CAIRO UNIVERSITY FACULTY OF ENGINEERING *Revision*	*ELECTRIC CIRUITS*	ELECTRONICS AND COMMUNICATION DEPT. **2^{nd} Year** *Sheet (1)*

[1]Using nodal analysis for the circuit shown in Fig.1 , calculate the current I_o and the power dissipated in the resistance R .

[2]Find V_o in the circuit shown in Fig.2 using node analysis .

[3]Using loop equations ,calculate the voltage across the resistance R in the circuit Shown in Fig.3 .

[4]Calculate the power dissipated in the 3Ω resistor in the circuit shown in Fig.4 .

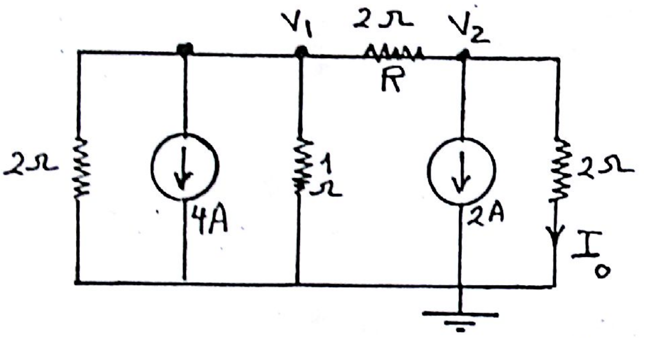

Fig.1

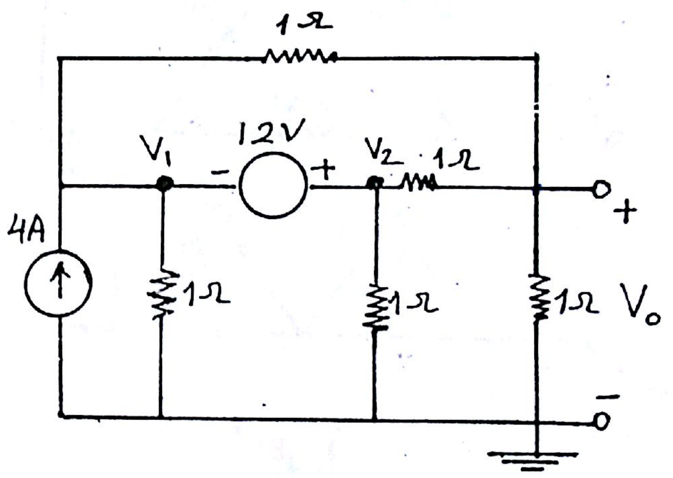

Fig.2

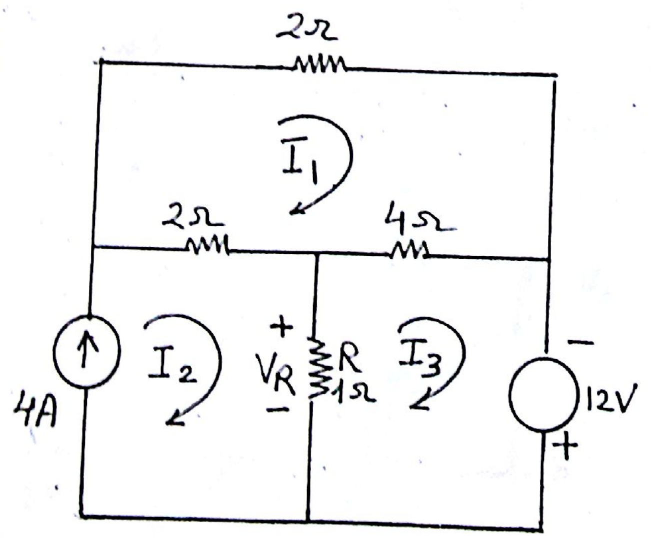

Fig.3

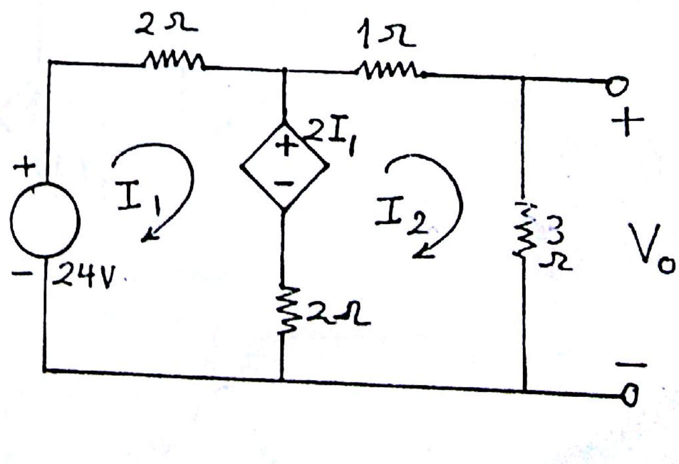

Fig.4

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[5]Use loop equations to calculate the output voltage V_o of the circuit shown in Fig.5 .

[6]Calculate the voltage V_o in the circuit shown in Fig.6 using the superposition theorem.

[7]Apply Thevenin's theorem to calculate the voltage V_o in the circuit shown in Fig.7 .

[8]Use Thevenin's theorem to calculate the output voltage V_o of the circuit shown in Fig.8.

