CMR
INSTITUTE OF
TECHNOLOGY

IAT 1 Solution

Internal Assesment Test - I

Sub:	Electric Circuit Analysis							Code:	18EE32
Date:	06/09/2019	Duration:	90 mins	Max Marks:	50	Sem:	3 - B	Branch:	EEE

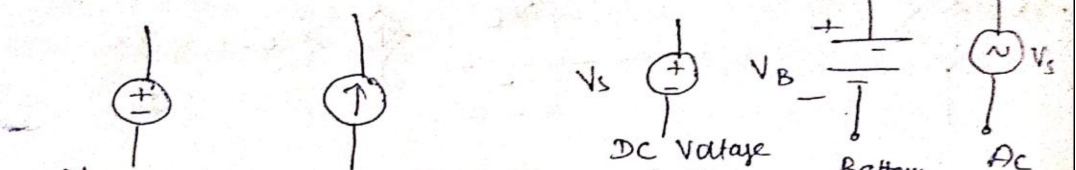
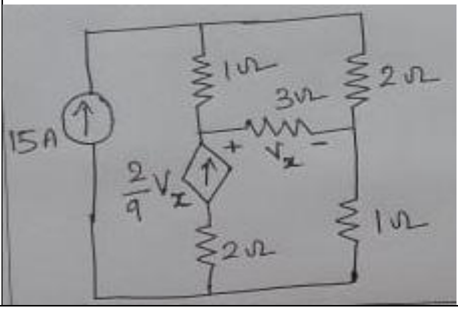
		M	OBE CO	OBE RBT
1a	Distinguish between (i) ideal and practical sources, (ii) active and passive elements.	[2]	CO 1	L2

Ideal Sources.

→ Imaginary electrical sources.
→ Which provide constant voltage or current to the circuit regardless of load
→ They don't have any internal resistance (R_s) ZERO Internal Resistance
→ It is impossible to build a source with zero internal resistance.
→ Ideal sources are not the practical sources.
→ Not available in the market.

Practical Sources.

→ Practically possible available.
→ Have some internal resistance (R_s)
→ Provides variable current / voltage.
→ Available in market.

	Independent Source * The source does not depend on any other quantity (voltage & current) in the circuit.  Voltage source — current source. — DC Voltage Source — Battery — AC Voltage Source **Dependent and Independent Sources.** **Dependent Sources / controlled source.** → Source quantity is determined by the voltage (or) current existing at some other location in the system.			
1b	Determine three unknown currents using Mesh Analysis. 	[8]	CO 1	L4

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from figure,

$\boxed{i_1 = 15A}$

$$i_3 - i_1 = \frac{2V_x}{9} \longrightarrow (1)$$

KVL for loop 2

$$-i_1 + 6i_2 - 3i_3 = 0 \quad (\because i_1 = 15A)$$

$$6i_2 - 3i_3 = 15 \longrightarrow (2)$$

$$V_x = 3(i_3 - i_2) \longrightarrow (3)$$

Sub. (3) in (1)

$$i_3 - i_1 = \frac{6}{9}(i_3 - i_2) = \frac{2}{3}(i_3 - i_2)$$

$$2i_2 + i_3 = 45 \longrightarrow (4)$$

Solving (2) & (4)

$\boxed{i_2 = 12.5A}$ $\boxed{i_3 = 20A}$

$\boxed{i_1 = 15A}$

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<td>2</td>
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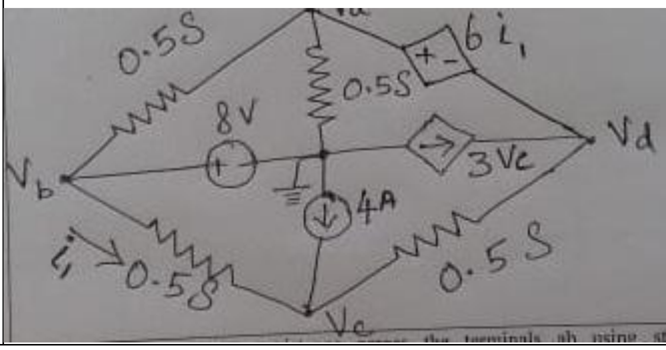
Find the node voltages for the circuit shown in Figure using nodal analysis.



