Paper 1, TDC Part-1
Chapter– 4, Circuit Theorems
Lecture – 5 Superposition Theorem

By:

Mayank Mausam

Assistant Professor (Guest Faculty)

Department of Electronics

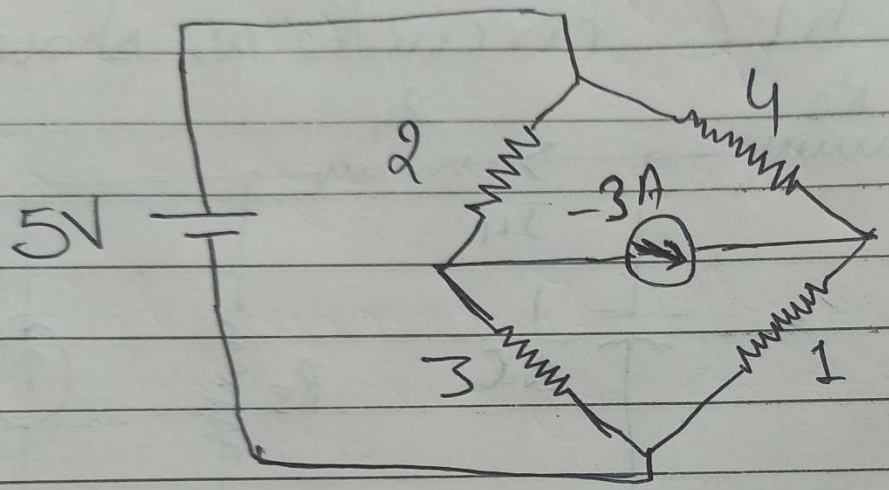
L.S. College, BRA Bihar University,

Muzaffarpur, Bihar

Circuit Theorem – Superposition Theorem

Solutions of problem discussed

Q1)



Find the current & voltage in 3Ω Resistor using superposition theorem.

figure 1(a)

Sol:- As per superposition theorem while solving the n/w we will consider one source at a time and removing remaining other sources with their internal resistance.

So let us consider 5V voltage source 1st, so removing -3A current source with it's

Circuit Theorem – Superposition Theorem

So let us consider 5V voltage source 1st, so removing -3A current source with it's equivalent internal resistance. So the ckt is,

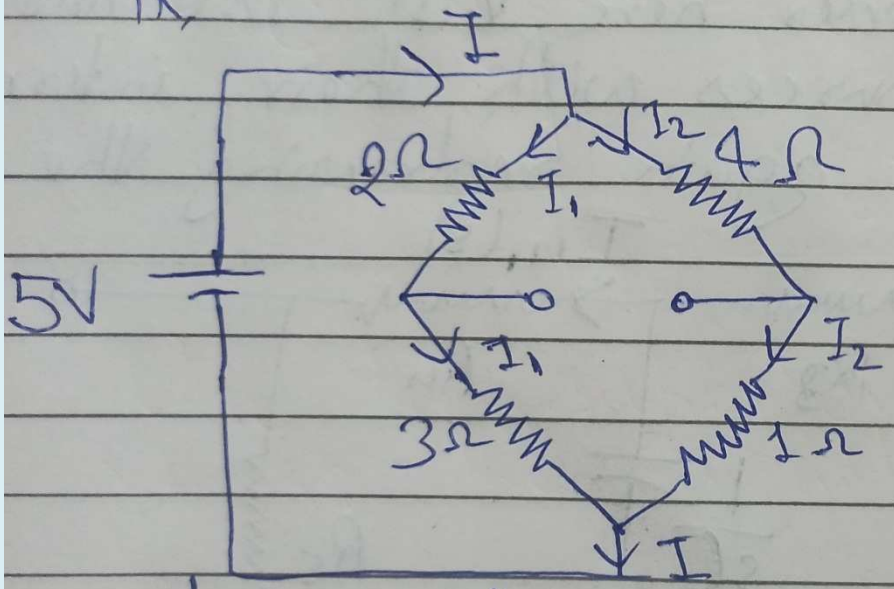


figure 1(b)

For the ckt. shown in figure 1(b)

We have 2Ω & 3Ω resistor are in series & on other side 4Ω & 1Ω resistor are in series

So the ckt. can reconsidered as shown in figure 1(c).