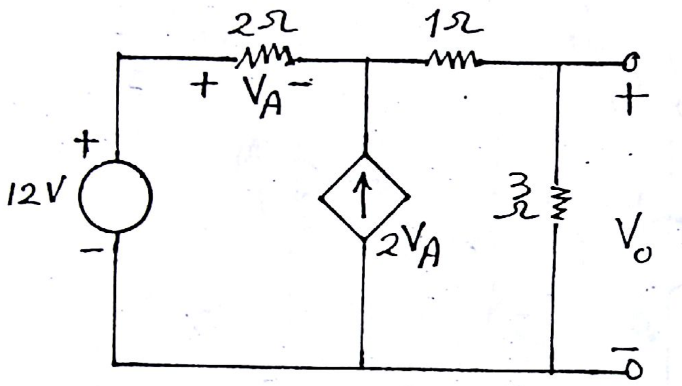

Fig.5

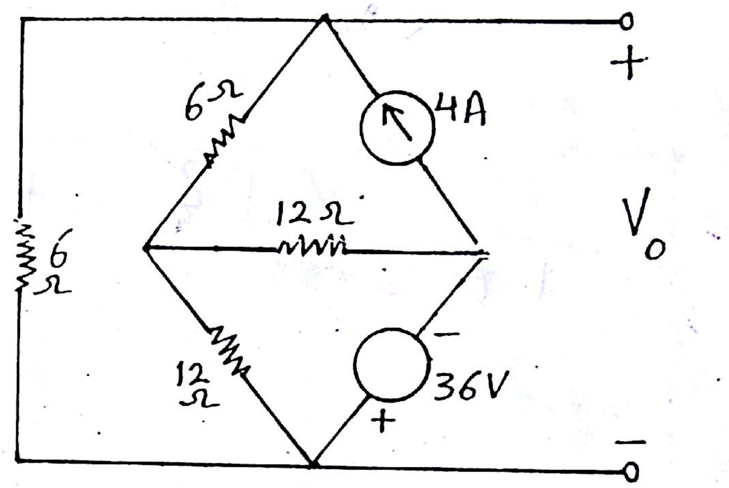

Fig.6

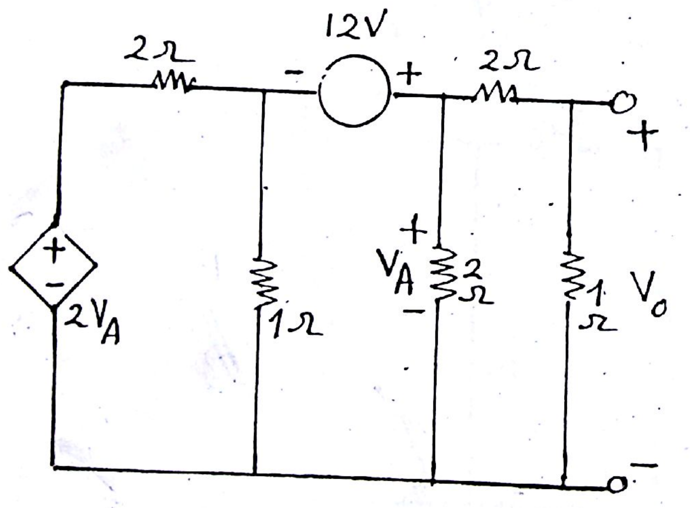

Fig.7

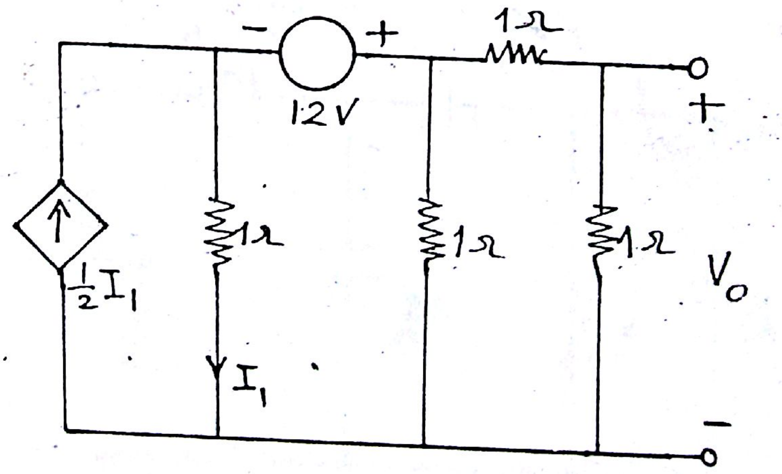

Fig.8

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[9]Apply Norton's theorem to find the current I_o in the circuit shown in Fig.9 .

[10]Calculate the value of the resistance R_L in the circuit shown in Fig.10 to receive maximum power and the value of this power .

[11]Calculate the input impedance Z_{in} to the circuit shown in Fig.11 .

[12]Calculate the input admittance Y_{in} to the circuit shown in Fig.12 .

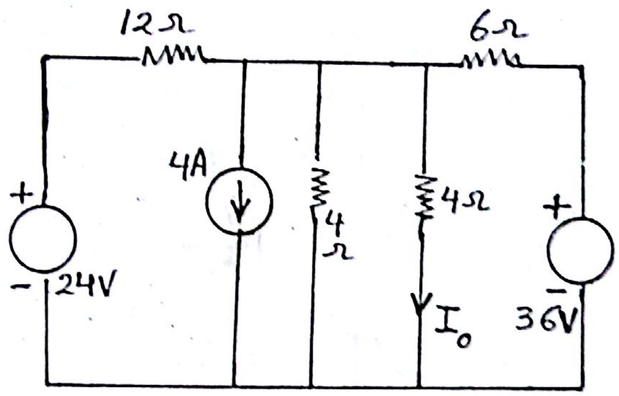

Fig.9

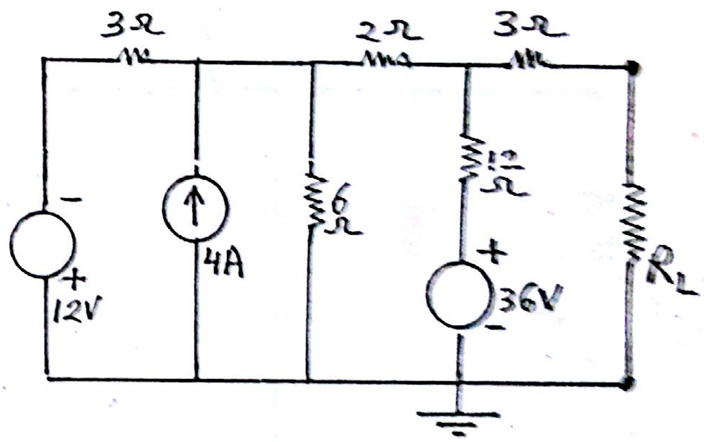

Fig.10

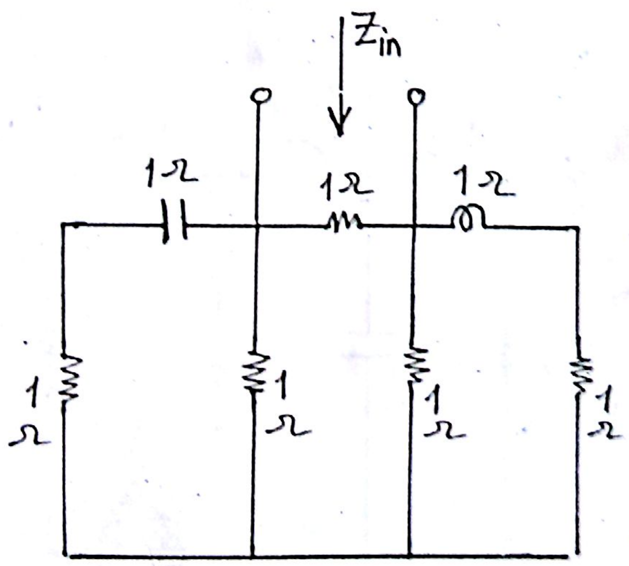

Fig.11

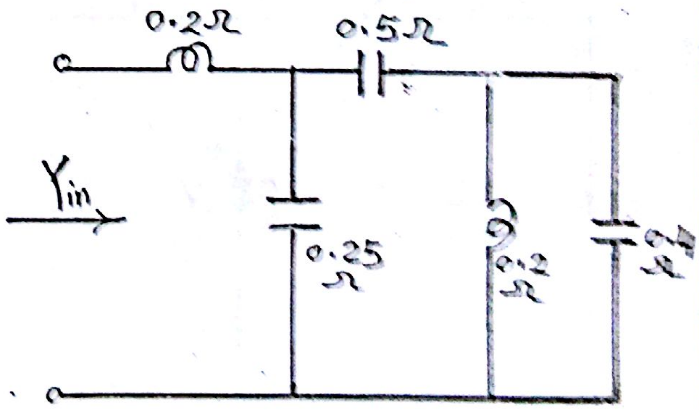

Fig.12

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[13]Make the necessary analysis to calculate the branch currents of the circuit shown in Fig.13 .

[14]Find the source current I_s in the circuit shown in Fig.14 if the output voltage V_o is $12\angle 0°$ volts .

[15]For the circuit shown in Fig.15 , calculate the output voltage V_o .

[16]Calculate the source voltage V_s in the circuit shown in Fig.16 if $V_1 = 4 \angle 0°$ volts .

