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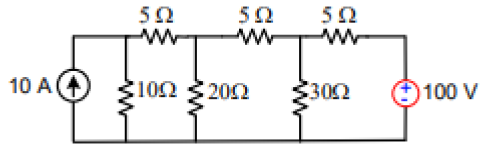
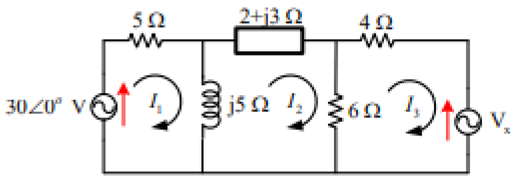
Internal Assessment Test 1 – July 2023

Sub:	Circuits & Controls					Sub Code:	21EC43	Branch:	ECE
Date:	05-07-2023	Duration:	90 Minutes	Max Marks:	50	Sem / Sec:	4/A,B,C,D		OBE

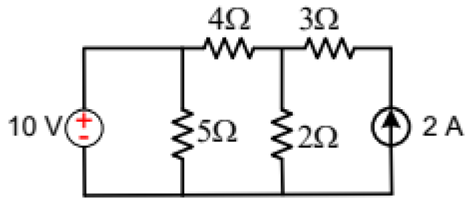
<table>
<tr><th></th><th><u>Answer any FIVE FULL Questions</u></th><th>MARKS</th><th>CO</th><th>RBT</th></tr>
<tr><td>1</td><td>In the circuit shown in fig.1 determine all branch currents by mesh current analysis.
Fig.1



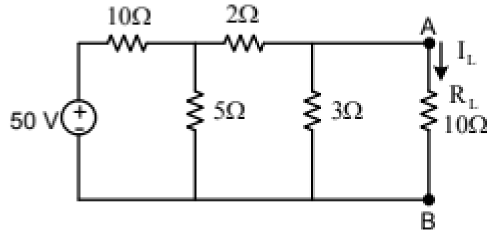
</td><td>[10]</td><td>CO1</td><td>L2</td></tr>
<tr><td>2</td><td>Use loop analysis to find Vx in the circuit shown in fig.2. Such that the current through 2 + j3 Ω is zero.
Fig.2



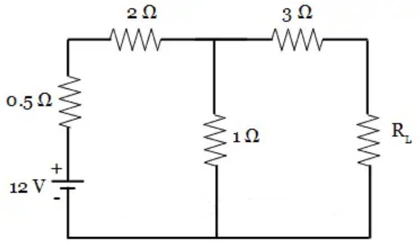
</td><td>[10]</td><td>CO1</td><td>L3</td></tr>
<tr><td>3</td><td>Using superposition theorem find the voltage drop across 2 Ω resistance of the circuit shown in fig.3.
Fig.3



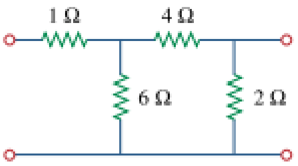
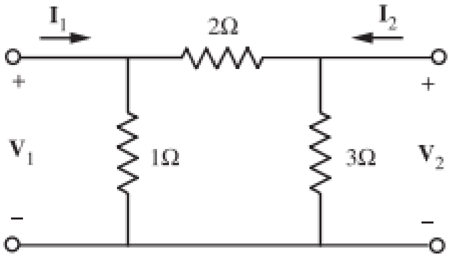
</td><td>[10]</td><td>CO1</td><td>L2</td></tr>
<tr><td>4</td><td>Find the Thevenin and Norton equivalent for the circuit shown in fig.4 with respect terminals A-B
Fig.4



</td><td>[10]</td><td>CO1</td><td>L3</td></tr>
<tr><td>5</td><td>Find the value of R_L at which maximum power is transferred to the load in the following circuit shown in fig.5. Also, find the maximum power transferred.
Fig.5



</td><td>[10]</td><td>CO1</td><td>L2</td></tr>
</table>

6	Obtain the z parameters for the network in Fig. 6. Fig.6.  	[10]	CO2	L2
7	Find the y parameters of the two-port network shown in fig.7. Then determine the current in a 4Ω load, that is connected to the output port when a 2A source is applied at the input port. Fig.7.  	[10]	CO2	L2

