(131)

CMR INSTITUTE OF TECHNOLOGY

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CMR

Internal Assesment Test - I

Sub:	ELECTRIC CIRCUIT ANALYSIS							Code:	15EE32
Date:	18/ 09/2017	Duration:	90 mins	Max Marks:	50	Sem:	III	Branch:	EEE

Note: **Answer any FIVE questions.** Sketch figures as necessary. Each Question is for 10 marks. (5x10=50M)

		Marks	OBE CO	OBE RBT
1 (a)	Calculate i_o using mesh analysis in the circuit shown in fig1a.	[07]	CO1	L2
(b)	Find node voltages V_1, V_2, V_3 in the circuit shown in fig1b.	[03]	CO1	L3

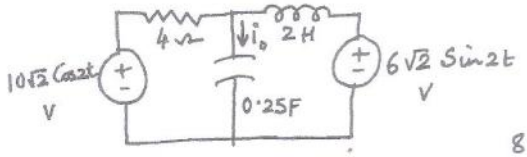

Fig 1a

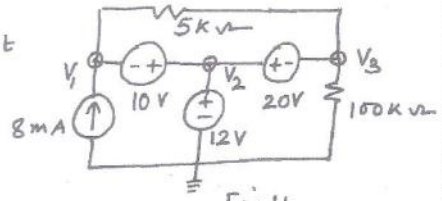

Fig 1b.

2 (a)	Using node and supernode method find power delivered by 20V source in the network shown in fig2a.	[06]	CO4	L2
(b)	Obtain the equivalent resistance R_{ab} for the circuit shown in fig2b.	[04]	CO4	L2

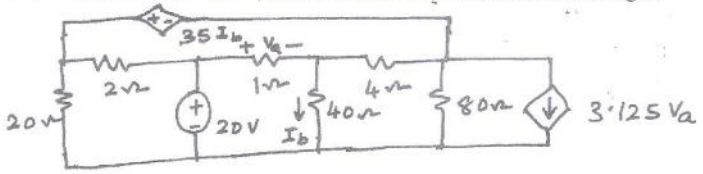

Fig 2a

3 (a)	Using mesh and supermesh analysis, calculate I_x shown in fig3a.	[04]	CO3	L2
(b)	Using source shifting and source transformation method, determine the voltage V shown in fig3b.	[06]	CO4	L5

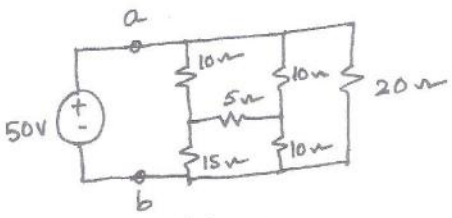

Fig 2b

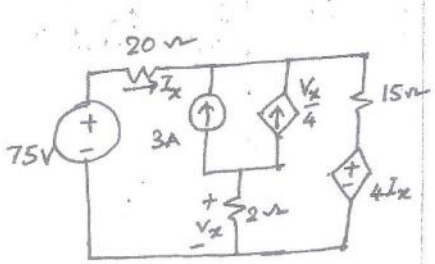

Fig 3a.

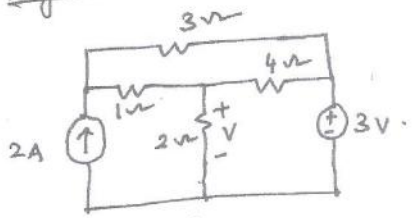

Fig 3b

PTO

4 (a)	Referring the network shown in fig4a, find the power delivered by the dependent voltage source in the network.	[05]	CO4 L4
(b)	Find V_x, I_x in the circuit shown in fig4b.	[05]	CO2 L1

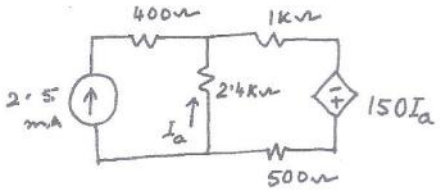

Fig 4a

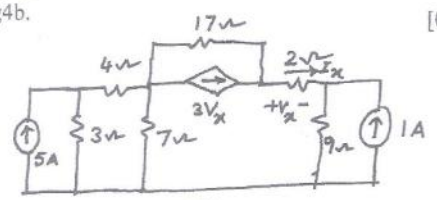

Fig 4b.

