2020-Aug) Use superposition theorem to find I_O in the circuit shown in Figure ?? .

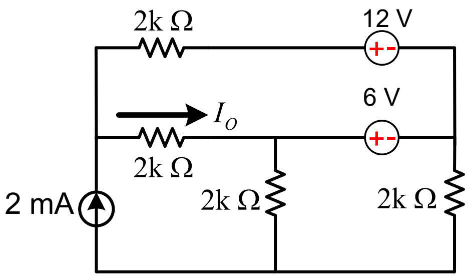

Figure 1

Solution:

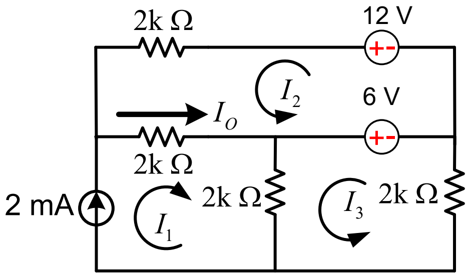

Figure 2

$$
\begin{aligned}
2I_2 + 2(I_1 + I_2) + 6 - 12 &= 0 \\
2I_1 + 4I_2 + 0I_3 &= 6
\end{aligned}
$$

$$
\begin{aligned}
2(I_1 + I_3) + 2I_3 - 6 &= 0 \\
2I_1 + 0I_2 + 4I_3 &= 6
\end{aligned}
$$

$$
\begin{aligned}
2I_1 + 4I_2 + 0I_3 &= 6 \\
2I_1 + 0I_2 + 4I_3 &= 6
\end{aligned}
$$

$$I_1 = 2mA$$

$$
\begin{aligned}
4I_2 + 0I_3 &= 2 \\
0I_2 + 4I_3 &= 2
\end{aligned}
$$

On solving

$$I_1 = 2mA, \; I_2 = 0.5 \; I_3 = 0.5$$

$$I_O = I_1 + I_2 = 2 + 0.5 = 2.5mA$$

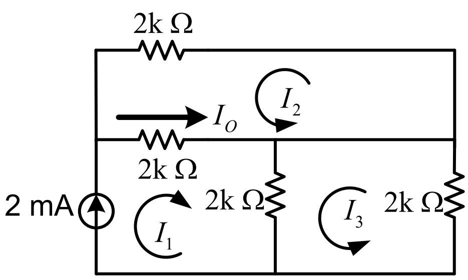

Figure 3

$$
\begin{aligned}
2I_2 + 2(I_1 + I_2) &= 0 \\
2I_1 + 4I_2 + 0I_3 &= 0
\end{aligned}
$$

$$
\begin{aligned}
2(I_1 + I_3) + 2I_3 &= 0 \\
2I_1 + 0I_2 + 4I_3 &= 0
\end{aligned}
$$

$$
\begin{aligned}
2I_1 + 4I_2 + 0I_3 &= 0 \\
2I_1 + 0I_2 + 4I_3 &= 0
\end{aligned}
$$

$$I_1 = 2mA$$

$$
\begin{aligned}
4I_2 + 0I_3 &= -4 \\
0I_2 + 4I_3 &= -4
\end{aligned}
$$

On solving

$$I_1 = 2mA, \; I_2 = -1 I_3 = -1$$

$$I_{O1} = I_1 + I_2 = 2 - 1 = 1mA$$

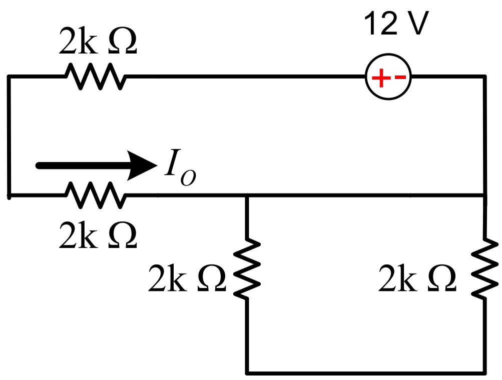

Figure 4

$$I_{02} = \frac{12}{4} = 3mA$$

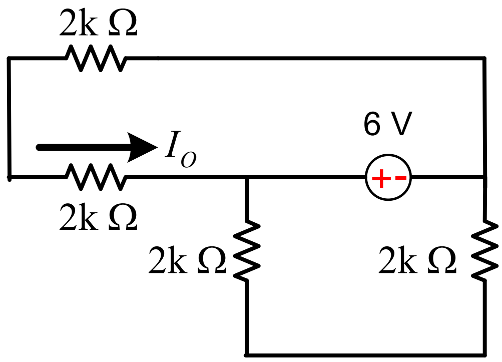

Figure 5

$$I_{03} = \frac{6}{4} = 1.5mA$$

$$I_O = I_1 + I_2 = 1 + 3 - 1.5 = 2.5mA$$

2020-AugEE) Use superposition theorem to find I_O in the circuit shown in Figure 6 .