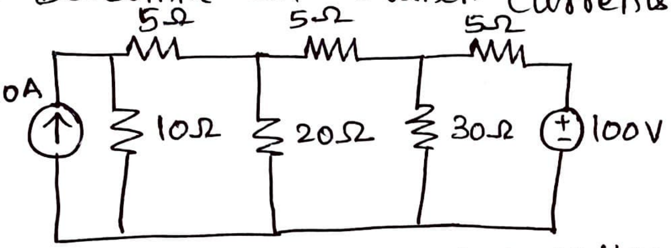
COURSE INSTRUCTOR CCI HOD

21EC43 - Circuits & Controls

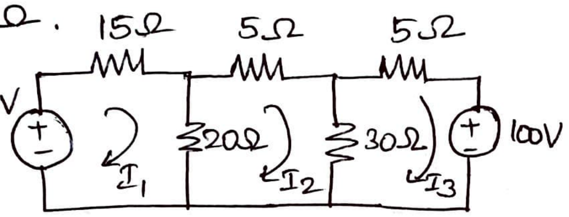
Internal Assessment Test 1

Answer key

1. Determine all branch currents by Mesh Analysis :



Converting current source to voltage source and then 10Ω is in series with 5Ω.



(4 Marks)

Applying the KVL for the loop

$$35I_1 - 20I_2 = 100 \quad \text{—— (1)}$$

$$-20I_1 + 55I_2 - 30I_3 = 0 \quad \text{—— (2)}$$

$$-30I_2 + 35I_3 = -100 \quad \text{—— (3)}$$

$$\Delta = \begin{bmatrix} 35 & -20 & 0 \\ -20 & 55 & -30 \\ 0 & -30 & 35 \end{bmatrix}$$

$$= 25875 - 14000 = 21875$$

$$\Delta 1 = \begin{bmatrix} 100 & -20 & 0 \\ 0 & 55 & -30 \\ -100 & -30 & 35 \end{bmatrix} = 42500$$

$$\frac{\Delta 1}{\Delta} = \frac{42500}{21875} \Rightarrow \boxed{I_1 = 1.9428\text{ A}}$$ (2 Marks)

$$\Delta 2 = \begin{bmatrix} 35 & 100 & 0 \\ -20 & 0 & -30 \\ 0 & -100 & 35 \end{bmatrix} = -35000$$

$$\frac{\Delta 2}{\Delta} = \frac{-35000}{21875} \Rightarrow \boxed{I_2 = -1.6\text{A}}$$ (2 Marks)

$$\Delta 3 = \begin{bmatrix} 35 & -20 & 100 \\ -20 & 55 & 0 \\ 0 & -30 & -100 \end{bmatrix}$$

$$= 35(-5500) + 20(2000) + 100(600)$$

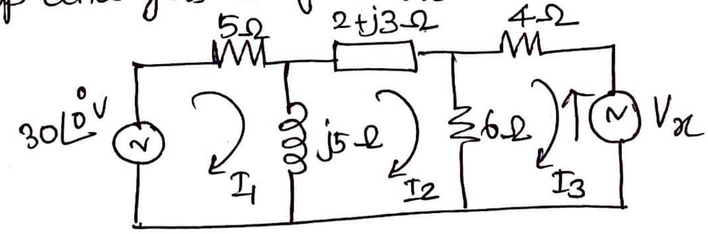
$$= -192500 + 40000 + 60000$$

$$= -92500$$

$$\frac{\Delta 3}{\Delta} = \frac{-92500}{21875} \Rightarrow \boxed{I_3 = -4.2285\text{A}}$$ (2 Marks)

$$\boxed{I_1 = 1.9428\text{A},\ I_2 = -1.6\text{A},\ I_3 = -4.2285\text{A}}$$

2. Use loop analysis to find V_x, such that the current through $2+j3\,\Omega$ is zero.



Applying KVL to mesh I_1

$$5I_1 + j5(I_1 - I_2) - 30\angle 0^\circ = 0$$

$$(5+j5)I_1 - j5I_2 = 30\angle 0^\circ \quad \text{--- (1)}$$

(2 Marks)