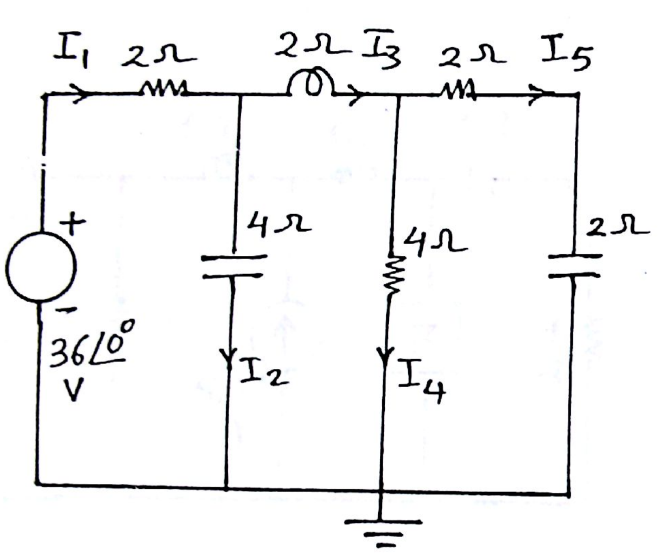

Fig.13

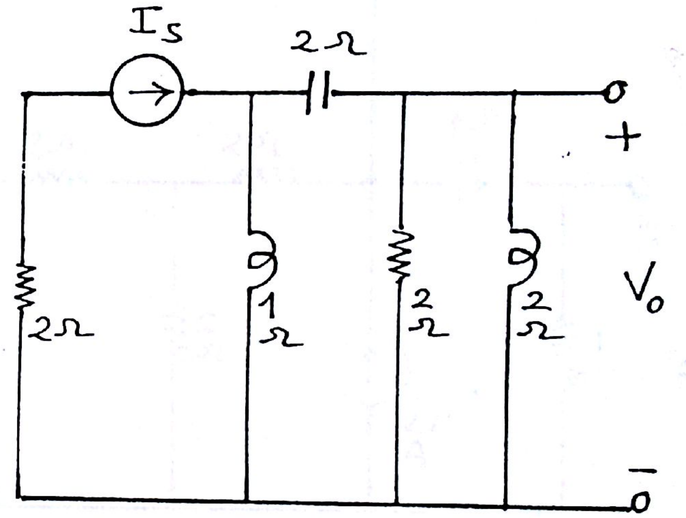

Fig.14

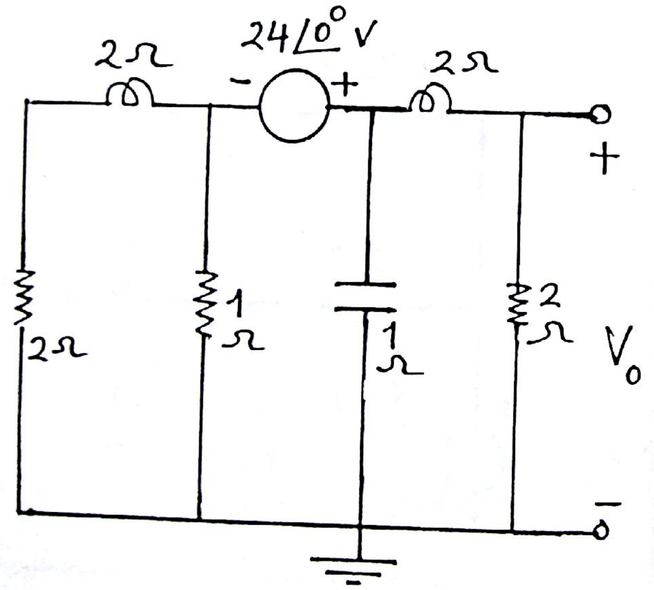

Fig.15

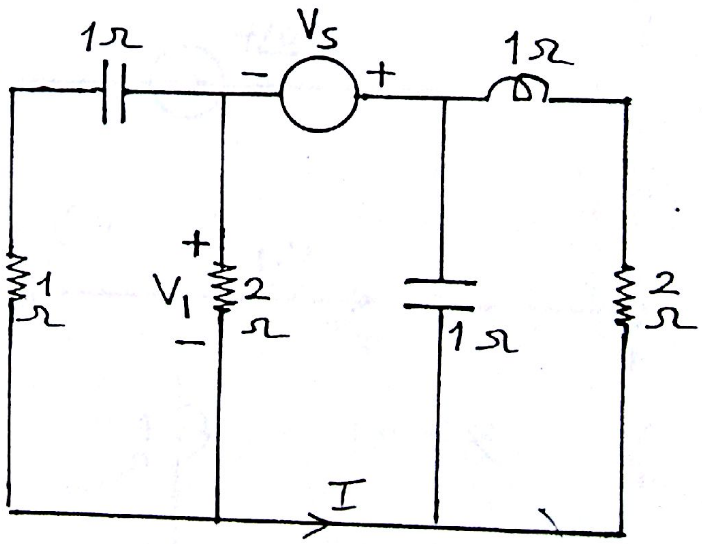

Fig.16

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[17]In the circuit shown in Fig.17, $V_1 = 2\angle 45^0$ volts. Calculate the impedance Z.

[18]Calculate the output voltage V_o in the circuit shown in Fig.18.

[19]Given the circuit shown in Fig.19, write the loop equations to calculate the currents I_1 and I_2.

[20]In the circuit shown in Fig.20, calculate the voltage V_R.