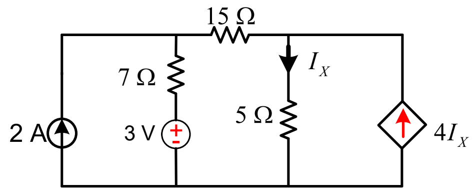

Figure 6

Solution:

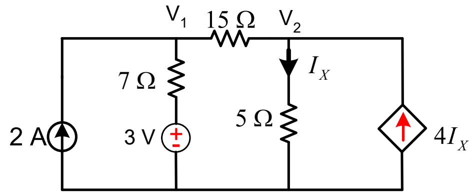

Figure 7

$$\begin{aligned}\frac{V_1 - 3}{7} + \frac{V_1 - V_2}{15} - 2 &= 0 \\ V_1[0.1428 + 0.067] - 0.428 - 0.0.067V_2 - 2 &= 0 \\ 0.21V_1 - 0.067V_2 &= 2.428\end{aligned}$$

$$\begin{aligned}\frac{V_2}{5} + \frac{V_2 - V_1}{15} - 4I_X &= 0 \\ -0.067V_1 + V_2[0.5 + 0.067] - 4I_X &= 0 \\ -0.067V_1 + 0.567V_2 - 4I_X &= 0\end{aligned}$$

$$I_X = \frac{V_2}{5} = 0.2V_2$$

$$\begin{aligned}-0.067V_1 + 0.567V_2 - 4I_X &= 0 \\ -0.067V_1 + 0.567V_2 - 4(0.2V_2) &= 0 \\ -0.067V_1 + 1.367V_2 &= 0\end{aligned}$$

$$\begin{aligned}0.21V_1 - 0.067V_2 &= 2.428 \\ -0.067V_1 + 1.367V_2 &= 0\end{aligned}$$

On Solving

$$V_1 = 11.745 \quad V_2 = 0.575$$

$$I_X = \frac{V_2}{5} = \frac{0.575}{5} = 0.115$$

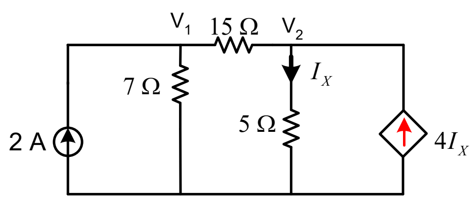

Figure 8

$$\begin{aligned}\frac{V_1}{7} + \frac{V_1 - V_2}{15} - 2 &= 0 \\ V_1[0.1428 + 0.067] - 0.067V_2 - 2 &= 0 \\ 0.21V_1 - 0.067V_2 &= 2\end{aligned}$$

$$\begin{aligned}0.21V_1 - 0.067V_2 &= 2 \\ -0.067V_1 + 1.367V_2 &= 0\end{aligned}$$

On Solving

$$V_1 = 9.675 \quad V_2 = 0.474$$

$$I_{X1} = \frac{V_2}{5} = \frac{0.474}{5} = 0.095$$

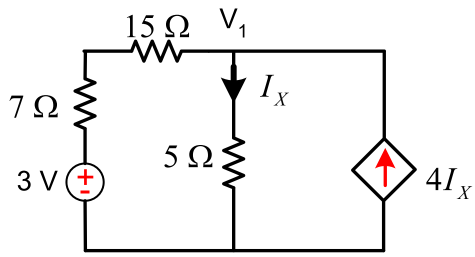

Figure 9

$$\begin{aligned}\frac{V_1 - 3}{22} + \frac{V_1}{5} - 4I_x &= 0 \\ V_1[0.045 + 0.2] - 0.136 - 4\frac{V_1}{5} &= 0 \\ 0.245V_1 - 0.8V_1 &= 0.136 \\ -0.555V_1 &= 0.136 \\ V_1 &= -\frac{0.136}{0.555} = -0.245\end{aligned}$$

$$I_{X2} = \frac{V_1}{5} = \frac{-0.245}{5} = -0.049$$

2018-DEC-17Scheme) For the circuit shown in Figure find the current I_X 10 using superposition theorem.

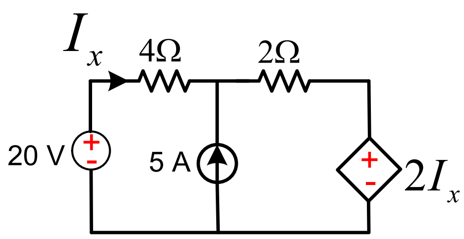

Figure 10

Solution:

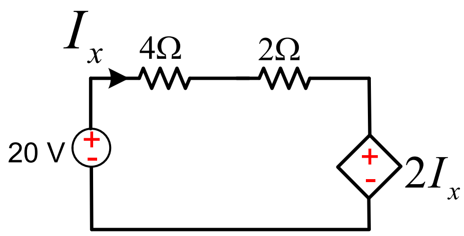

Figure 11

$$
\begin{aligned}
20 - 6I_X - 2I_X &= 0 \\
I_X &= \frac{20}{8} = 2.5A
\end{aligned}
$$

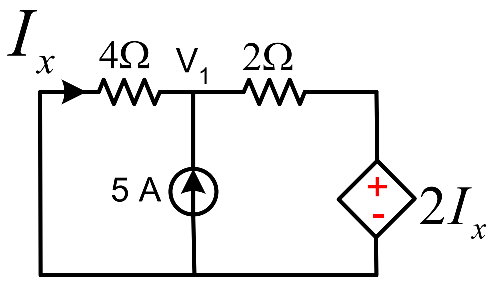

Figure 12

$$
\begin{aligned}
\frac{V_1}{4} + \frac{V_1 - 2I_x}{2} - 5 &= 0 \\
(0.25 + 0.5)V_1 - I_x &= 5
\end{aligned}
$$

$$
I_x = \frac{V_1}{4} = 0.25V_1
$$

$$
\begin{aligned}
[0.75]V_1 - 0.25V_1 &= 5 \\
V_1 &= \frac{5}{0.5} = 10
\end{aligned}
$$

$$
I_x = \frac{V_1}{4} = \frac{10}{4} = 2.5
$$

Verification

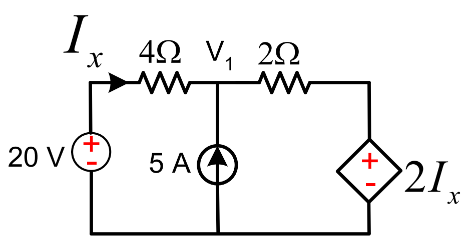

Figure 13

$$
\begin{aligned}
\frac{V_1 - 20}{4} + \frac{V_1 - 2I_x}{2} - 5 &= 0 \\
(0.25 + 0.5)V_1 - I_x &= 10
\end{aligned}
$$

$$
I_x = \frac{V_1}{4}
$$

$$
\begin{aligned}
[0.75]V_1 - 0.25V_1 &= 10 \\
V_1 &= \frac{10}{0.5} = 20
\end{aligned}
$$

$$
I_x = \frac{V_1}{4} = \frac{20}{4} = 5
$$

2017-June) Using superposition theorem find the current in 6 Ω resistor in circuit shown in Figure 14.