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<td>[10]</td>
<td>CO 1</td>
<td>L3</td>
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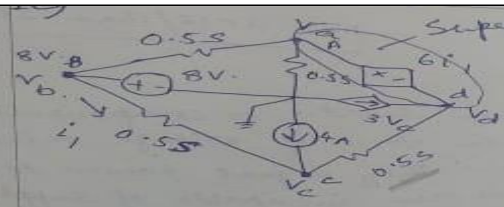


KCL at node c;

$4 - \frac{V_c - V_d}{\frac{1}{0.5}} - 0.5\times\frac{(V_c - V_b)}{1} -$

or, $4 - 0.5(V_c - V_d) - 0.5(V_c - V_b) - 3V_c = 0$.

or, $-4V_c + 0.5V_b + 0.5V_d =$

or, $-V_b + \frac{4}{0.5}V_c - \frac{0.5}{0.5}V_d =$

or, $-V_b + 8V_c - V_d = 20 \longrightarrow (1)$

$V_b = 8V \rightarrow (2)$

Constraint eqn.

$V_a - V_d = 6i_1 = 6\times0.5(V_b - V$

$i_1 = 0.5(V_b - V_c)$.

or, $V_a - V_d = 3V_b - 3V_c$

or, $V_a + 3V_c - 3V_b - V_d = 0 \longrightarrow (3)$.

From (1)

$8 + 8V_c - V_d = 20$.

or, $8V_c - V_d = 12 \longrightarrow (4)$.

From (3), $V_a + 3V_c - 3\times8 - V_d = 0$.

or, $V_a + 3V_c - V_d = 24 \longrightarrow (5)$

KCL at Supernode;

$-(V_a - V_b)\times0.5 - V_a\times0.5 + 3V_c - 0.5(V_d - V_c)$

or, $-V_a + V_b - V_a - \frac{3}{0.5}V_c - V_d + V_c = 0$

or, $-2V_a + V_b - 5V_c - V_d = 0$.

or, $2V_a - V_b + 5V_c + V_d = 0 \longrightarrow (6)$

or, $2V_a - 8 + 5V_c + V_d = 0$.

or, $2V_a + 5V_c + V_d = 8 \rightarrow (7)$

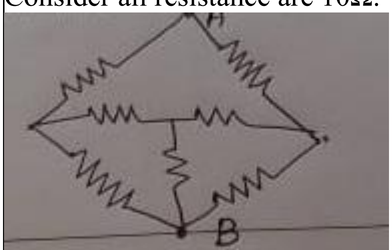
solving eqn. (4), (5) & (6).

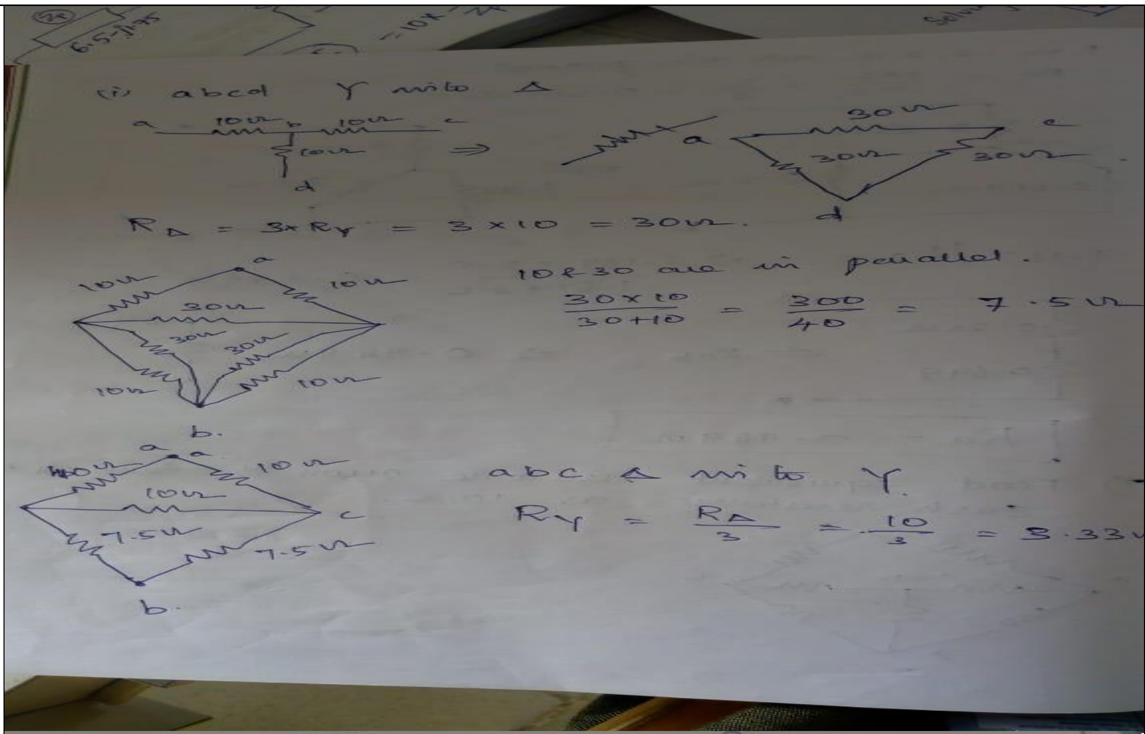
$V_a = 63.281V$.