5 (a)	Obtain expression to convert delta connected impedances into equivalent star connected impedances.	[05]	CO1 L3
(b)	Find the equivalent resistance R_{ab} for the fig5b.	[05]	CO4 L3

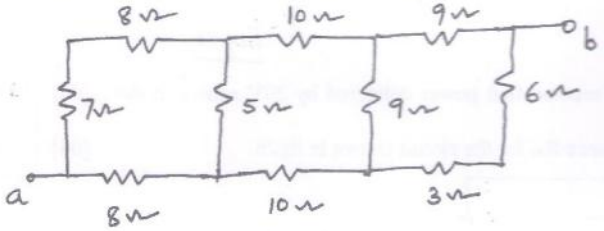

Fig 5b

6.	For the network shown in fig6, write mesh equations for the meshes indicated in time domain. Draw dual network and write it's node equations.	[10]	CO4 L4

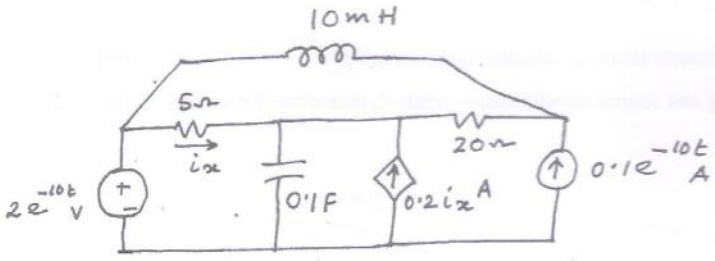

Fig 6

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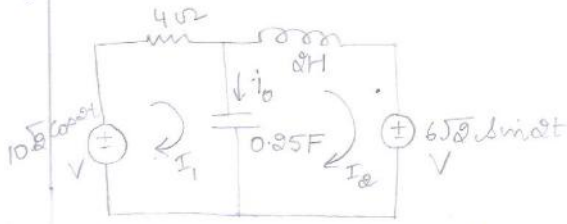
Solution of IAT-1

Subject - Electric Circuit Analysis.

Sub-Code - 15EE32.

3a) Calculate I_o using mesh analysis in the circuit shown in fig



Applying KVL to the first mesh

$$10\sqrt{2}\angle 0^\circ - I_1 4 - (-2j)(I_1 - I_2) = 0$$

$$4I_1 - (2j)I_1 + 2j I_2 = 10\sqrt{2}\angle 0^\circ$$

$$I_1(4-2j) + 2j I_2 = 10\sqrt{2}\angle 0^\circ \quad -(1)$$

KVL to mesh 2

$$-6\angle 0^\circ - (2j)(I_2 - I_1) - (4j)(I_2) = 0$$

$$(-2j)(I_2 - I_1) + (4j)I_2 = 6\angle 0^\circ$$

$$2j I_1 + j I_2 - 2j I_2 = 6\angle 0^\circ$$

$$2j I_1 + 2j I_2 = 6\angle 0^\circ \quad -(2)$$

$$\begin{bmatrix} 4-2j & 2j \\ 2j & 2j \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 10\sqrt{2}\angle 0^\circ \\ 6\angle 0^\circ \end{bmatrix}$$

$$I_1 = \frac{\begin{bmatrix} 10\sqrt{2}\angle 0^\circ & 2j \\ 6\angle 0^\circ & 2j \end{bmatrix}}{\Delta} =$$