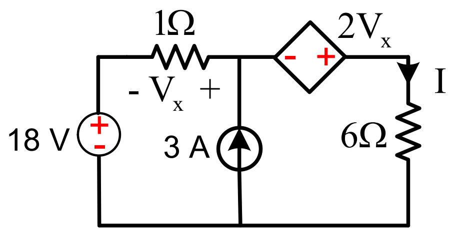

Figure 14

Solution:

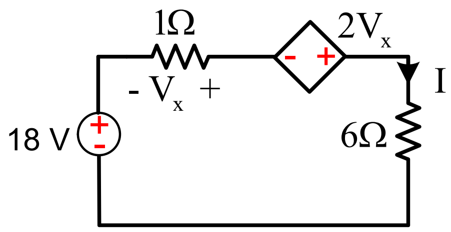

Figure 15

$$
18 - 1I + 2V_X - 6I = 0
$$

$$
V_X = I
$$

$$
\begin{aligned}
18 - 1I + 2V_X - 6I &= 0 \\
18 - 1I + 2(I) - 6I &= 0 \\
I &= \frac{18}{5} = 3.6
\end{aligned}
$$

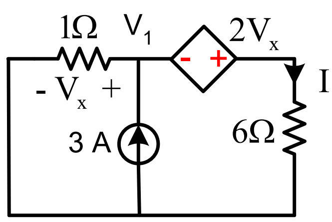

Figure 16

$$
\begin{aligned}
\frac{V_1}{1} + \frac{V_1 + 2V_x}{6} - 3 &= 0 \\
(1 + 0.166)V_1 + 0.333V_x &= 3
\end{aligned}
$$

$$\begin{aligned} V_x &= V_1 \\ 1.166V_1 + 0.33V_1 &= 3 \\ V_1 &= \frac{3}{1.5} = 2 \end{aligned}$$

$$I_x = \frac{V_1}{4} = \frac{10}{4} = 2.5$$

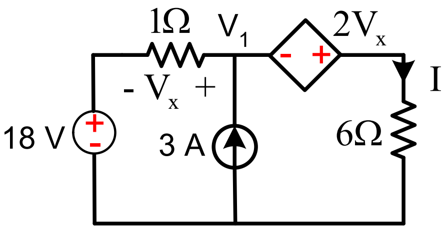

Figure 17

2016-June) Using superposition theorem find the current I in circuit shown in Figure 18.

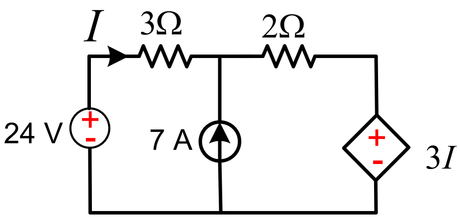

Figure 18

Solution:

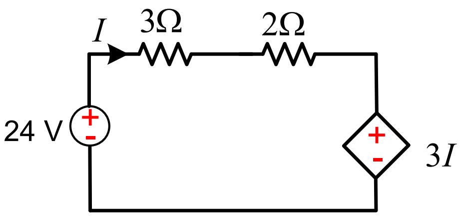

Figure 19

$$\begin{aligned} 24 - 5I - 3I &= 0 \\ I &= \frac{24}{8} = 3 \end{aligned}$$

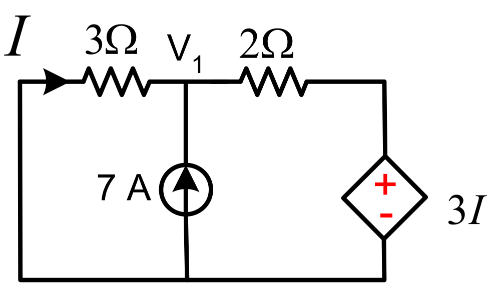

Figure 20

$$\begin{aligned} \frac{V_1}{3} + \frac{V_1 - 3I}{2} - 7 &= 0 \\ (0.333 + 0.5)V_1 - 1.5I &= 7 \end{aligned}$$

$$I = \frac{V_1}{3}$$

$$\begin{aligned} [0.8333]V_1 - 0.5V_1 &= 7 \\ V_1 &= \frac{7}{0.333} = 21 \end{aligned}$$

$$I = \frac{V_1}{3} = \frac{21}{3} = 8$$

Total current I in the circuit is

$$I = 3 - 8 = -5A$$

Which is flowing opposite to the direction.

Verification

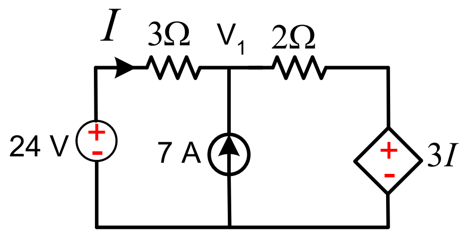

Figure 21

$$\begin{aligned} \frac{V_1 - 24}{3} + \frac{V_1 - 3I}{2} - 7 &= 0 \\ (0.333 + 0.5)V_1 - 1.5I &= 15 \end{aligned}$$

$$I = \frac{V_1 - 24}{3} = 0.333V_1 - 8$$

$$\begin{aligned} (0.833)V_1 - 1.5(0.333V_1 - 8) &= 15 \\ (0.833)V_1 - 0.5V_1 + 12 &= 15 \\ 0.333V_1 &= 3 \\ V_1 &= \frac{3}{0.333} = 9 \end{aligned}$$

$$I = \frac{V_1 - 24}{3} = \frac{9 - 24}{3} = -5$$

2015-Dec) Find I_X for the circuit shown in Figure 22 using superposition theorem.