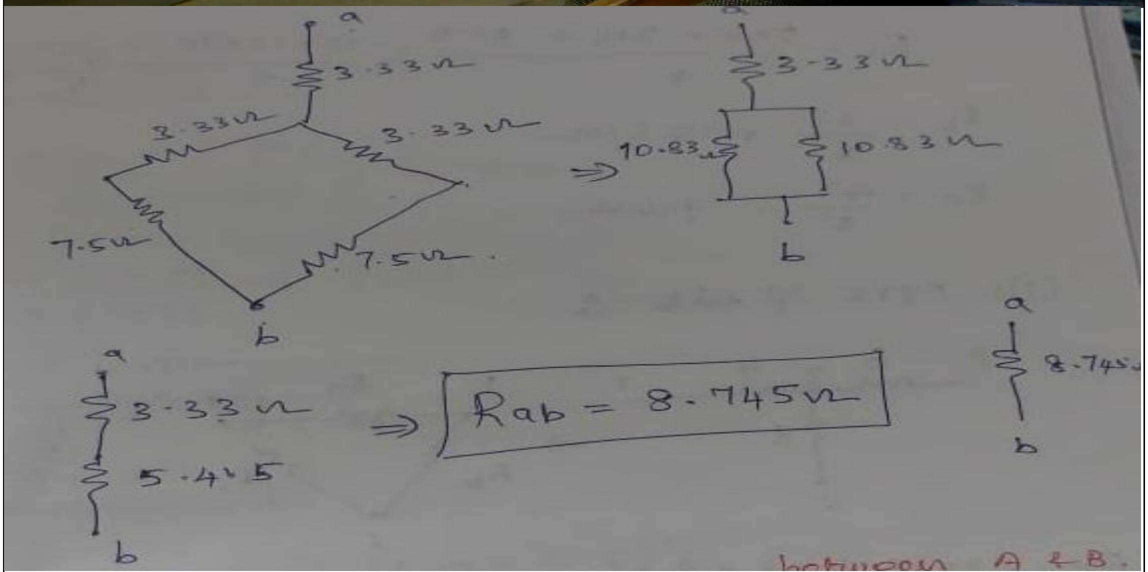
$V_b = 8V$,

$V_c = -0.173V$.

$V_d = -39.8V$.

3a	Determine the equivalent resistance across the terminals ab using star-delta transformation. Consider all resistance are 10Ω. 	[6]	CO 2	L4

<table>
<tr><td></td><td>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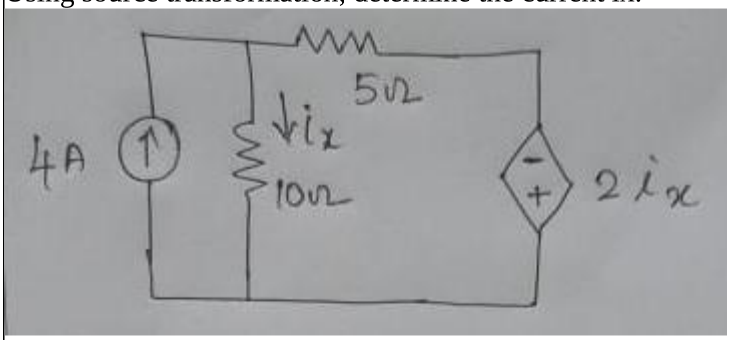
<tr><td>3b</td><td>Using source transformation, determine the current ix.