Applying KVL to mesh I_2

$$(2+j3)I_2 + 6(I_2 - I_3) + j5(I_2 - I_1) = 0$$

$$-j5I_1 + (8+j8)I_2 - 6I_3 = 0 \quad \text{--- (2)}$$

(2 Marks)

Applying KVL to mesh I_3

$$4I_3 + 6(I_3 - I_2) + V_x = 0$$

$$-6I_2 + 10I_3 = -V_x \quad \text{--- (3)}$$

(2 Marks)

$$\Delta = \begin{bmatrix} 5+j5 & -j5 & 0 \\ -j5 & 8+j8 & -6 \\ 0 & -6 & 10 \end{bmatrix}$$

$$= (5+j5)(80+j80-36) + j5(-j50)$$

$$= 870 + j620 = 1068\angle 35.47$$

Finding V_x.

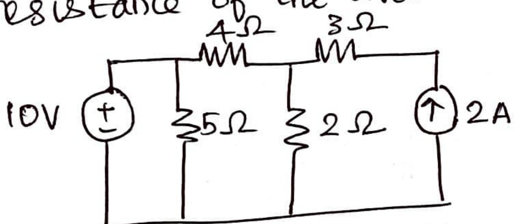
$$\Delta_2 = \begin{bmatrix} 5+j5 & 30 & 0 \\ -j5 & 0 & -6 \\ 0 & -V_x & 10 \end{bmatrix}$$

$$0 = (5+j5)(-6V_x) + j1500$$

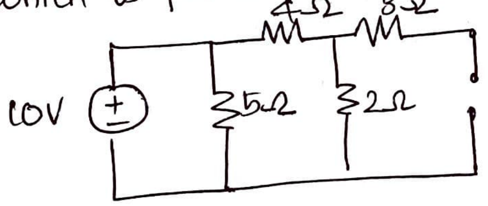
$$6V_x = \frac{j1500}{5+j5} = \frac{1500\angle 90^\circ}{707\angle 45}$$ (4 Marks)

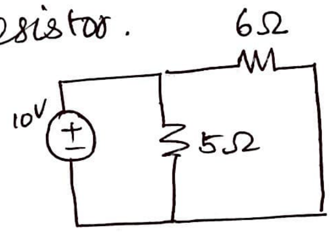
$$\boxed{V_x = 35.36\angle 45^\circ \text{ V}}$$

3. Using superposition theorem, find the voltage drop across 2Ω resistance of the circuit



Considering a single voltage source of 10V and the current source is kept open. So the 4Ω and 2Ω resistors are connected in series, which is parallel with 5Ω resistor.





(4 Marks)

$$R = \frac{5\times 6}{5+6} = 2.727\Omega$$

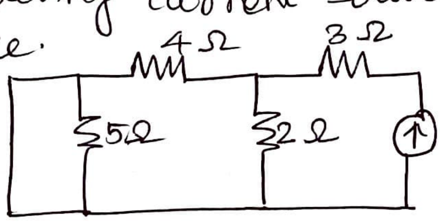
$$I = \frac{V}{R} = \frac{10}{2.727} = 3.666A$$

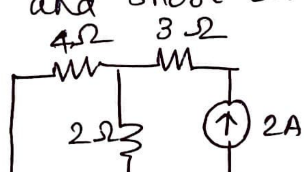
Using current division method, the current through 2Ω resistor is

$$I_1 = \frac{3.666 \times 5}{5+6} = 1.666 \text{ A}$$

$$\boxed{I_1 = 1.666 \text{ A}}$$

Considering current source of 2A and short circuiting the voltage source.





$$R = \frac{4\times 2}{4+2} = 1.333\Omega$$

(4 Marks)