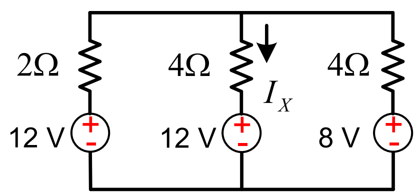

Figure 22

Solution:

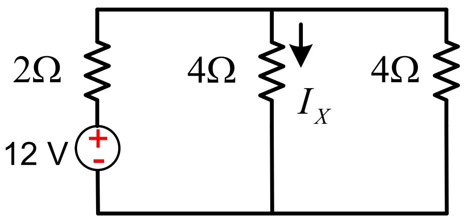

Figure 23

$$\begin{aligned} \frac{V-12}{2}+\frac{V}{4}+\frac{V}{4} &= 0 \\ V &= 6 \end{aligned}$$

$$I = \frac{V}{4} = \frac{6}{4} = 1.5$$

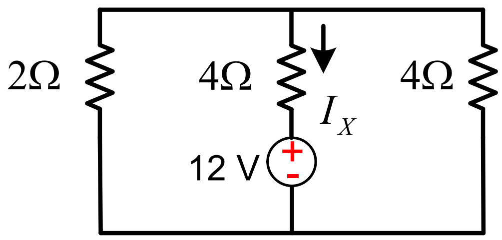

Figure 24

$$\begin{aligned} \frac{V}{2}+\frac{V-12}{4}+\frac{V}{4} &= 0 \\ V &= 3 \end{aligned}$$

$$I = \frac{V-12}{4} = \frac{3-12}{4} = -2.25$$

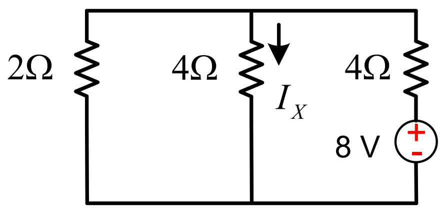

Figure 25

$$\begin{aligned} \frac{V}{2}+\frac{V}{4}+\frac{V-8}{4} &= 0 \\ V &= 2 \end{aligned}$$

$$I = \frac{V}{4} = \frac{2}{4} = 0.5$$

Total current I_X is

$$I = 1.5 - 2.25 + 0.5 = -0.25$$

Verification

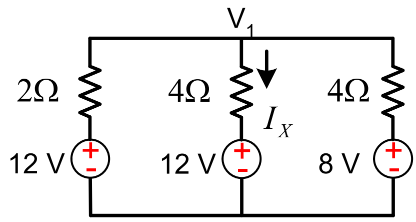

Figure 26

$$\begin{aligned} \frac{V-12}{2}+\frac{V-12}{4}+\frac{V-8}{4} &= 0 \\ V &= 11 \end{aligned}$$

$$I = \frac{V-12}{4} = \frac{11-12}{4} = -0.25$$

2011-June) Find V using the principle of superposition in network shown in Figure 27 .

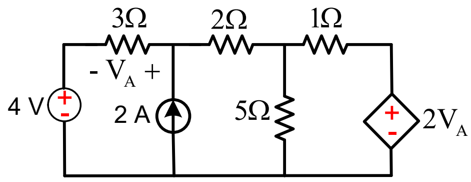

Figure 27

Solution:

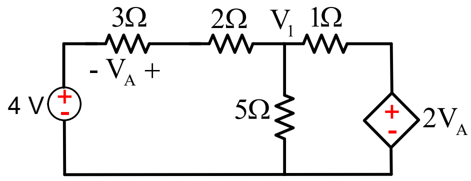

Figure 28

$$\begin{aligned} \frac{V_1-4}{5}+\frac{V_1}{5}+\frac{V_1-2V_A}{1} &= 0 \\ V_1(0.2+0.2+1)-2V_A &= 0.8 \end{aligned}$$

$$V_A = 3\left(\frac{V_1-4}{5}\right) = 0.6V_1 - 2.4$$

$$\begin{aligned} 1.4V_1 - 2(0.6V_1-2.4) &= 0.8 \\ 1.4V_1 - 1.2V_1 + 4.8 &= 0.8 \\ 0.2V_1 &= -4 \\ V_1 &= -\frac{4}{0.2} = -20 \end{aligned}$$

$$V_A = 3\left(\frac{V_1-4}{5}\right) = 0.6(-20) - 2.4 = -14.4$$

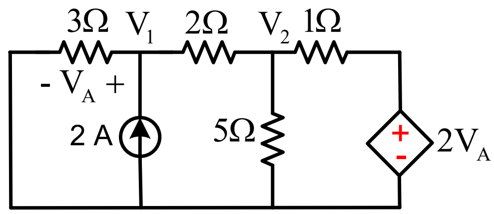

Figure 29

$$\begin{aligned}
\frac{V_1}{3} + \frac{V_1 - V_2}{2} - 2 &= 0 \\
(0.33 + 0.5)V_1 - 0.5V_2 &= 2 \\
(0.833)V_1 - 0.5V_2 &= 2
\end{aligned}$$

$$\begin{aligned}
\frac{V_2 - V_1}{2} + \frac{V_2}{5} + \frac{V_2 - 2V_A}{1} &= 0 \\
-0.5V_1 + (0.2 + 0.5 + 1)V_1 - 2V_A &= \\
-0.5V_1 + 1.7V_1 - 2V_A &=
\end{aligned}$$

$$V_A = V_1$$

$$-2.5V_1 + 1.7V_1 = 0$$

$$\begin{aligned}
0.833V_1 - 0.5V_2 &= 2 \\
-2.5V_1 + 1.7V_1 &= 0
\end{aligned}$$

$$V_1 = 20.46 \quad V_2 = 30.1$$

Total Voltage V_A is

$$V_A = 20.46 \quad V_2 = -14.4 + 20.46 = 6.06V$$

2014-July Find the voltage across 3Ω resistor using superposition theorem for the circuit shown in Figure 30