</td><td>[4]</td><td>CO 2</td><td>L4</td></tr>
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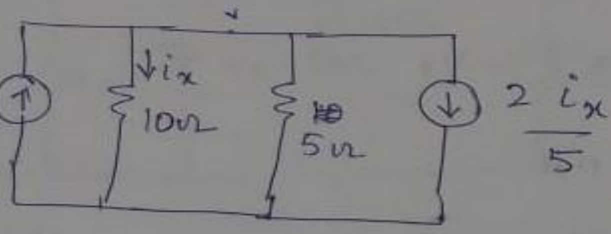
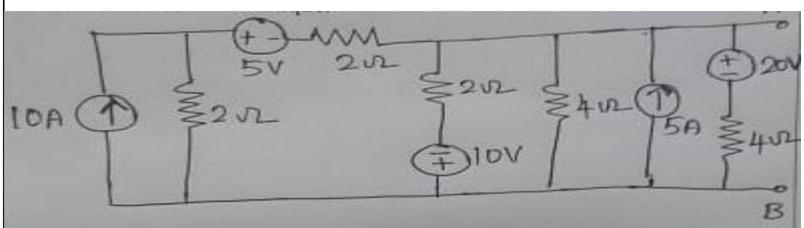
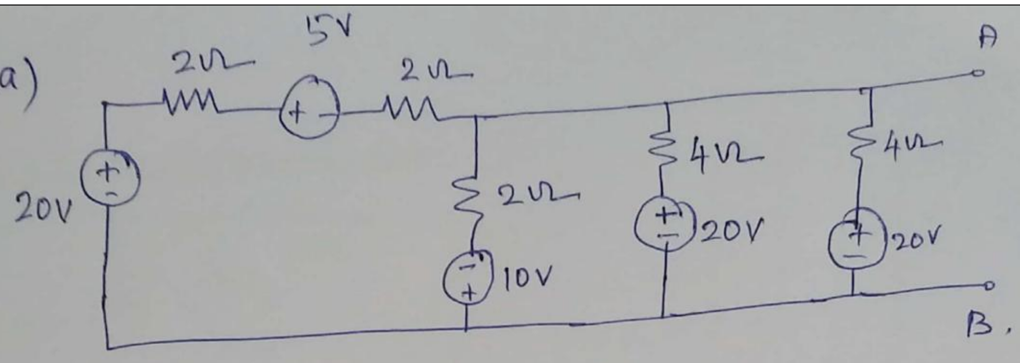
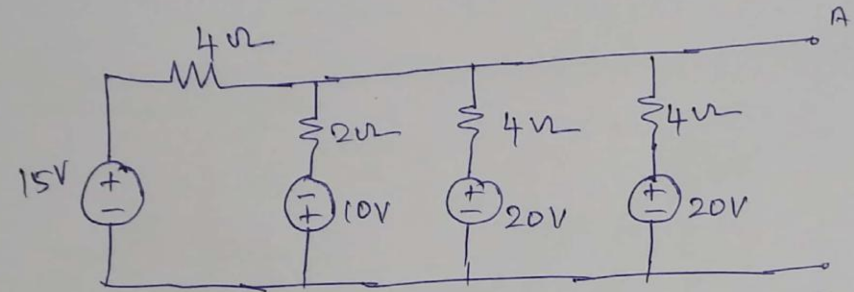
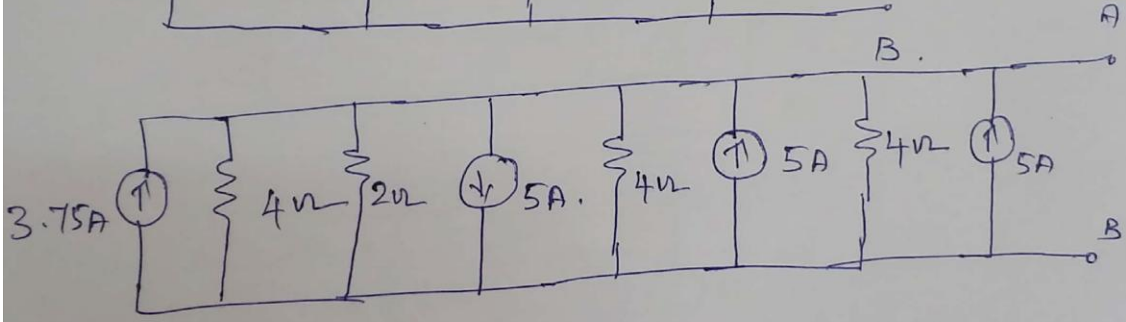
<tr><td></td><td>Voltage source
(i) Convert $\frac{2i_x}{5}$ ~~4A~~, 5 ~~10~~ Ω into current source