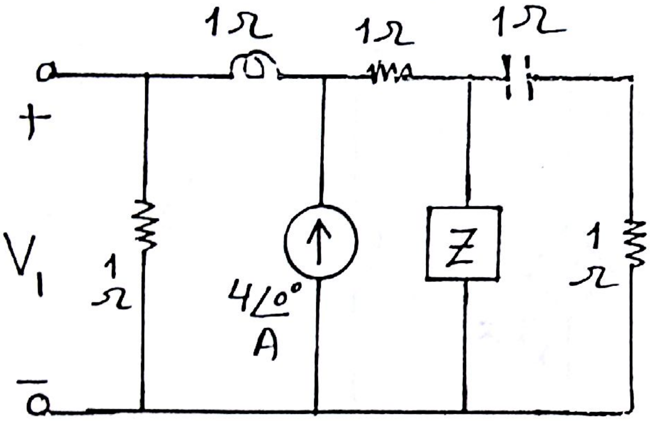

Fig.17

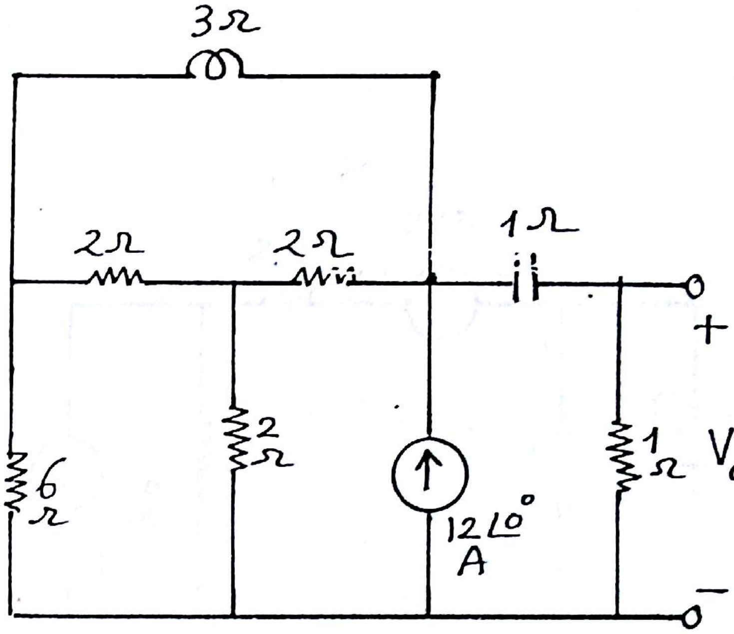

Fig.18

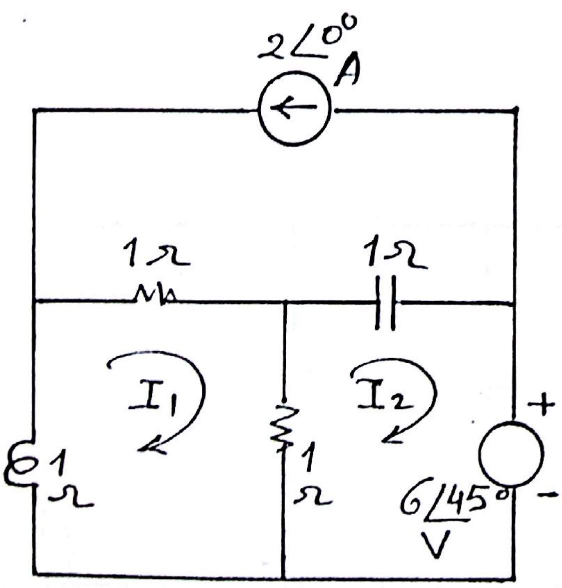

Fig.19

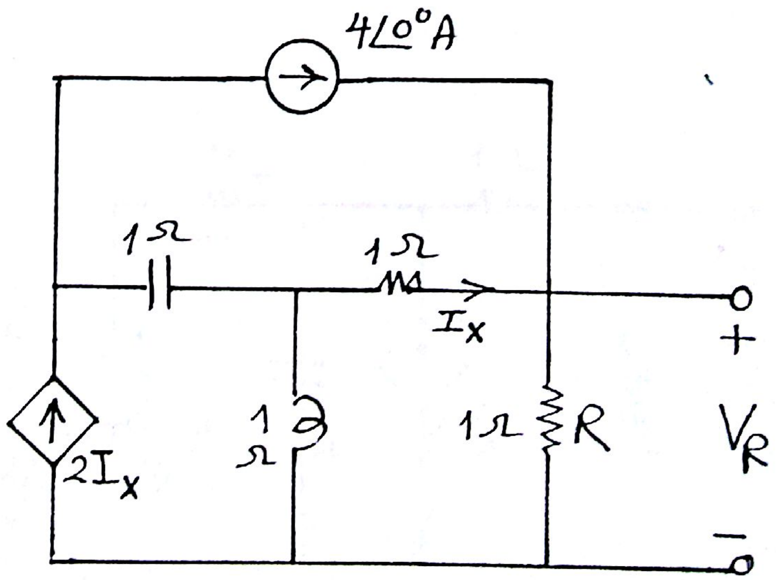

Fig.20

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[21] Use Thevenin's theorem to calculate the voltage V_o in the circuit shown in Fig.21 .

[22] Determine the value of the load impedance Z_L , shown in Fig.22 , to receive maximum average power and the value of this power .

[23] Calculate the average power absorbed by the 4 Ω resistor shown in Fig.23 .

[24] Calculate the value of the load impedance Z_L , shown in Fig.24 , to receive maximum average power and the value of this power .

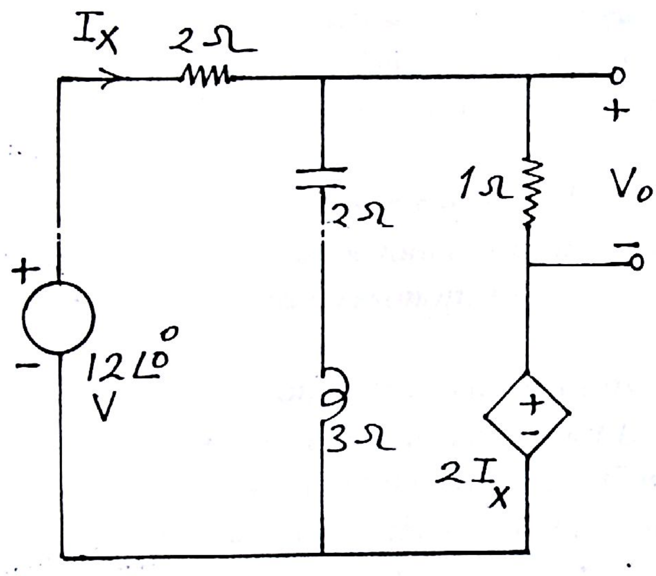

Fig.21

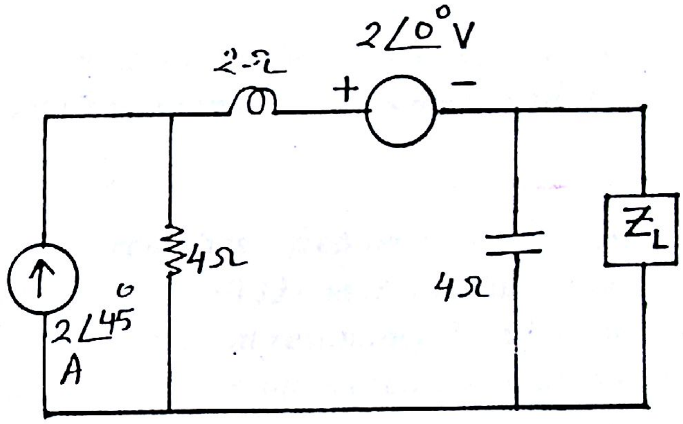

Fig.22

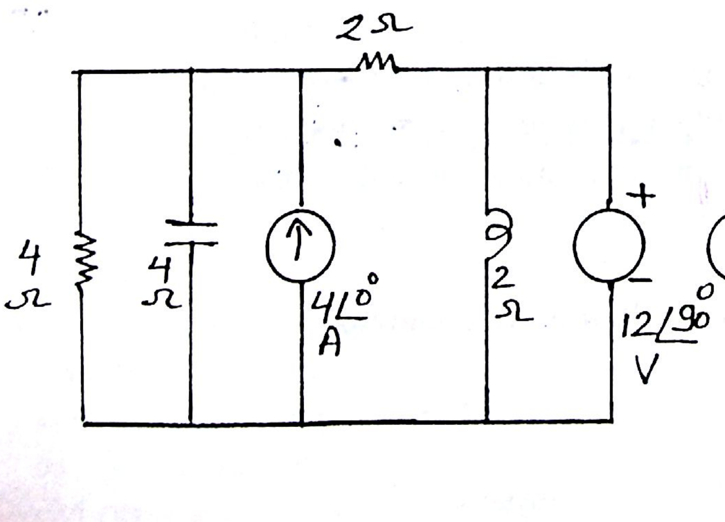

Fig.23

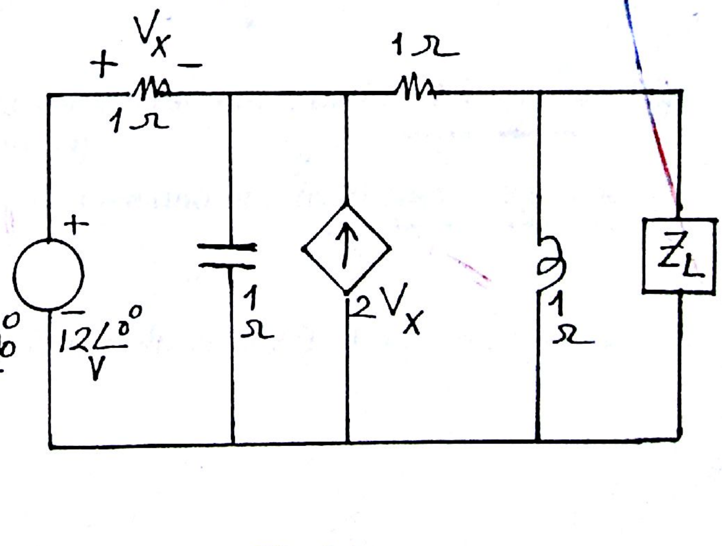

Fig.24

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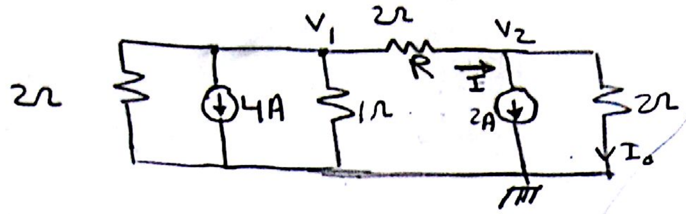
Sheet ① Revision

1



Apply Nodal Analysis

$$\begin{bmatrix} 2 & -0.5 \\ -0.5 & 1 \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} -4 \\ -2 \end{bmatrix}$$