Using current division method, the current through 2Ω resistor is

$I_1 = \frac{2(1.333)}{2} = 1.333A.$

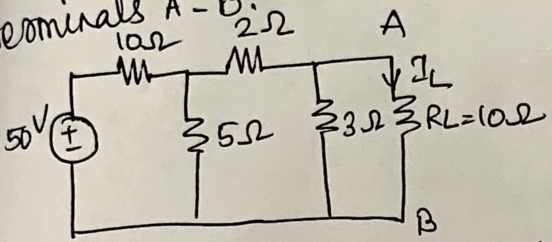
Total current in the 2Ω resistor is

$I_1 = 1.666A + 1.333A = 3A$ (2 Marks)

Voltage across 2Ω resistor is

$V = 2 \times 3 = 6V.$

4. Find Thevenin and Norton equivalent for the circuit with respect to terminals A - B.



Determine the Thevenin voltage V_{TH}. (2 Marks)

Apply KVL for the circuit given

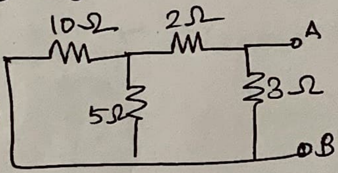
$15x - 5y = 50$

$-5x + 10y = 0$

By solving $x = 4A, y = 2A$

$V_{TH} = 2A \times 3 = 6V$ (2 Marks)

Find R_{TH}.



$R_{TH} = [(10 \| 5) + 2] \| 3$

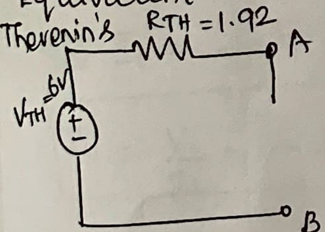
$= [3.33 + 2] \| 3$

$= 5.33 \| 3$

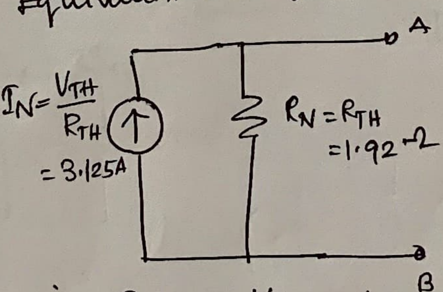
$R_{TH} = 1.92Ω$ (3 Marks)

(3 Marks)

Equivalent ckt. Thevenin's

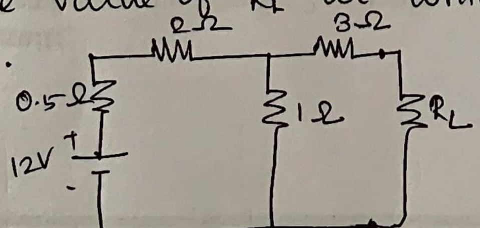


Equivalent ckt. of Nortons



Current through R_L is $I_L = \frac{V_{TH}}{R_L} \Rightarrow \frac{6}{1.92+10} = 0.503A.$

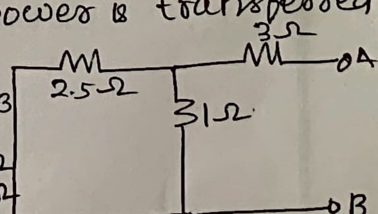
5. Find the value of R_L at which maximum power is transferred to load.



$R_{TH} = \frac{2.5 \times 1}{2.5+1} + 3$

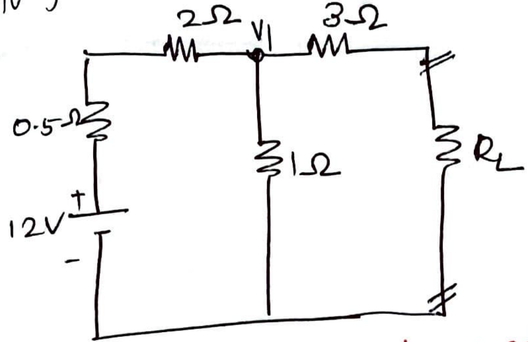
$= 3.714Ω$

$= \cancel{4.3636Ω}$



(2 Marks)

To find V_{TH} remove R_L.