$$I_1 = 1.01 + j\,1.01$$

$$I_2 = -1.01 - j\,4.01$$

$$I_o = I_1 - I_2$$

$$= 2.02 + 5.01\,j$$

$\omega = 2$

$2\pi f = 2$

$f = \frac{2}{2\pi} = 0.318$ H

$-jX_C = -j\frac{1}{2\pi f C} = \frac{1}{2j}$

$= 2j$

$jX_L = j(2\pi f L)$

$j(2\times\pi\times 0.318)$

$= 4j$

$\Delta = \begin{vmatrix} 4-2j & 2j \\ 2j & 2j \end{vmatrix}$

$= 8j - 4j^2 - 4j^2$

$= 8j - 8j^2 = 8 + 8j$

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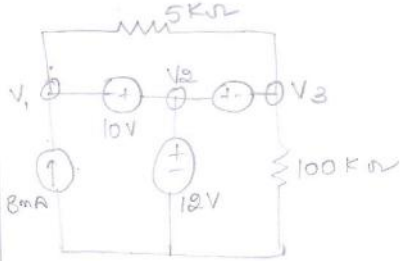
b) Find node ~~an~~ voltage V_1, V_2, V_3 in the circuit shown



$V_2 = 12\,V$

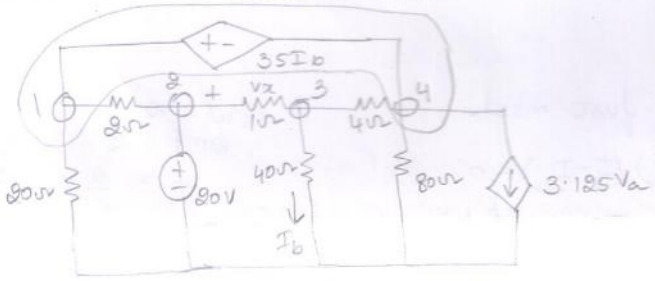
$V_2 - V_3 = 20$

$V_3 = -8\,V$

$V_2 - V_1 = 10\,V$

$V_1 = 2\,V$

2) a) Using node & supernode method find power delivered by 20V source in the network shown.



Constraint eqn at Supernode

$V_1 - V_4 = 35 I_b = 35 \times \frac{V_3}{40}$ — (1)

$V_2 = 20$ — (2)

At supernode KCL

$-I_1 - I_2 + I_4 - I_5 - 3.125 V_a = 0$

$V_a = V_2 - V_3$

$-\frac{V_1 - 0}{20} - \frac{V_1 - V_2}{2} + \frac{V_3 - V_4}{4} - \frac{V_4 - 0}{80} - 3.125(V_2 - V_3) = 0$ — (3)

At node 3 KCL

$I_3 - I_b - I_4 = 0$

$\frac{V_2 - V_3}{1} - \frac{V_3 - 0}{40} - \left(\frac{V_3 - V_4}{4}\right) = 0$ — (4)

$V_1 - V_4 = 0.875 V_3$ — (1)