Solve to get $V_1 = -20/7$ V

$V_2 = -24/7$ V

to get I_o: $I_o = I - 2$

$$I_o = \frac{V_1 - V_2}{2} - 2 = \frac{-12}{7} \text{ A} \quad \text{or} \quad I_o = \frac{V_2}{2}$$

$$P_R = I^2 * R = \left(\frac{2}{7}\right)^2 * 2 = \frac{8}{49} \text{ watt} \quad \text{or} \quad \frac{(V_1 - V_2)^2}{R}$$

checking Power balance (Not Required)

$$P_{2\Omega} = \frac{V_1^2}{R} = \frac{200}{49} \text{ watt}$$

$$P_{1\Omega} = \frac{V_1^2}{R} = \frac{400}{49} \text{ watt}$$

$$P_{2\Omega} = I_o^2 * R = \frac{288}{49} = \frac{V_2^2}{R} = \frac{288}{49} \text{ Watt}$$

$$\sum P_{diss.} = \frac{8}{49} + \frac{200}{49} + \frac{400}{49} + \frac{288}{49} = \boxed{\frac{128}{7}} \text{ watt}$$

$$P_{4A} = (0 - V_1) * 4 = \frac{20}{7} * 4 = \frac{80}{7} \text{ watt}$$

$$P_{2A} = (0 - V_2) * 2 = \frac{24}{7} * 2 = \frac{48}{7} \text{ watt}$$

$$\sum P_{supplied} = \frac{80 + 48}{7} = \boxed{\frac{128}{7}} \text{ Watt}$$

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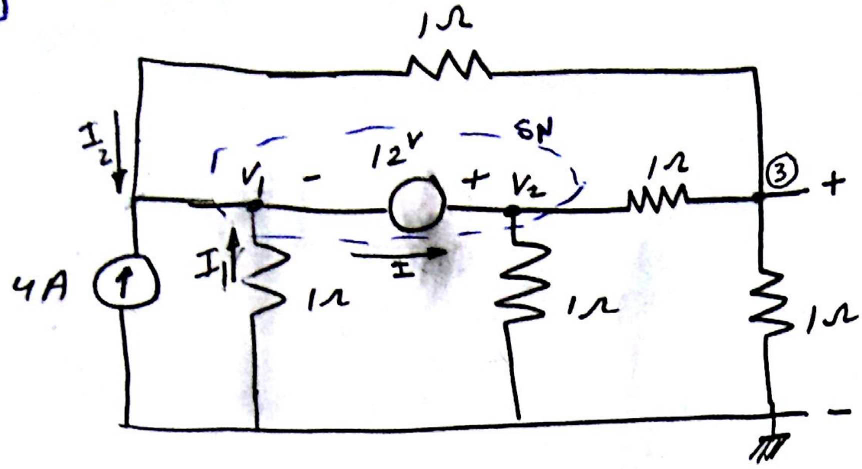
(2)



$$
\begin{array}{l}
SN(1,2) \\
V\ eqn \\
Node\ ③
\end{array}
\begin{bmatrix} 2 & 2 & -2 \\ -1 & 1 & 0 \\ -1 & -1 & 3 \end{bmatrix}
\begin{bmatrix} V_1 \\ V_2 \\ V_3 \end{bmatrix}
=
\begin{bmatrix} 4 \\ 12 \\ 0 \end{bmatrix}
$$

Solve to get $V_1 = \frac{-9}{2}\,V$

$V_2 = \frac{15}{2}\,V$

$V_3 = 1\,V$

$\therefore\ V_o = V_3 = \underline{\underline{1}}\,V$

<u>Power</u> (Not Required)

$$\Sigma P_{diss} = \frac{V_1^2}{1} + \frac{V_2^2}{1} + \frac{V_3^2}{1} + \frac{(V_2-V_3)^2}{1} + \frac{(V_1-V_3)^2}{1} = \underline{\underline{150}}\ \text{watt}$$

$P_{4A} = V_1 * 4 = -18$ watt

$P_{12V} = 12 * I$

$$I = 4 + I_1 + I_2 = 4 + \left(\frac{9/2}{1}\right) + \left(\frac{1+9/2}{1}\right) = \underline{\underline{14}}\ A$$

$\therefore\ P_{12V} = 12 * 14 = 168$ watt

$\Sigma P_{supp.} = 168 - 18 = \underline{\underline{150}}$ watt

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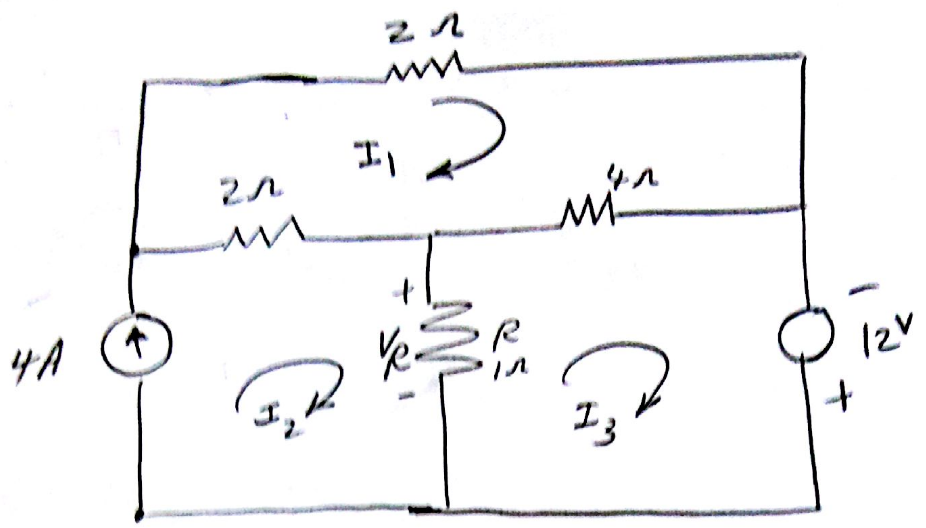
3



$$\begin{array}{l} \text{loop 1} \\ \text{loop 3} \\ \text{current equation} \end{array} \begin{bmatrix} 8 & -2 & -4 \\ -4 & -1 & 5 \\ 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} 0 \\ 12 \\ 4 \end{bmatrix}$$

$I_1 = \frac{13}{3}$ A

$I_2 = 4$ A

$I_3 = \frac{20}{3}$ A

$V_R = (I_2 - I_3) R = \frac{-8}{3}$ V

Power

$$\Sigma P_{diss} = 2(I_1 - I_2)^2 + 1(I_2 - I_3)^2 + 4(I_1 - I_3)^2 + 2 I_1^2$$
$$= \frac{2}{9} + \frac{64}{9} + \frac{196}{9} + \frac{338}{9} = \boxed{\frac{200}{3}} \text{ watt}$$

$P_{12V} = 12 I_3 = \boxed{80}$ watt

$P_{4A} = 4 * [2(I_2 - I_1) + 1(I_2 - I_3)] = \boxed{\frac{-40}{3}}$ watt

$\Sigma P_{supp} = 80 - \frac{40}{3} = \frac{200}{3}$ watt

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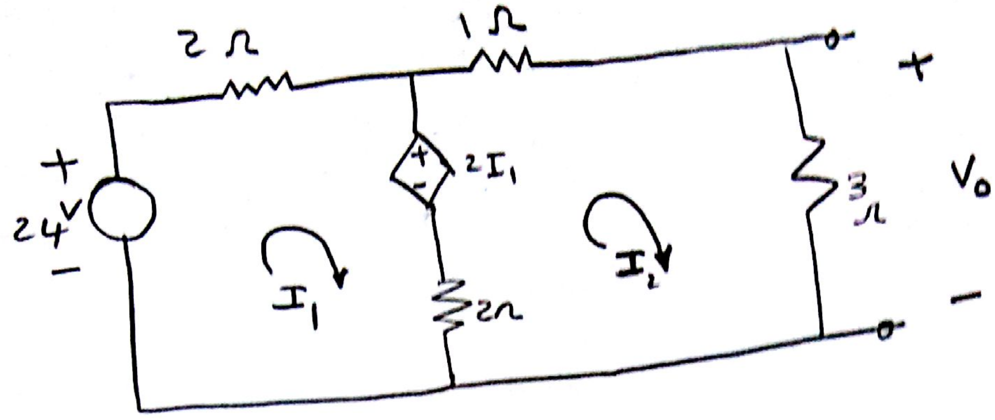
7