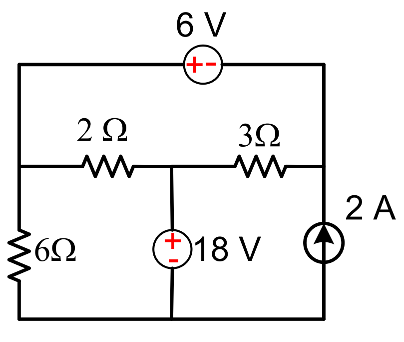

Figure 30: 2014-July-Question Paper

Solution:

By considering 6 Volt supply the circuit is redrawn which is as shown in Figure 31

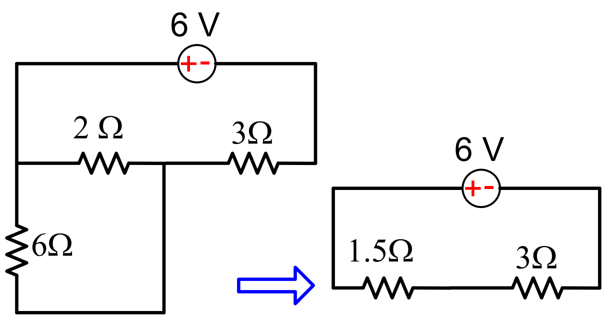

Figure 31

Voltage across 3 Ω resistor is

$$V_1 = \frac{6}{3 + 1.5} 3 = 4V$$

By considering 18 Volt supply the circuit is redrawn which is as shown in Figure 32

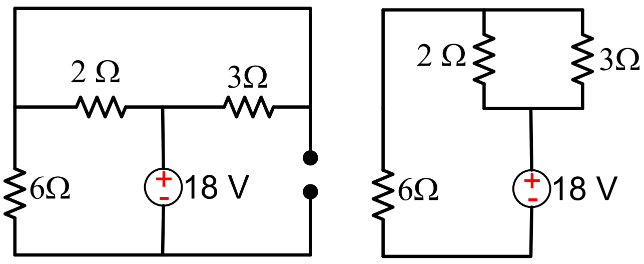

Figure 32

The network resistance is

$$R_t = 6 + \frac{2 \times 3}{2 + 3} = 7.2$$

The total current flowing in the network is

$$I = \frac{18}{R_t} = 2.5A$$

Current through 3 Ω resistor is

$$I = 2.5\frac{1.2}{3} = 1A$$

Voltage across 3 Ω resistor is

$$V_2 = 1 \times 3 = 3V$$

By considering 2A current source the circuit is redrawn which is as shown in Figure 33

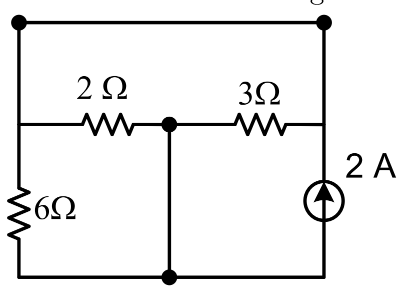

Figure 33

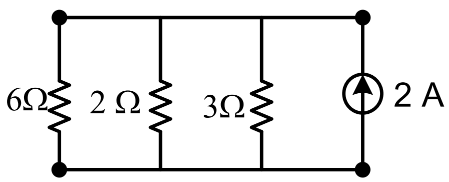

Figure 34

The network resistance is

$$R_t = \frac{1}{6} + \frac{1}{2} + \frac{1}{3} \approx 1\Omega$$

Current through 3 Ω resistor is

$$I = 1\frac{2}{3} = 0.6666A$$

Voltage across 3 Ω resistor is

$$V_3 = -0.666 \times 3 = -2V$$

The overall Voltage across 3 Ω resistor by considering all the voltage sources is

$$V = V_1 + V_2 + V_3 = 4 + 3 - 2 = 5V$$

2012-DEC Using superposition theorem obtain the response I for the circuit shown in Figure 35

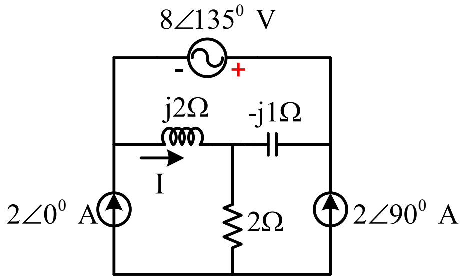

Figure 35: 2012-DEC-Question Paper

Solution:

By considering Voltage source the circuit is redrawn which is as shown in Figure 36

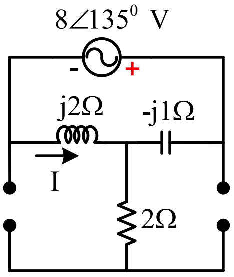

Figure 36

There is no current flows in Voltage across 2 Ω resistor. Current through inductor is

By KVL

$$I_1(j2 - j1) + 8\angle 135 = 0$$

$$I_1 = -\frac{8\angle 135}{j2 - j1} \times j2 = -\frac{8\angle 135}{j1} \times j2$$

$$I_1 = -8\angle 135$$

By considering Current source of 2A the circuit is redrawn which is as shown in Figure 37