$V_2 = 20V$

$-4V_1 - 40V_1 + 40V_3 + \frac{20V_3}{80} - 20V_4 - V_4 - 250(V_2 - V_3) = 0$

$-44V_1 - 210V_2 + 270V_3 - 21V_4 = 0$

$$-44V_1 - 4200 + 270V_3 - 81V_4 = 0 \quad -(2)$$

$$40V_2 - 40V_3 - \frac{V_3 - 10V_3}{40} - 10V_3 + 10V_4 = 0$$

$$800 - 51V_3 + 10V_4 = 0 \quad -(5)$$

$V_1 = -20.25\,V$

$V_2 = 20V$

$V_3 = 10\,V$

$V_4 = -29V$

$$I_2 = \frac{V_1 - V_2}{2} = \frac{-20.5 - 20}{2} = -20.25A$$

$$I_3 = \frac{V_2 - V_3}{1} = \frac{20 - 10}{1} = 10A$$

At node 2, KCL

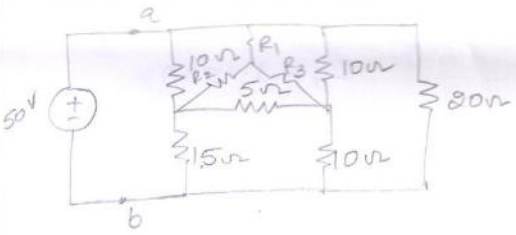
$I_2 - I - I_3 = 0$

$I = I_2 + I_3$

$I = -30.25A$

$P = 20 \times 30.25 = 605\,W$

b) Obtain the equivalent resistance R_{ab} for the circuit

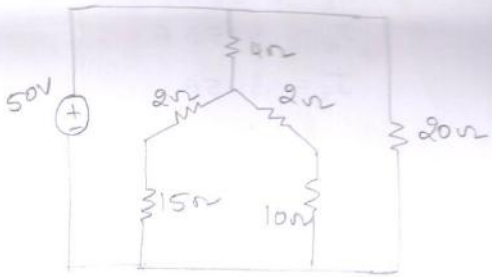


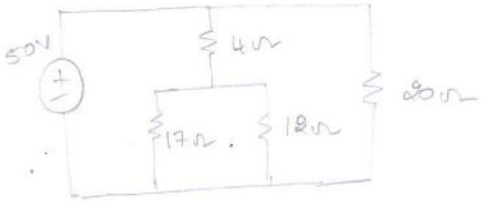
$$R_1 = \frac{10 \times 10}{10+5+10} = 4\Omega$$

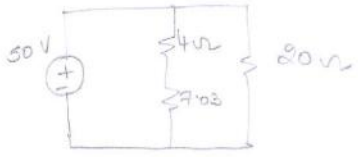
$$R_2 = \frac{10 \times 5}{10+5+10} = 2\Omega$$

$$R_3 = \frac{5 \times 10}{10+5+10} = 2\Omega$$

$R_{AB} = 7.10\Omega$







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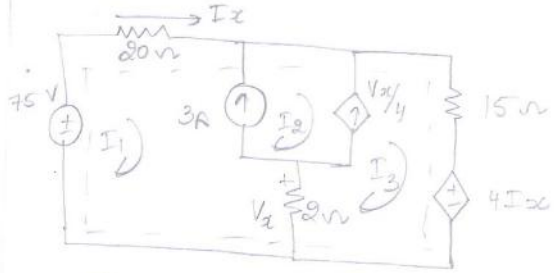
3 a) Using mesh and supermesh analysis calculate I_x



$I_2 - I_1 = 3$ — (1)

$I_3 - I_2 = \frac{V_x}{4} = \frac{1}{2}(I_1 - I_3)$ — (2)