$i = \frac{V}{R} = \frac{2i}{5}$
$4 - \frac{2i_x}{5} = \frac{V}{10} + \frac{V}{5}$
$\Rightarrow 0.1V + 0.2V$
$4 - 0.4i_x = 0.3V$
$i_x = \frac{V}{10}$
$4 - 0.4\frac{V}{10} = 0.3V$
$4 - 0.04V = 0.3V$
$4 = 0.34V$
$\boxed{V = 11.7V}$
$i_x = \frac{V}{10} = \frac{11.7}{10}$
$\boxed{i_x = 1.17A}$
$(4 - \frac{2i_x}{5})$
$\frac{(4 - \frac{2i_x}{5}) \times 5}{15}$
$\Rightarrow \frac{20 - 2i_x}{15}$</td><td></td><td></td><td></td></tr>
<tr><td>4a</td><td>Transform the network given in Figure into a single voltage source using source transformation technique.
</td><td>[5]</td><td>CO 2</td><td>L2</td></tr>
</table>

4a)



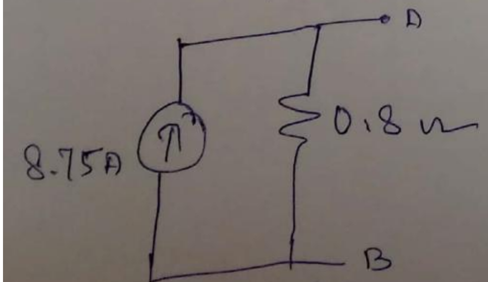




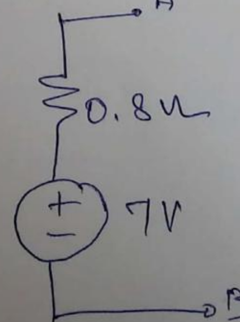
$$I = 3.75 - 5 + 5 + 5 = 8.75 \text{ A}.$$