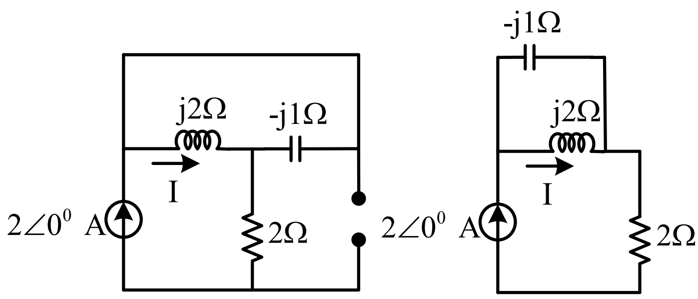

Figure 37

Using current divider rule the current is

$$I_2 = 2\angle 0\frac{-j1}{j2 - j1} = 2\angle 0\frac{-j1}{j1} = 2\angle 0$$

By considering Current source of 2∠90 A the circuit is redrawn which is as shown in Figure 38

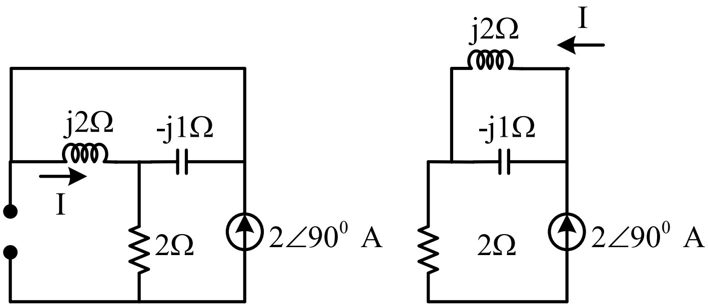

Figure 38

Using current divider rule the current is

$$I_3 = 2\angle 90\frac{-j1}{j2 - j1} = 2\angle 90\frac{-j1}{j1} = 2\angle 90$$

The direction of the current is reversed

$$I_3 = -2\angle 90$$

The total current in the inductor is

$I = I_1 + I_2 + I_3 = -8\angle 135 + 2\angle 0 - 2\angle 90 = -(-5.65 + j5.65) + 2 +$

7.65-j7.65=

$$I = 10.8283\angle -45$$

2012-June Determine the current through 10 Ω resistance using superposition theorem for the circuit shown in Figure 35

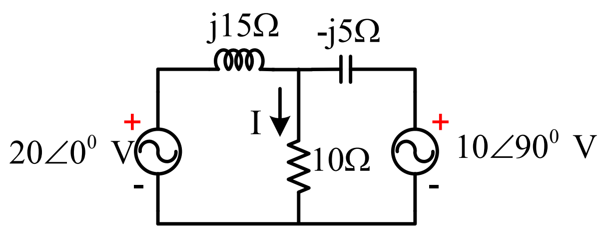

Figure 39: 2012-June1-1-Question Paper

Solution:

By considering 20 V Voltage source the circuit is redrawn which is as shown in Figure 36

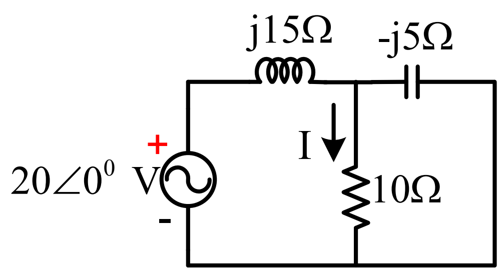

Figure 40

By using current division method the current through 10 Ω resistance is

$$\begin{aligned} \frac{V_1}{10}+\frac{V_1}{-j5}+\frac{V_1}{j15} &= \frac{20}{j15} \\ V_1[0.1+j0.2-j0.0666] &= -j1.333 \\ V_1[0.1+j0.1334] &= -j1.333 \\ 0.1666\angle 53.14 V_1 &= -1.333\angle 90 \\ V_1 &= \frac{-1.333\angle 90}{0.1666\angle 53.14} \\ &= -8\angle 36.86 \end{aligned}$$

$$I=\frac{-8\angle 36.86}{10}=-0.8\angle 36.86=-0.64-j0.48$$

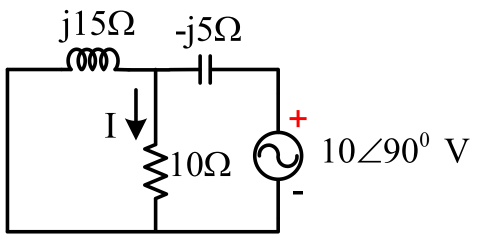

Figure 41

By using current division method the current through 10 Ω resistance is

$$\begin{aligned} \frac{V_2}{10}+\frac{V_2}{-j5}+\frac{V_2}{j15} &= \frac{10\angle 90}{-j5} \\ V_2[0.1+j0.2-j0.0666] &= 2\angle 180 \\ V_2[0.1+j0.1334] &= -2 \\ 0.1666\angle 53.14 V_2 &= -2 \\ V_2 &= \frac{-2}{0.1666\angle 53.14} \\ &= -12\angle-53.14 \end{aligned}$$

The total current by considering both the sources is

$$I_2=\frac{-12\angle-53.14}{10}=-1.2\angle{-53.14}=-0.72+j0.96$$

$$\begin{aligned} I &= I_1+I_2=-0.64-j0.48-0.72+j0.96 \\ &= -1.36+j0.48=1.422\angle 160.56 \end{aligned}$$

2011-December Determine the current through Z_3 using superposition theorem for the circuit shown in Figure 42