Apply loop Analysis

$$\begin{bmatrix} 6 & -2 \\ -4 & 6 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 24 \\ 0 \end{bmatrix}$$

$$4 I_1 - 2 I_2 = 24 - 2 I_1$$

$$\boxed{6 I_1 - 2 I_2 = 24}$$

$$6 I_2 - 2 I_1 = 2 I_1$$

$$\boxed{6 I_2 - 4 I_1 = 0}$$

Solve to get: $I_1 = \frac{36}{7}$ A

$I_2 = \frac{24}{7}$ A

$$P_{3\Omega} = I_2^2 * R = \frac{1728}{49} = \underline{35.265} \text{ watt}$$

Power

$$\Sigma P_{diss} = 2 I_1^2 + 4 I_2^2 + 2 (I_1 - I_2)^2 = \boxed{\frac{5184}{49}} \text{ watt}$$

$$P_{24V} = 24 I_1 = \frac{864}{7} \text{ watt}$$

$$P_{2I_1} = 2 I_1 * (I_2 - I_1) = \frac{-864}{49} \text{ watt}$$

$$\Sigma P_{supp} = \frac{864}{7} - \frac{864}{49} = \boxed{\frac{5184}{49}} \text{ watt}$$

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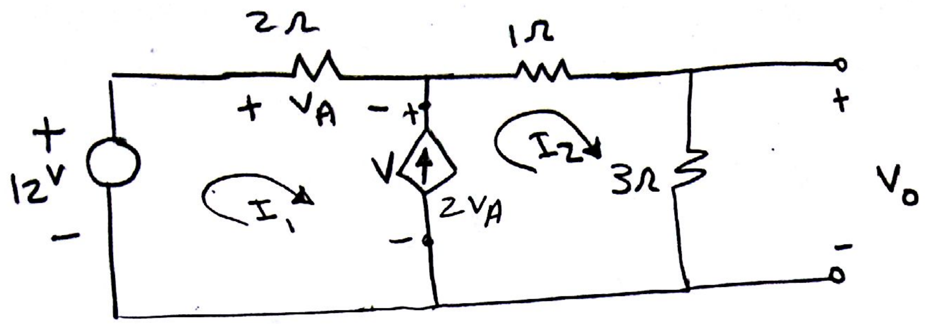
5



$$I_2 - I_1 = 2V_A$$

$$\therefore \; I_2 - I_1 = 2 * 2I_1$$

$$\therefore \; -5I_1 + I_2 = 0 \rightarrow (1)$$

$$12 = 2I_1 + 4I_2 \rightarrow (2)$$

Solve to get $I_1 = \frac{6}{11}$ A

$I_2 = \frac{30}{11}$ A

$$V_o = 3I_2 = 3 * \frac{30}{11} = \boxed{\frac{90}{11}} \text{ V}$$

Power

$$\Sigma P_{diss} = 2I_1^2 + 4I_2^2 = \boxed{\frac{3672}{121}} \text{ waTT}$$

$$P_{12V} = 12 I_1 = \frac{72}{11} \text{ watt}$$

$$P_{2V_A} = 2V_A * V$$

$$2V_A = 4I_1 = \frac{24}{11}$$

$$V = -2I_1 + 12 = \frac{120}{11}$$

$$\therefore \; P_{2V_A} = \frac{2880}{121} \text{ watt}$$

$$\Sigma P_{supp.} = \frac{72}{11} + \frac{2880}{121} = \boxed{\frac{3672}{121}} \text{ watt}$$

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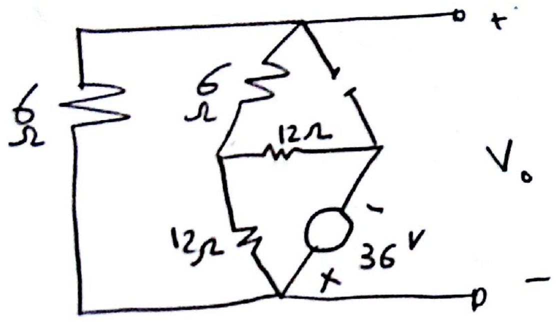
6 Super Position Theorem

1 Due to 36^V



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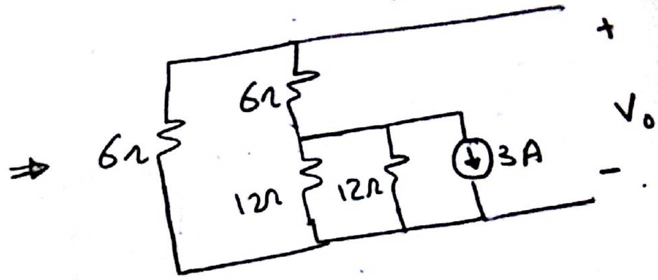

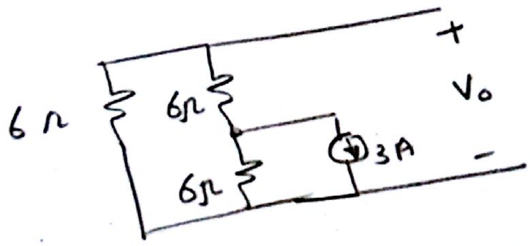

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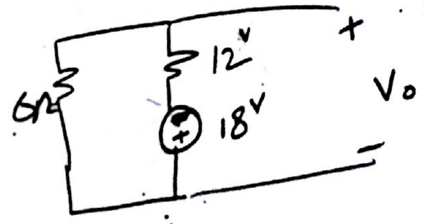

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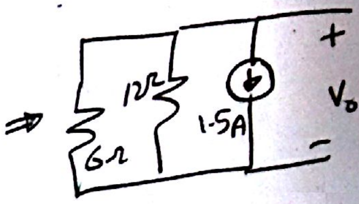
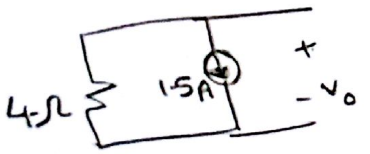
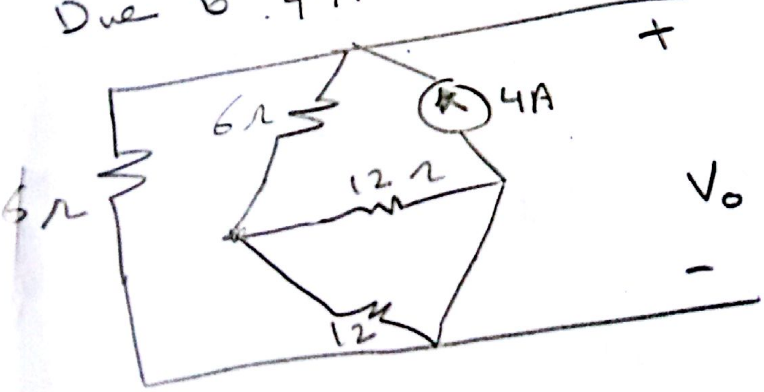




$\therefore \; V_o' = -6^V$

Due to 4A



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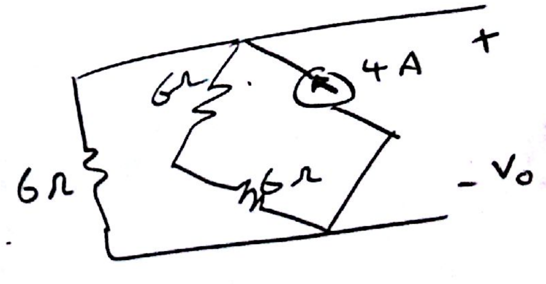