$$\frac{1}{R_T} = \frac{1}{4} + \frac{1}{2} + \frac{1}{4} + \frac{1}{4} = 1.25$$

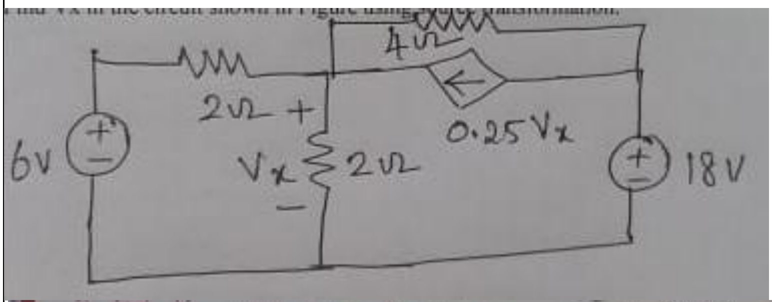
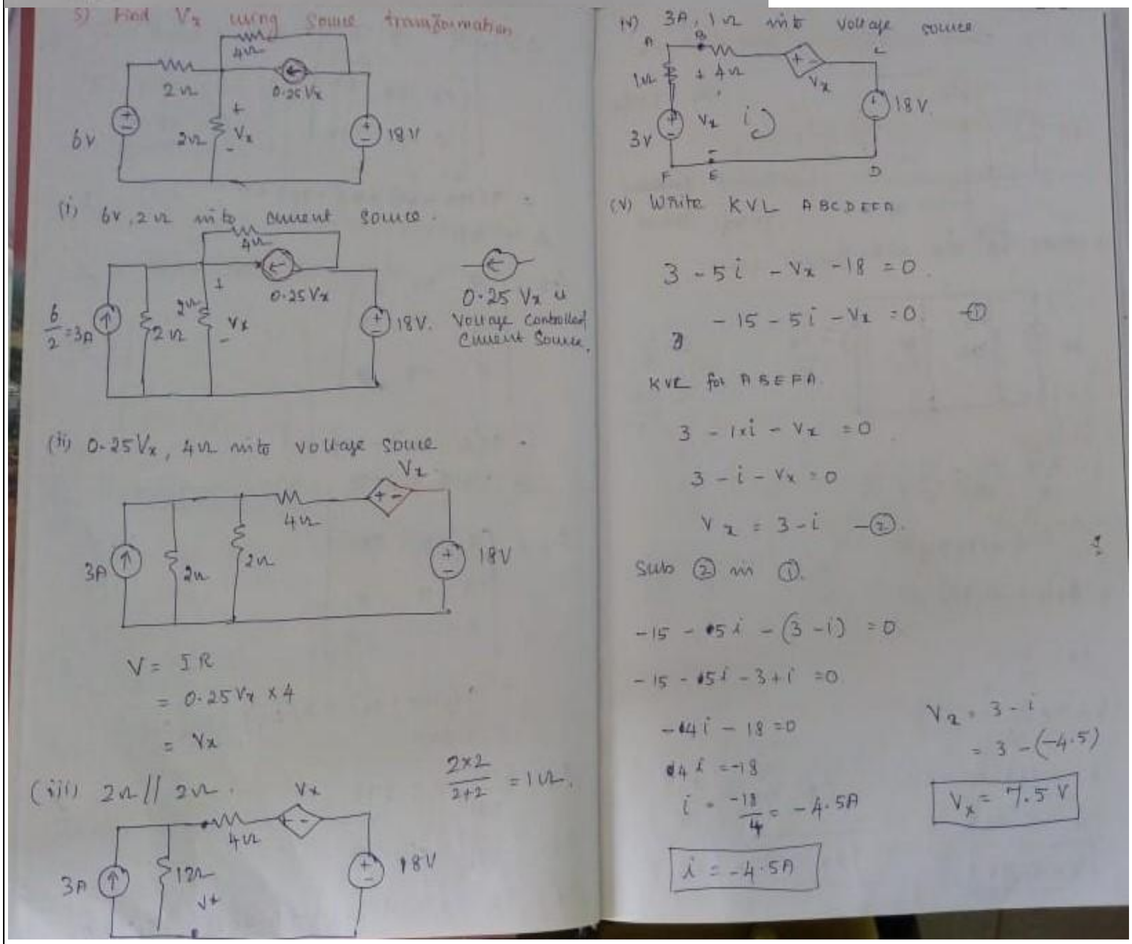
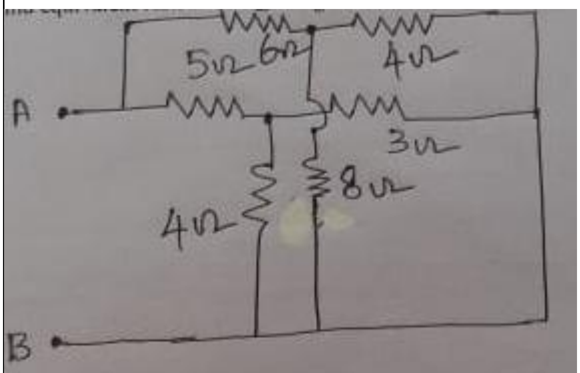
$$R_T = \frac{1}{1.25} = 0.8\ \Omega.$$



⇒



$$V = IR$$
$$= 8.75 \times 0.8 = 7 \text{ V}.$$

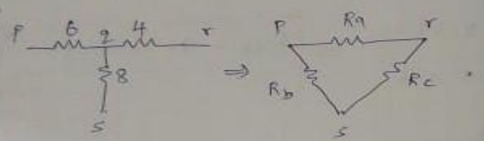
4b	Find Vx in the circuit shown in Figure using source transformation.  	[5]	CO 2	L3
5.	Find equivalent resistance R_{ab} using star/delta or delta/star conversion. 	[10]	CO 2	L3