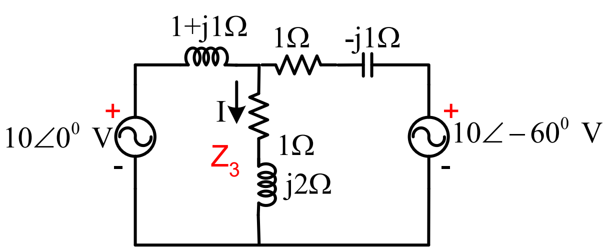

Figure 42: 2011-December-Question Paper

Solution:

By considering single voltage 10∠0, the circuit is redrawn which is as shown in Figure 36

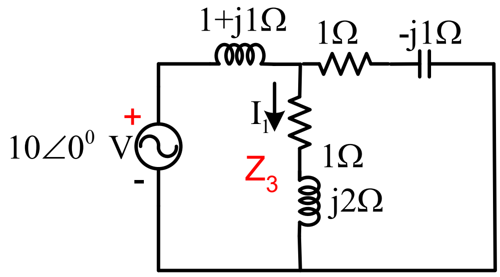

Figure 43

By applying node voltage method

$$\begin{aligned} V_1[\frac{1}{1+1j}+\frac{1}{1+j2}+\frac{1}{1-j1}] &= \frac{10}{1+j1} \\ V_1[\frac{1-j1}{2}+\frac{1+j1}{2}+\frac{1-j2}{3}] &= \frac{10}{1+j1} \end{aligned}$$

$$V_1[0.5-j0.5+0.5+j0.5+0.33-j0.666]=\frac{10}{1+j1}$$

$$V_1[1.333-j0.666]=7.07\angle-45$$

$$V_1 1.5\angle-26.54=7.07\angle-45$$

$$V_1=\frac{7.07\angle-45}{1.5\angle-26.54}=4.713\angle-18.46$$

Current through Z_3 is

$$I_1=\frac{V_1}{1+j2}=\frac{4.713\angle-18.46}{2.23\angle 63.43}$$

$$I_1=2.1\angle-81.89$$

By considering single voltage 10∠0, the circuit is redrawn which is as shown in Figure ??

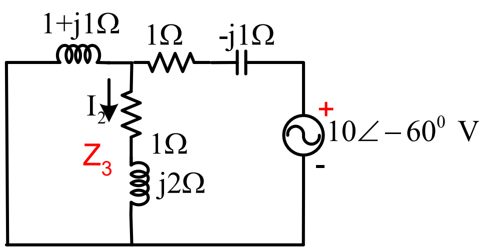

Figure 44

By applying node voltage method

$$\begin{aligned} V_2[\frac{1}{1+1j}+\frac{1}{1+j2}+\frac{1}{1-j1}] &= \frac{10\angle-60}{1+j1} \\ V_2[\frac{1-j1}{2}+\frac{1+j1}{2}+\frac{1-j2}{3}] &= \frac{10\angle-60}{1+j1} \end{aligned}$$

$$V_2[0.5-j0.5+0.5+j0.5+0.33-j0.666]=\frac{10\angle-60}{1+j1}$$

$$V_2[1.333-j0.666]=7.07\angle-15$$

$$V_2 1.5\angle-26.54 = 7.07\angle-15$$

$$V_2 = \frac{7.07\angle-15}{1.5\angle-26.54} = 4.713\angle 11.53$$

Current through Z_3 is

$$I_2 = \frac{V_2}{1+j2} = \frac{4.713\angle 11.53}{2.23\angle 63.43}$$

$$I_2 = 2.1\angle-51.9$$

The total current by considering both the sources is

$$I_2 = \frac{-12\angle-53.14}{10} = -1.2\angle-53.14 = -0.72+j0.96$$

$$\begin{aligned} I &= I_1 + I_2 = 2.1\angle-81.89 + 2.1\angle-51.9 \\ &= 0.29 - j2 + 1.29 - j1.65 \\ &= 1.58 - j3.65 = 3.977\angle-66.6 \end{aligned}$$

2011-June Determine V_A using superposition theorem for the circuit shown in Figure 45

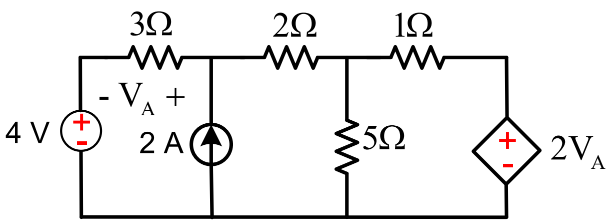

Figure 45: 2011-December-Question Paper

Solution:

By considering single voltage 4 volts, the circuit is redrawn which is as shown in Figure 36

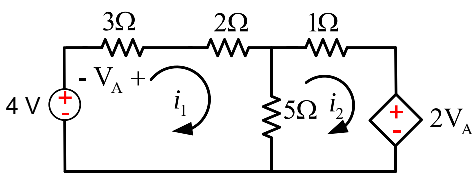

Figure 46

By applying KVL for the loops

$$\begin{aligned} 5i_1 + 5(i_1 - i_2) - 4 &= 0 \\ 10i_1 - 5i_2 &= 4 \end{aligned}$$

$$V_A = -3i_1$$

$$\begin{aligned} 1i_2 + 5(i_2 - i_1) + 2V_A &= 0 \\ -5i_1 + 6i_2 + 2(-3i_1) &= 0 \\ -11i_1 + 6i_2 &= 0 \\ 11i_1 - 6i_2 &= 0 \end{aligned}$$

$$\begin{aligned} 10i_1 - 5i_2 &= 4 \\ 11i_1 - 6i_2 &= 0 \end{aligned}$$

$$\Delta = \begin{vmatrix} 10 & -5 \\ 11 & -6 \end{vmatrix} = -60 + 55 = -5$$

$$i_1 = \frac{\begin{vmatrix} 4 & -5 \\ 0 & -6 \end{vmatrix}}{\Delta} = \frac{-24}{-5} = 4.8A$$

$$V_A = -3i_1 = -3 \times 4.8 = 14.4V$$

By considering single current source 2A, the circuit is redrawn which is as shown in Figure 37