$V_{TH} = V_1$

Apply KCL to the circuit.

$$\frac{V_1 - 12}{2.5} + \frac{V_1}{1} + \cancel{\frac{V_1}{3}} = 0 \Rightarrow \frac{V_1 - 12 + 2.5V_1}{2.5} = 0$$

$$\frac{3V_1 \cancel{- 36 + 7.5V} + 2.5V_1}{\cancel{7.5}} \cancel{= 0}$$

$\cancel{13V_1 = 36}$

$\boxed{\cancel{V_1 = 2.76V}}$

$3.5V_1 = 12$

$\boxed{V_1 = 3.43V}$

(2 Marks)

(4 Marks)

$R_L = R_{eq} = R_{TH}$.

$= 3.714\Omega$

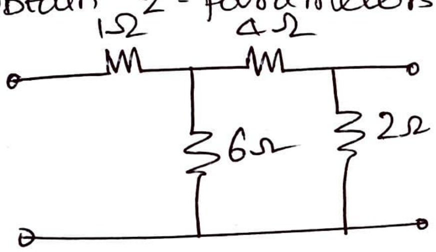
$= \cancel{1.3636\ \Omega}$.

$$P_{Max} = \frac{V_{TH}^2}{4 R_L} = \frac{(3.43)^2 \quad \cancel{(2.76)^2}}{4 \times \cancel{1.3636}\ 3.714\Omega} = \frac{11.7\cancel{6}176}{14.85\cancel{6}} = \cancel{1.396W}$$

(2 Marks)

$P = 0.7919W$

6. obtain Z-parameters.



Z parameter eq.

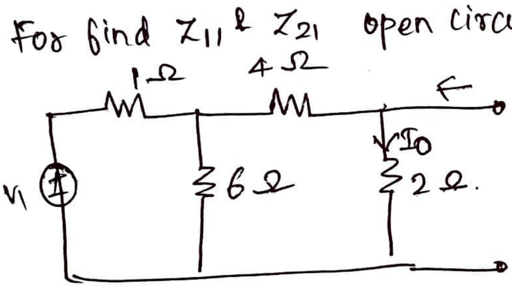
$V_1 = Z_{11} I_1 + Z_{12} I_2$

$V_2 = Z_{21} I_1 + Z_{22} I_2$.

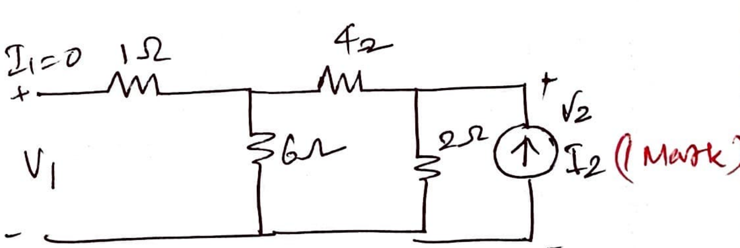
$Z_{11} = \left.\frac{V_1}{I_1}\right|_{I_2 = 0}$ $Z_{21} = \left.\frac{V_2}{I_1}\right|_{I_2 = 0}$

$Z_{12} = \left.\frac{V_1}{I_2}\right|_{I_1 = 0}$ $Z_{22} = \left.\frac{V_2}{I_2}\right|_{I_1 = 0}$

For find Z_{11} & Z_{21} open circuit → I_2.



(1 Mark)



(1 Mark)

$Z_{11} = \frac{V_1}{I_1} \Rightarrow$ Resistance $R = \frac{6 \times 6}{6+6} + 1$

$= 4\Omega$

$\cancel{\bullet}\ I_0 = \frac{1}{2} I_1 \Rightarrow I_1 = 2I_0$

$\boxed{Z_{11} = \frac{V_1}{I_1} = 4\Omega}$ (2 Marks)

$V_2 = 2 I_0 = I_1$

$\boxed{Z_{21} = \frac{V_2}{I_1} = 1\Omega}$ (2 Marks)

$Z_{22} = \frac{V_2}{I_2} = 2 \parallel (4+6)$ (2 Marks)