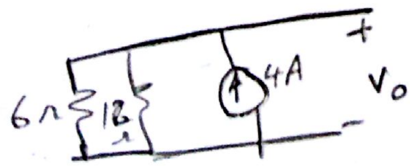

$V_o'' = 16^V$

$\therefore \; V_o = 16 - 6 = 10^V$

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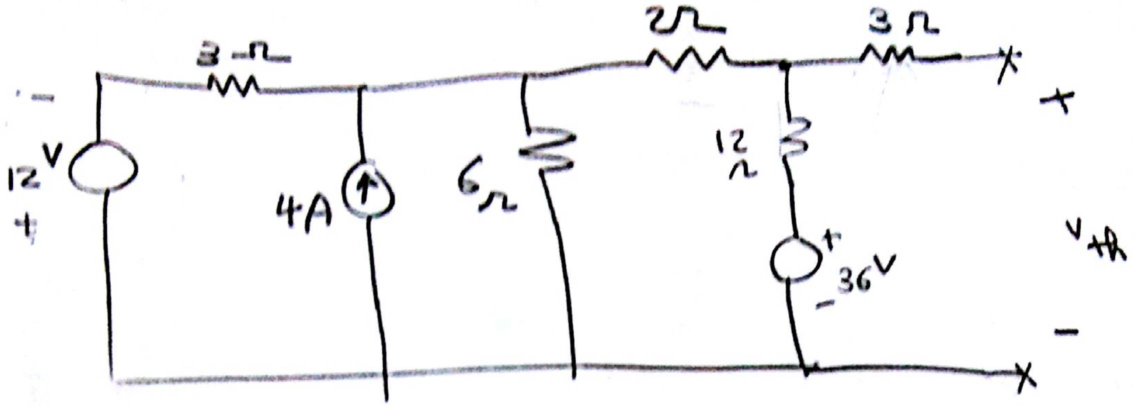
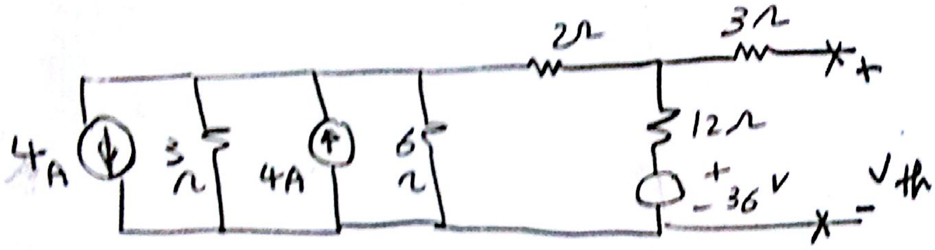
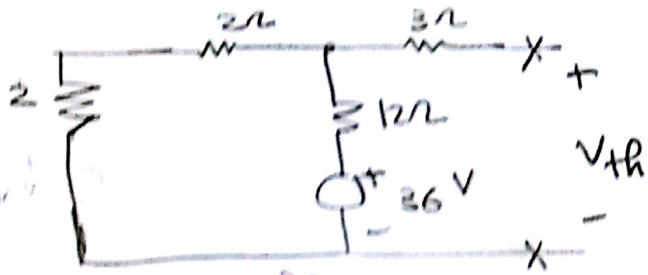
(10)

get V_{th}







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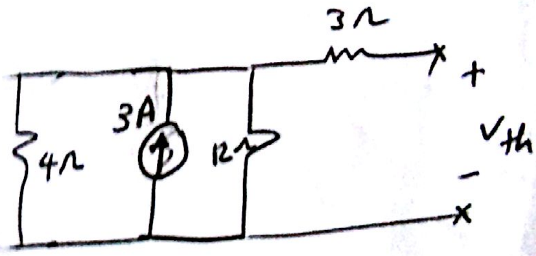
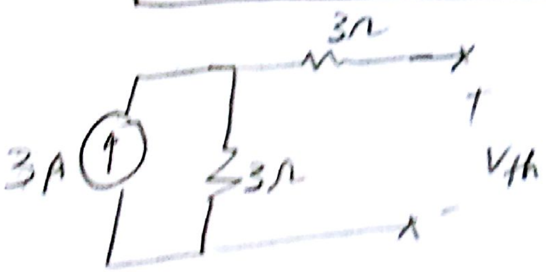
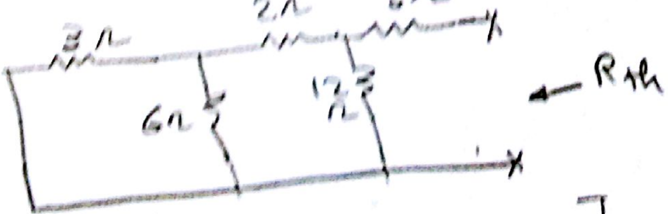




$V_{th} = \underline{9^V}$

get R_{th}

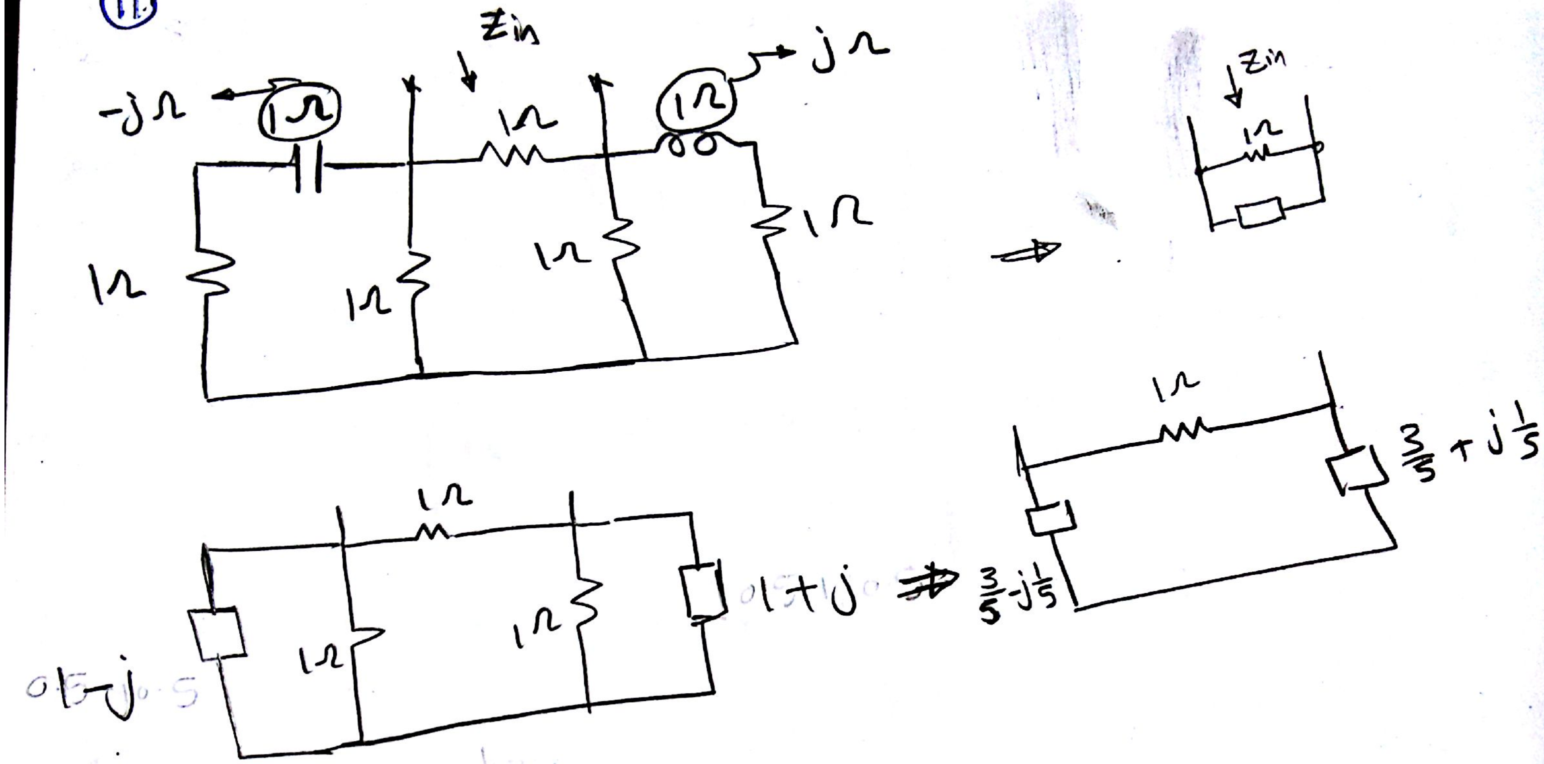


$R_{th} = \left[\left[(3 \parallel 6) + 2\right] \parallel 12\right] + 3 = \underline{6}\ \Omega$

$R_L = R_{th} = \underline{6}\ \Omega = R_L$

$P_{max} = \frac{V_{th}^2}{4 R_{th}} = \frac{(9)^2}{24} = \frac{81}{24} = \underline{3.375}$ watt

