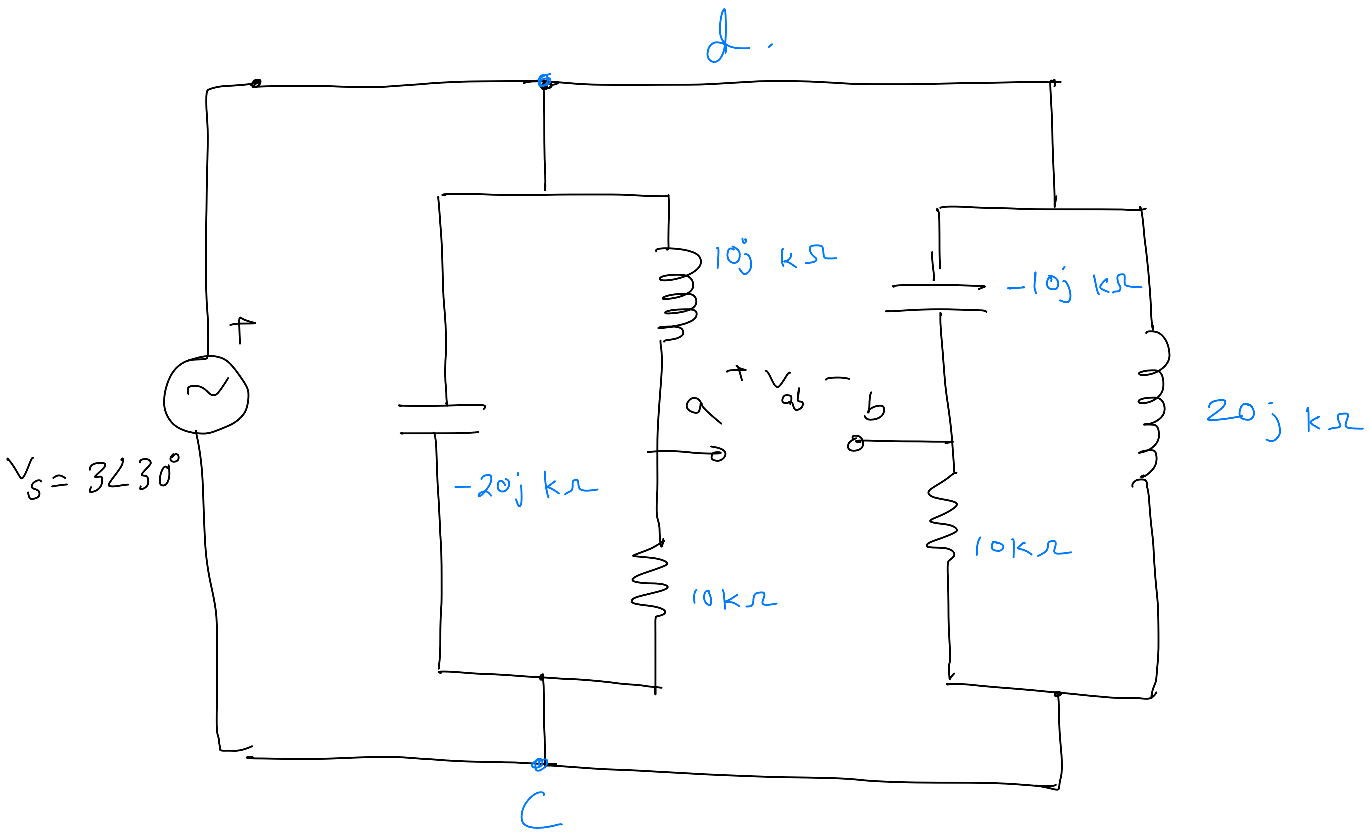


$$Z_{AB} = 1 + 1 \parallel (-j + j)$$

$$= 1\ \Omega.$$

$\therefore$ peak of $i(t) \Rightarrow \frac{1}{1} = \boxed{1A.\ \text{Ans.}}$

5. C. point 5



$$V_{dc} = V_s = 3\angle 30°$$

Applying voltage divider rule,

$$V_{ac} = V_s \cdot \frac{10}{10+10j}$$

$$V_{bc} = V_s \frac{10}{10-10j}$$

$$V_{ab} = V_{ac} - V_{bc}$$

$$= 10V_s \left(\frac{1}{10+10j} - \frac{1}{10-10j} \right)$$

$$= 10V_s \frac{10-10j - 10-10j}{(10+10j)(10-10j)}$$

$$= 10V_s \cdot \frac{-20j}{10^2 + 10^2}$$

$$= \frac{200}{200}(3\angle 30^\circ)(1\angle -90^\circ)$$

$$\boxed{V_{ab} = 3\angle -60^\circ \cdot \text{ volt. Ans.}}$$