$= 1.667\Omega$

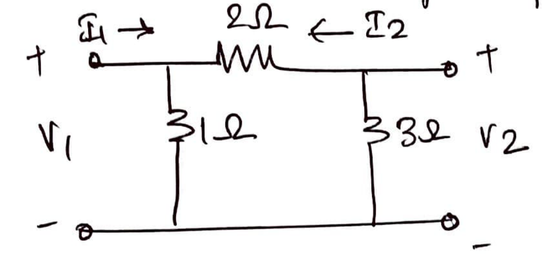
$I_0 = \frac{2}{2+10} I_2 = \frac{1}{6} I_2$

$V_1 = 6I_0 = I_2$

$Z_{12} = \frac{V_1}{I_2} = 1\Omega$. (2 Marks)

$$\begin{bmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{bmatrix} = \begin{bmatrix} 4 & 1 \\ 1 & 1.667 \end{bmatrix} \Omega.$$

Find Y Parameter, then determine the current in a 4Ω load, that is connected to the output port when a 2A source is connected to the input port.



To find y_{11} & y_{21} → SC → o/p terminal

$$I_1 = \frac{V_1}{1\Omega \| 2\Omega} = \frac{V_1}{\frac{1\times 2}{1+2}} = \frac{3}{2} V_1$$

$$\boxed{y_{11} = \left.\frac{I_1}{V_1}\right|_{V_2=0} = \frac{3}{2}\ S}$$

(1 Mark)

Using CD rule

$$-I_2 = \frac{I_1 \times 1}{1+2} = +\frac{1}{3} I_1$$

$$-I_2 = \frac{1}{3} I_1 \Rightarrow -I_2 = \frac{1}{3}\left(\frac{3}{2}\right)V_1 = \frac{1}{2} V_1$$

$$\boxed{y_{21} = \frac{I_2}{V_1} = -\frac{1}{2}\ S}$$

(2 Marks)

To find y_{12} and y_{22}, SC ⟶ i/p terminals.

$$I_2 = \frac{V_2}{2\Omega \| 3\Omega} = \frac{V_2}{\frac{2\times 3}{2+3}} = \frac{5V_2}{6} \Rightarrow \boxed{y_{22} = \frac{I_2}{V_2} = \frac{5}{6}\ S}$$

(1 Mark)

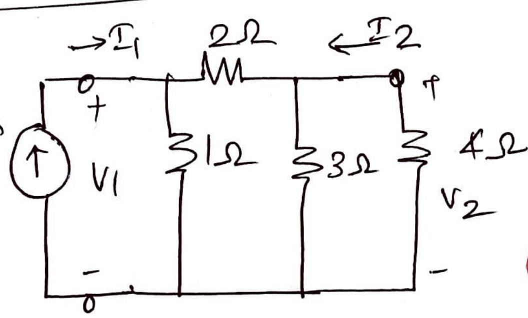
Using CD rule $-I_1 = \dfrac{I_2 \times 3}{2+3} = \; -I_1 = \dfrac{3}{5} I_2$

$$\boxed{y_{12} = \frac{-I_1}{V_2} = \frac{3/5\, I_2}{6/5\, I_2} = -\frac{1}{2}\ S}$$

(2 Marks)

$$I_1 = \frac{3}{2} V_1 - \frac{1}{2} V_2 \quad \text{— (1)}$$

$$I_2 = -\frac{1}{2} V_1 + \frac{5}{6} V_2 \quad \text{— (2)}$$



$$\begin{bmatrix} \frac{3}{2} & -\frac{1}{2} \\ -\frac{1}{2} & \frac{5}{6} \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} I_1 \\ I_2 \end{bmatrix}$$

(4 Marks)

$I_1 = 2A$, $V_2 = -4 I_2$. substituting we get

$$2 = \frac{3}{4} V_1 - \frac{1}{2} V_2$$

Mul. eq (2) by (-4) we get, $-4 I_2 = 2V_1 - \frac{20}{6} V_2$.

$$V_2 = 2V_1 - \frac{20}{6} V_2$$

$$0 = 2V_1 - \left(\frac{20}{6} + 1\right) V_2$$

$$0 = -\frac{1}{2} V + \frac{13}{12} V_1$$

Solving we get $V_2 = \frac{3}{2} V$, $I_2 = -\frac{1}{4} V_2 = -\frac{3}{8}$ A.