$R_a = \frac{\quad}{4}$

$R_b = \frac{47}{3} = 15.67\Omega$

$R_c = \frac{47}{5} = 9.4\Omega$

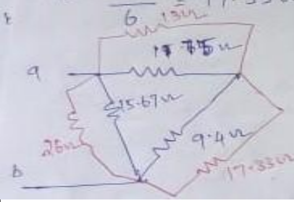
(ii) pqrs Y into Δ



$R_a = \frac{6\times4 + 4\times8 + 8\times6}{8} = \frac{24+32+48}{8} = \frac{104}{8} = 13\Omega$

$R_b = \frac{104}{4} = 26\Omega$

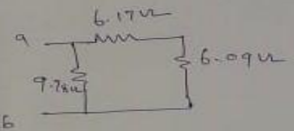
$R_c = \frac{104}{6} = 17.33\Omega$



$\frac{\quad}{13+71.75} = 6.17\Omega$

$\frac{9.4\times17.33}{9.4+17.33} = 6.09\Omega$

$\frac{15.67\times26}{15.67+26} = 9.78\Omega$



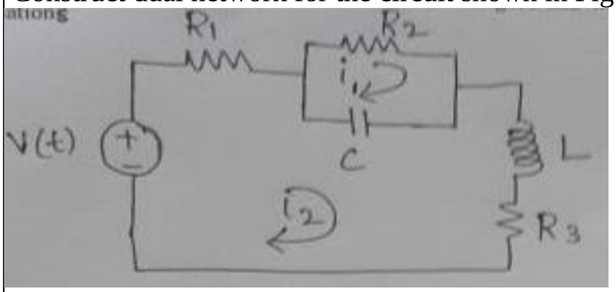
$R_{ab} = 9.78 \,||\, (6.17+6.09)$

$= 9.78 \,||\, 12.26$

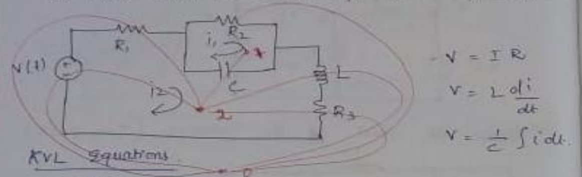
$R_{ab} = \frac{9.78\times12.26}{9.78+12.26}$

$\boxed{R_{ab} = 5.44\Omega}$

6.	Construct dual network for the circuit shown in Figure and write the equilibrium equation.	[10]	CO 2	L3



5) Write equilibrium equations using KVL, draw its dual and write its equilibrium equations.



$V = IR$

$V = L\frac{di}{dt}$

$V = \frac{1}{C}\int i\,dt$

KVL Equations

Mesh 1

$i_1 R_1 + \frac{1}{C}\int(i_1 - i_2)\,dt = 0$ —(1)

Mesh 2

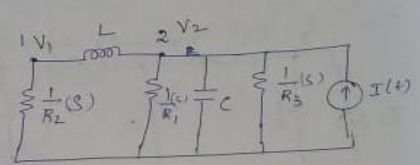
$i_2 R_1 + \frac{1}{C}\int(i_2 - i_1)\,dt + L\frac{di_2}{dt} + i_2 R_3 = V(t)$ —(2)

Dual Network

$I = \frac{V}{R} = VG$

$I = \frac{1}{L}\int V\,dt$

$I = C\frac{dV}{dt}$



KCL

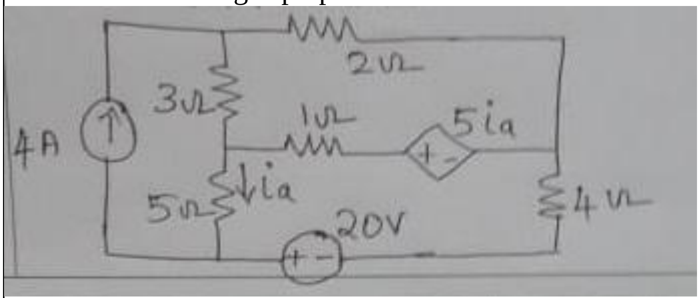
Node 1

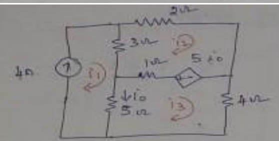
$V_1 \frac{1}{R_2} + \frac{1}{L}\int(V_1 - V_2)\,dt = 0$ —(1)