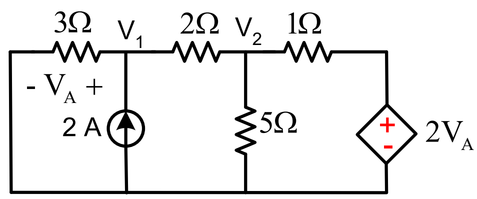

Figure 47

By applying KCL (Node analysis)

For Node V_1

$$\begin{aligned} V_1[\frac{1}{3} + \frac{1}{2}] - \frac{V_2}{2} - 2 &= 0 \\ 0.833V_1 - 0.5V_2 &= 2 \end{aligned}$$

For Node V_2

For Node $V_A = V_1$

$$\begin{aligned} V_2[\frac{1}{1} + \frac{1}{5} + \frac{1}{2}] - \frac{V_1}{2} - \frac{2V_A}{1} &= 0 \\ V_2[1 + 0.2 + 0.5] - 0.5V_1 - \frac{2V_1}{1} &= 0 \\ -2.5V_1 + 1.7V_2 &= 0 \\ 2.5V_1 - 1.7V_2 &= 0 \end{aligned}$$

Simultaneous equations are

$$\begin{aligned} 0.833V_1 - 0.5V_2 &= 2 \\ 2.5V_1 - 1.7V_2 &= 0 \end{aligned}$$

$$\Delta = \begin{vmatrix} 0.833 & -0.5 \\ 2.5 & -1.7 \end{vmatrix} = -1.416 + 1.25 = -0.166$$

$$V_1 = \frac{\begin{vmatrix} 2 & -0.5 \\ 0 & -1.7 \end{vmatrix}}{\Delta} = \frac{-3.4}{-0.166} = 20.4$$

By Superposition theorem

$$V_1 = -14.4 + 20.4 = 6V$$

2000-August Find the current through $R_L = 7.5\Omega$, using superposition theorem as shown in Figure 48

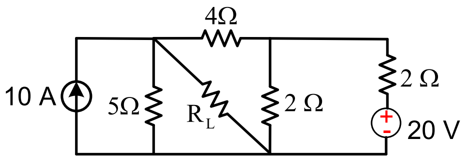

Figure 48: 2000-August-Question Paper

Solution:

Replace the voltage source by short circuit. 2Ω and 2 Ω are in parallel which is in series with 4 Ω. The details are as shown in Figure 49

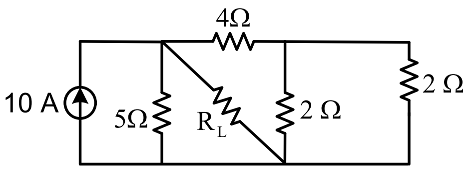

Figure 49

$$2\Omega || 2\Omega = 1\Omega$$

$$4\Omega + 1\Omega = 5\Omega$$

5 Ω and 5 Ω are in parallel

$$5\Omega || 5\Omega = 2.5\Omega$$

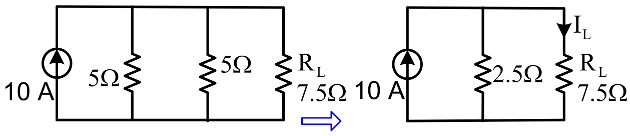

Figure 50

The current through 5 R_L using current division method is

$$I_{L1} = 10A\frac{2.5}{2.5 + 7.5} = 2.5A$$

By removing the current source the circuit is as shown in Figure 51

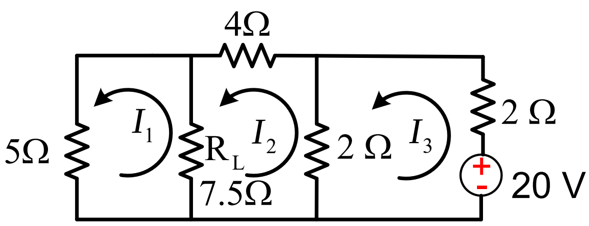

Figure 51

Apply KVL and solve for loop currents

$$I_L = 10A\frac{2.5}{2.5 + 7.5} = 2.5A$$

$$\begin{aligned} 12.5I_1 - 7.5I_2 + 0I_3 &= 0 \\ -7.5I_1 + 13.5I_2 - 2I_3 &= 0 \\ 0I_1 - 2I_2 + 4I_3 &= 20 \end{aligned}$$

$$\Delta = \begin{vmatrix} 12.5 & -7.5 & 0 \\ -7.5 & 13.5 & -2 \\ 0 & -2 & 4 \end{vmatrix}$$

12.5(54-4)+7.5(-30)=625-225=400

$$I_1 = \frac{\begin{vmatrix} 0 & -7.5 & 0 \\ 0 & 13.5 & -2 \\ 20 & -2 & 4 \end{vmatrix}}{\Delta}$$

20(15)=300

$$I_1 = \frac{300}{400} = 0.75$$

$$I_1 = \frac{\begin{vmatrix} 12.5 & 0 & 0 \\ -7.5 & 0 & -2 \\ 0 & 20 & 4 \end{vmatrix}}{\Delta}$$

12.5(40)=500

$$I_2 = \frac{500}{400} = 1.25$$

Current through R_L is

$$I_2 - I_1 = 1.25 - 0.75 = 0.5$$

Current through R_L by considering both the sources is

$$I_L = 2.5 + 0.5 = 3A$$