$V_x = 2(I_1 - I_3)$

$I_x = I_1$

$2I_3 - 2I_2 = I_1 - I_3$

$3I_3 - 2I_2 - I_1 = 0$

$75 - 20I_1 - 15I_3 - 4I_1 = 0$

$75 - 24I_1 - 15I_3 = 0$

$I_1 = 1.153\,A$

$I_2 = 4.153\,A$

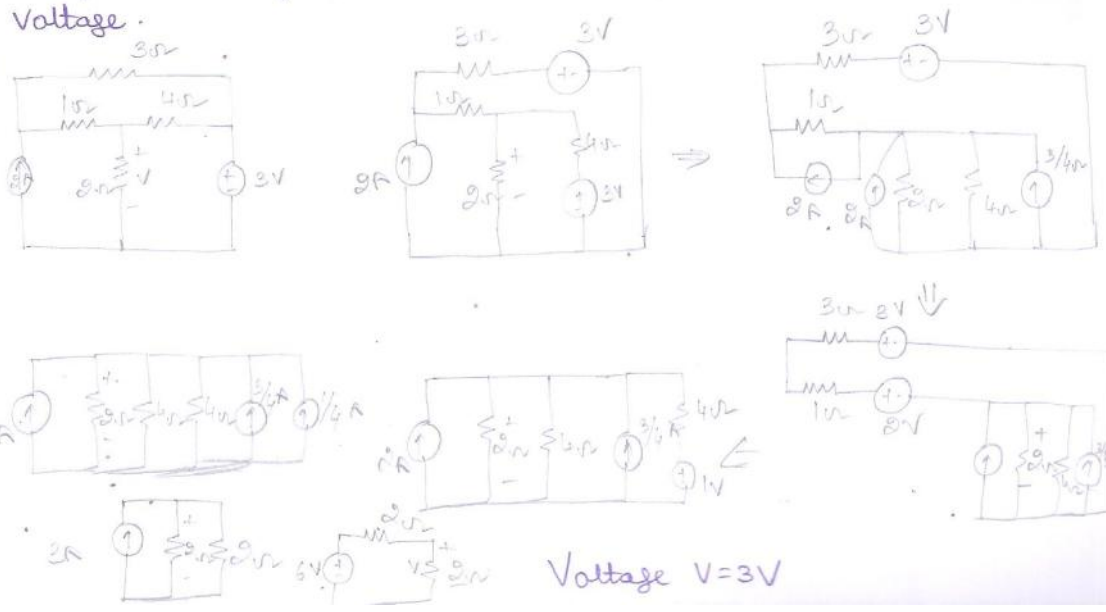
$I_3 = 3.15\,A$

$V_x = 2(1.153 - 3.15)$

$= -3.994\,V$

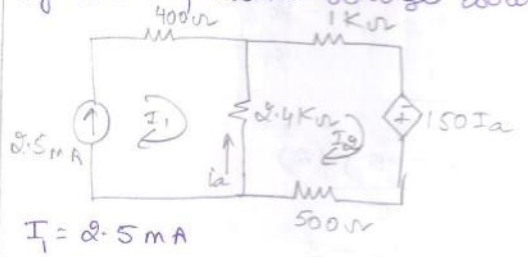
$I_x = 1.153\,A$

b) Using source shifting & source transformation, determine the voltage.



Voltage V=3V

4a) Refering the network shown in fig 4a find the power delivered by the dependent voltage source in the network