Node 2

$V_2 \frac{1}{R_1} + C\frac{dV_2}{dt} + V_2\frac{1}{R_3} + \frac{1}{L}\int(V_2 - V_1)\,dt = I(t)$ —(2)

7.	Find current ia using superposition theorem.	[10]	CO 3	L3





$\boxed{i_1 = 4A}$

KVL for Loop 2

$2i_2 + 3(i_2 - i_1) + 1(i_2 - i_3) = 5i_o$

$i_1 - i_3 = i_o$

$-3i_1 + 6i_2 - i_3 = 5i_o$ — (1)

$i_1 - i_3 = i_o$

$4 - i_3 = i_o$

$i_3 = 4 - i_o$; $i_1 = 4A$

Sub in (1).

$-3\times4 + 6i_2 - (4 - i_o) = 5i_o$

$-12 + 6i_2 - 4 + i_o = 5i_o$

$6i_2 - 16 = 4i_o$

$3i_2 - 2i_o = 8$ — (2)

KVL for Loop 3

$5(i_3 - i_1) + 1(i_3 - i_2) + 4i_3 = -5i_o$ — (3)

$i_1 = 4A$; $i_3 = 4 - i_o$

$5(i_3 - 4) + 1(i_3 - i_2) + 4i_3 = -5i_o$

$10i_3 - 20 - i_2 = -5i_o$

$i_3 = 4 - i_o$

$10(4 - i_o) - 20 - i_2 = -5i_o$

$40 - 10i_o - 20 + i_2 = -5i_o$

$-i_2 - 5i_o = -20$ — (4). $\boxed{i_2 + 5i_o = 20}$ — (4)

Solve (3) & (4)

(2) ⇒ $3i_2 - 2i_o = 8$

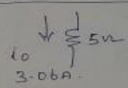
(4) × 3 ⇒ $3i_2 + 15i_o = 60$

$-17i_o = -52$

$\cancel{i_o = 3.884A}$

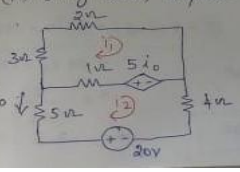
$i_o = \frac{52}{17}$

$\boxed{i_o = 3.06A}$



$\boxed{i_o' = 3.06A}$

(ii) Using 20V, Replace 4A.



$i_o = -i_2$

KVL for Loop 1

$2i_1 + 3i_1 + 1(i_1 - i_2) = 5i_o$

$6i_1 - i_2 = 5i_o$

$6i_1 + i_o = 5i_o$

$6i_1 - 4i_o = 0$ — (1)

KVL for Loop 2

$1(i_2 - i_1) + 5i_2 + 4i_2 = 20 - 5i_o$

$10i_2 - i_1 = 20 - 5i_o$

$i_2 = -i_o$

$-10i_o - i_1 = 20 - 5i_o$

$-i_1 + 5i_o = 20$. — (2).

$\boxed{i_o = -3.53A}$

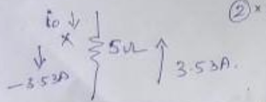
(1) ⇒ $6i_1 - 4i_o = 0$

(2) × 6 ⇒ $-6i_1 - 30i_o = 120$

$-34i_o = 120$

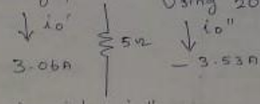
$i_o = \frac{120}{-34}$

$i_o = -3.53A$.



$\boxed{i_o'' = -3.53A}$

(iii) Algebraic sum

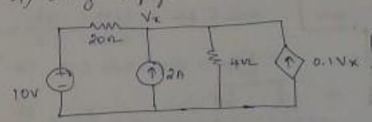


$i_o = i_o' + i_o''$

$= 3.06 - 3.53$

$\boxed{i_o = -0.47A}$

4) Using superposition theorem, determine V_x.



$\boxed{V_x = 12.5V}$