11



$$\therefore Z_{in} = \left(\frac{3}{5} - j\frac{1}{5} + \frac{3}{5} + j\frac{1}{5}\right) \parallel 1$$

$$= \left(\frac{6}{5}\right) \parallel 1 = \frac{6/5}{\frac{11}{5}} = \boxed{\frac{6}{11}} = 0.545\,\Omega$$

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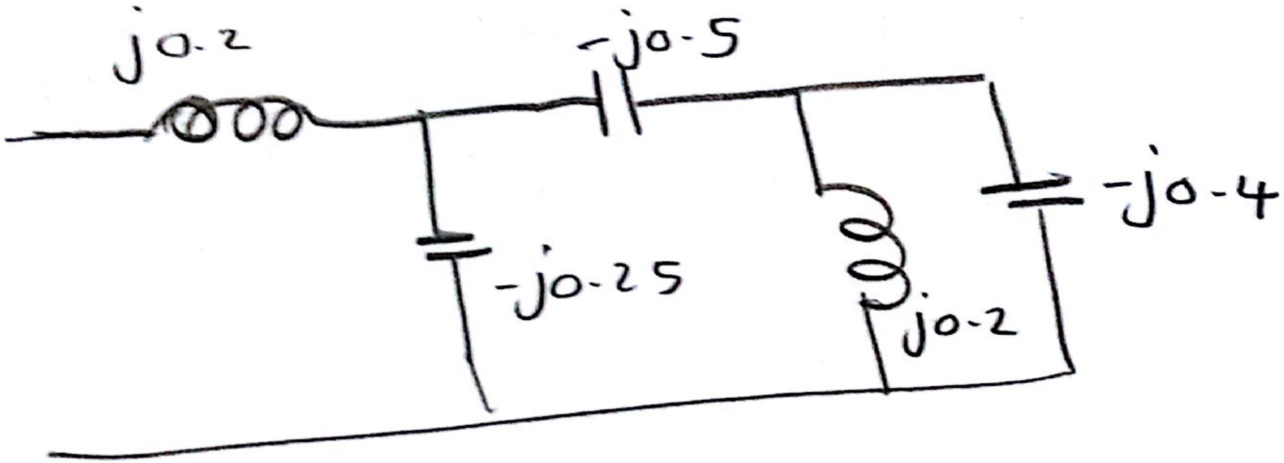
(12)



$$Z_{in} = \left[\left[(-j0.4 \parallel j0.2) + (-j0.5)\right] \parallel (-j0.25)\right] + j0.2$$

$$Z_{in} = j\frac{9}{70}$$

$$Y_{in} = -j\frac{70}{9} \cong -j7.78\ \Omega^{-1}\ (2J)$$

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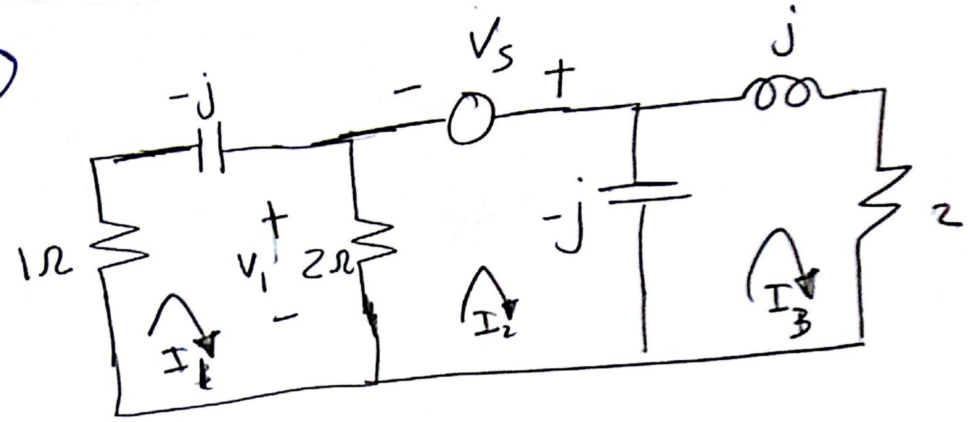

$$V_1 = (I_1 - I_2)\, 2$$

$$\therefore \quad I_1 - I_2 = 2 \quad \rightarrow (1)$$

$$-2I_1 + (2-j)\, I_2 + j I_3 = V_s \quad \rightarrow (2)$$

$$(3-j)\, I_1 - 2I_2 = 0 \rightarrow (3)$$

$$2I_3 + jI_2 = 0 \rightarrow (4)$$

Solve (1) & (3) to get $I_1 = -2 - j2 \ A = 2\sqrt{2} \angle -135^\circ$

$I_2 = -4 - j2 \ A = 2\sqrt{5} \angle -153.43$

$\therefore \quad I_3 = -1 + j2 \quad A$

$V_s = \underline{-8 + 3j} \ V = \sqrt{73} \angle 159.4439^\circ$

check : $P_{supp} = \sqrt{73} * 2\sqrt{5} * \cos(-159.443^\circ + 153.434^\circ)$

$\cong 26$ watt

$P_{diss} = |I_1|^2 + |I_1 - I_2|^2 * 2 + |I_3|^2 * 2$

$= 8 + 8 + 10 = 26$ watt

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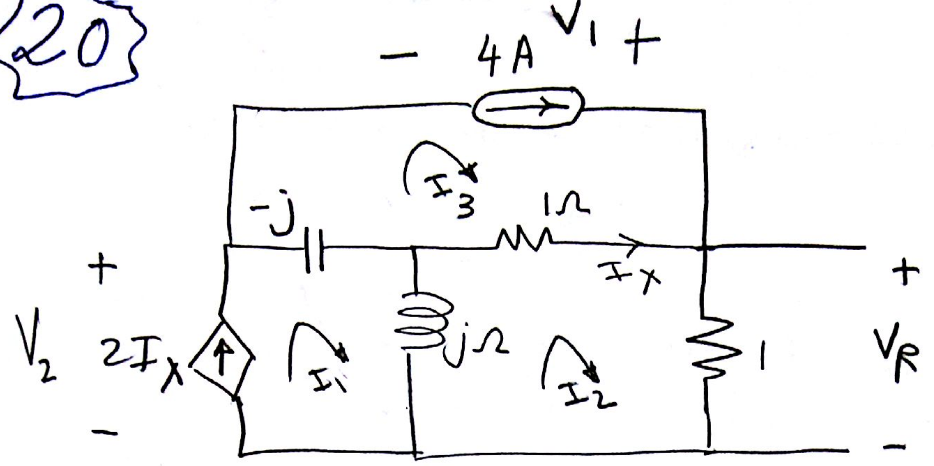

$I_3 = 4\ A$

$I_1 = 2I_x = 2(I_2 - I_3)$

$$\boxed{I_1 - 2I_2 + 2I_3 = 0}$$

$\therefore\quad I_1 - 2I_2 = -8 \rightarrow \boxed{I_1 = 2I_2 - 8} \rightarrow 1$

$(2+j)I_2 - jI_1 - I_3 = 0$

$$\boxed{-jI_1 + (2+j)I_2 = 4} \rightarrow 2$$

Substitute from 1 into 2

$-j(2I_2 - 8) + (2+j)I_2 = 4$

$(-j2 + 2 + j)I_2 + j8 = 4$

$(2-j)I_2 = 4 - j8 \rightarrow I_2 = \frac{16}{5} - j\frac{12}{5}\ A$

$I_1 = \frac{-8}{5} - j\frac{24}{5}\ A$

$V_R = I_2 = \frac{16}{5} - j\frac{12}{5} = \boxed{4\angle -36.869^\circ}\ V$

Check $P_{4A} = 4|V_1|\cos\theta$

$V_1 = (I_3 - I_2) - j(I_3 - I_1)$

$V_1 = 2.5298\angle 71.565^\circ + 7.3756\angle -49.398^\circ$

$= 6.44981275\angle -29.745^\circ$

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