$I_1 = 2.5\,mA$

Applying KVL to mesh

$$-(1K)I_2 + (150I_a) - 500(I_2) - (2.4K)(I_2 - I_1) = 0$$

$$1K I_2 - 500 I_2 - (2.4K)I_2 + 150 I_a + (2.4K)I_1 = 0$$

$$-1.9K I_2 + 2.4K(2.5mA) + 150 I_a = 0$$

$$-1.9K I_2 + 150 I_a = 6$$

$$150 I_a - (1.9K) I_2 = 6 \quad -(1)$$

$I_a = I_2 - I_1$

$I_a - I_2 = -I_1$

$I_2 - I_a = 2.5\,mA \quad -(2)$

$I_a = -6.4\,mA$

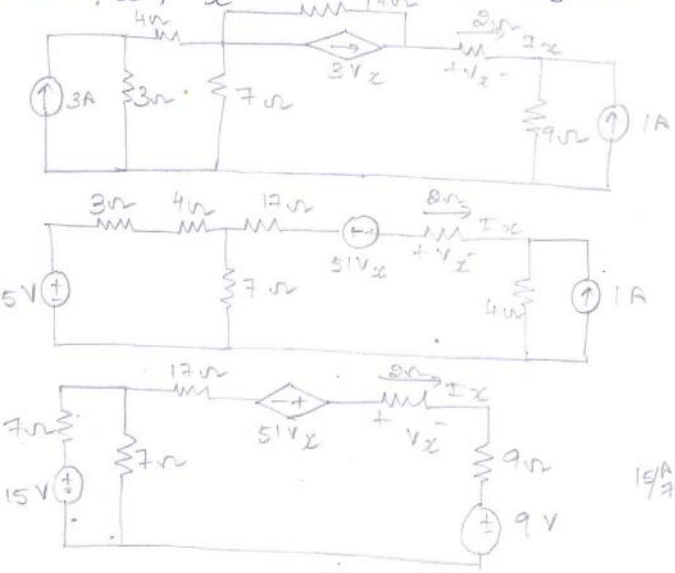
$I_2 = -3.64\,mA$

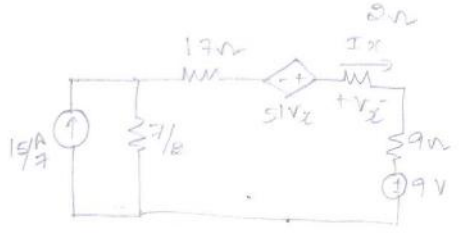
$V = 150(I_a) = 150(-6.14mA)$

$= -0.921\,V$

$P = VI = 3.35\,mW$

b) Find V_x, I_x in the circuit diagram





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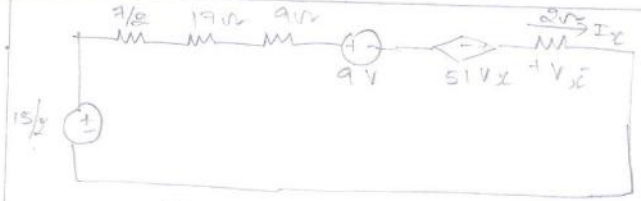
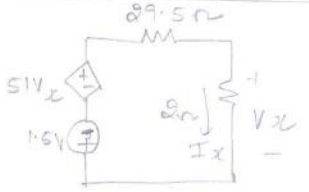
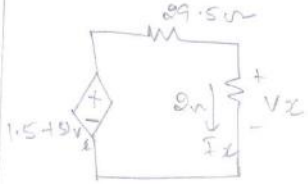






$$V_x = \frac{(51V_x - 1.5)}{31.5} \quad (2)$$

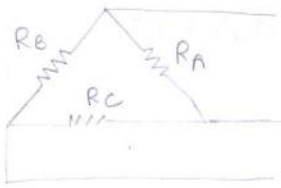
$$31.5V_x = 102V_x - 3$$

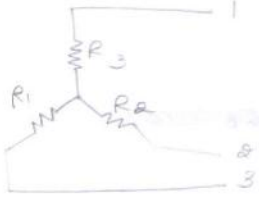
$$31.5V_x - 102V_x = -3$$

$$V_x = 0.0425\ V$$

$$I_x = 21.1mA$$

5 a) Obtain experience to convert delta connected impedances into equivalent star connected impedances.





The resistance across 1 & 2

$$R_{12} = R_A \,||\, (R_B + R_C)$$

$$R_{12} = \frac{A_A\,(R_B + R_C)}{R_A + R_B + R_C}$$

$$R_{12} = R_3 + R_2$$

$$R_3 + R_2 = \frac{R_A(R_B) + R_A R_C}{R_A + R_B + R_C} \quad -(1)$$

The resistance 2 & 3

$$R_{23} = R_C \,||\, (R_A + R_B)$$

$$R_{23} = \frac{R_C\,(R_A + R_B)}{R_A + R_B + R_C}$$

$$R_1 + R_2 = \frac{R_C R_A + R_C R_B}{A_A + R_B + R_C} \quad -(2)$$

The resistance across 3 & 1

$$R_{31} = R_B \,||\, (R_A + R_C)$$

$$= \frac{R_B\,(A_A + R_C)}{R_A + R_B + R_C}$$

$$R_{31} = R_1 + R_3$$

$$R_1 + R_3 = \frac{R_A R_B + R_B R_C}{R_A + R_B + R_C} \quad -(3)$$

Subtract (3) from (1)

$$R_3 + R_2 - R_1 - R_3 = \frac{R_A R_B + R_A R_C - R_A R_B - R_B R_C}{R_A + R_B + R_C}$$

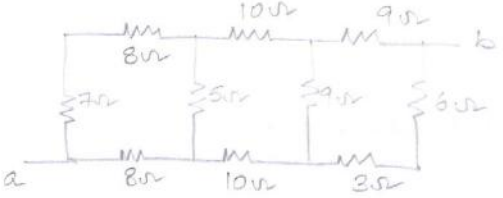
$$R_2 - R_1 = \frac{R_A R_C - R_B R_C}{R_A + R_B + R_C} \quad \text{— (4)}$$

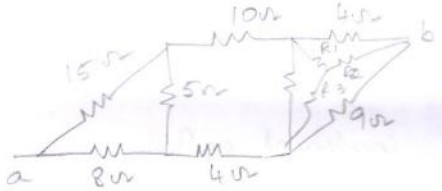
Adding (4) ← (2)

$$2R_2 = 2\frac{R_A R_C}{\Sigma R}$$

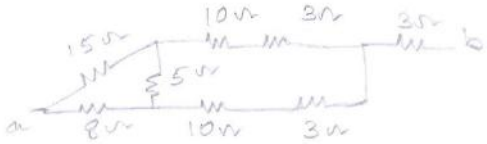
$$R_2 = \frac{R_A R_C}{\Sigma R} \qquad R_1 = \frac{R_B R_C}{\Sigma R} \qquad R_3 = \frac{R_A R_B}{\Sigma R}$$

b) Find the equivalent resistance R_{AB}





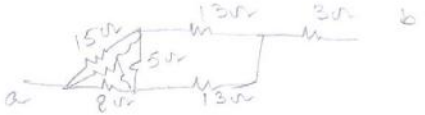
$$R_1 = R_2 = R_3 = \frac{9 \times 9}{9+9+9} = 3\Omega$$



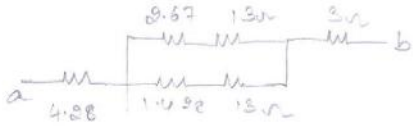
$$R_A = \frac{15 \times 5}{8+15+5} = 2.67\Omega$$

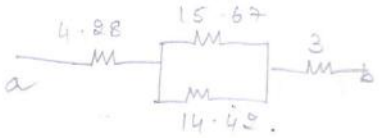
$$R_C = 4.18\Omega$$

$$R_B = 1.428\Omega$$



$$R_{AB} = 14.19\Omega$$





with λ=548nm is used.

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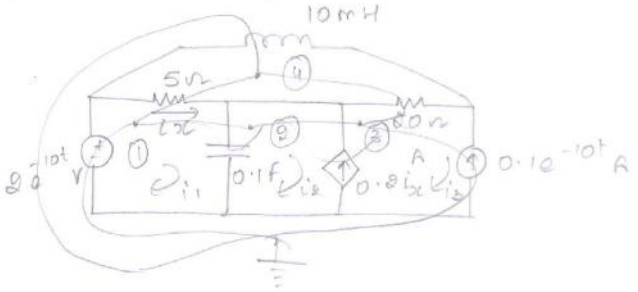
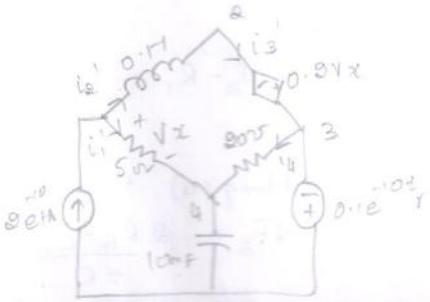
6) For the network shown, write mesh equation for the mesh indicated in time domain.





KVL mesh 1

$$2e^{-10t} - 5(i_1 - i_4) - \frac{1}{0.1}\int (i_1 - i_2)\,dt = 0$$

$$2e^{-10t} - 5V_1 - \frac{1}{0.1}\int (V_1 - V_2)\,dt = 0$$

At node 1, KCL

$$2e^{-10t} - i_1' - i_2' = 0$$

$$2e^{-10t} - 5(V_1 - V_4) - \frac{1}{0.1}\int (V_1 - V_2)\,dt = 0$$

Constraint eqn

$$i_3 - i_2 = 0.2\,i_x = 0.2(i_1 - i_4) \quad -(3)$$

$$i_3 = -0.1e^{-10t} \quad -(4)$$

KVL, mesh 4

$$-10\times10^{-3}\frac{di_4}{dt} - 20(i_4 - i_3) - 5(i_4 - i_1) = 0$$

KCL at node 1

$$2e^{-10t} - i_1' - i_2' = 0$$

$$2e^{-10t} - 5(V_1 - V_4) - \frac{1}{0.1}\cdot\int (V_1 - V_3)\,dt = 0$$

$(V_3 - V_2) = 0.2(V_1 - V_4)$ / $i_x = i_1 - i_4$, $v_x = v_1 - V_4$

$V_3 = -0.1e^{-10t}$ volts

At node 4; KCL

$$i_1' + i_4' - i_5' = 0$$

$$5(V_4 - V_1) + 20(V_4 - V_3) - 10\times10^{-3}dV_4 = 0$$