Circuit Theorem – Superposition Theorem

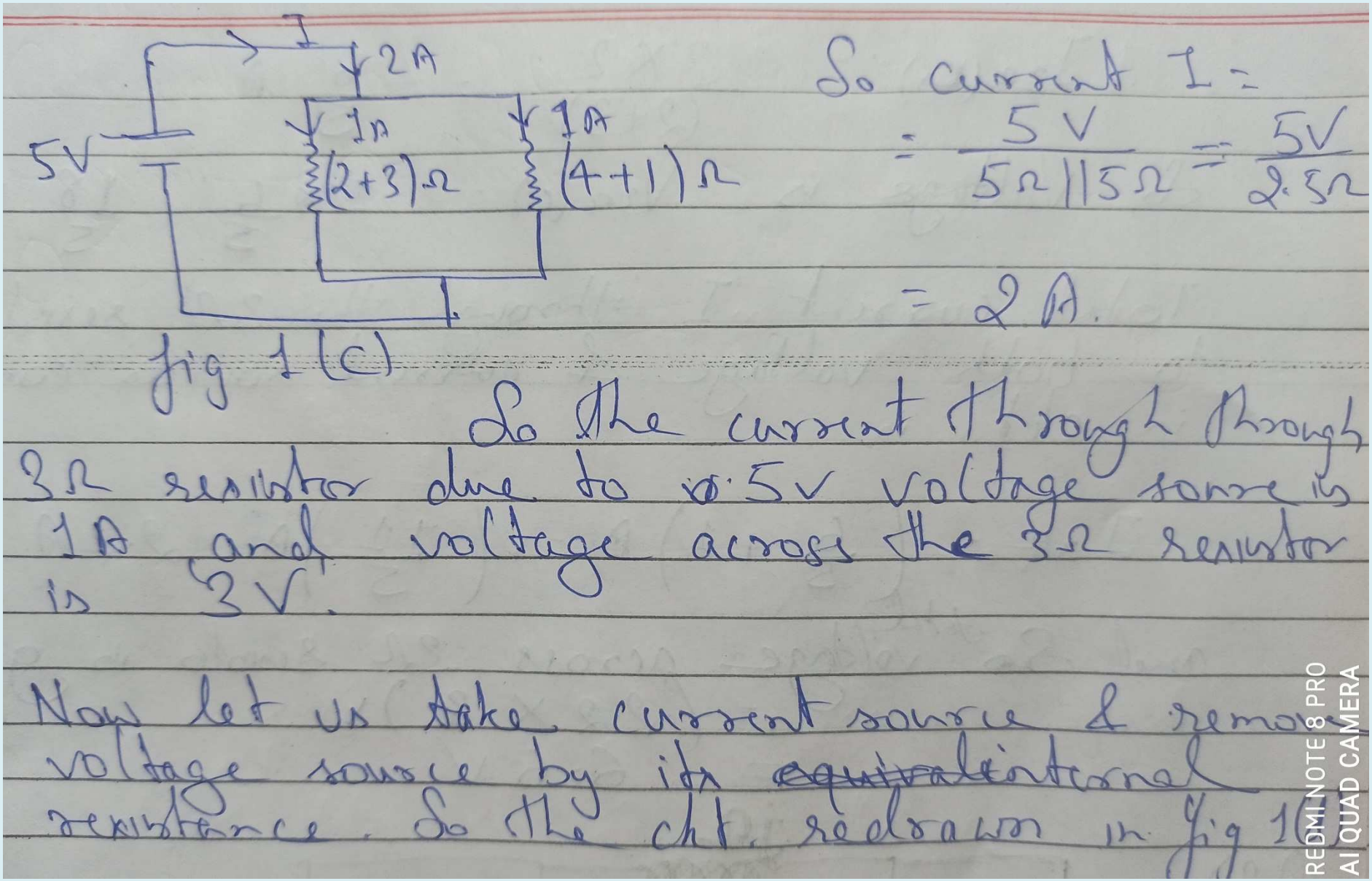


fig 1(c)

So current I =

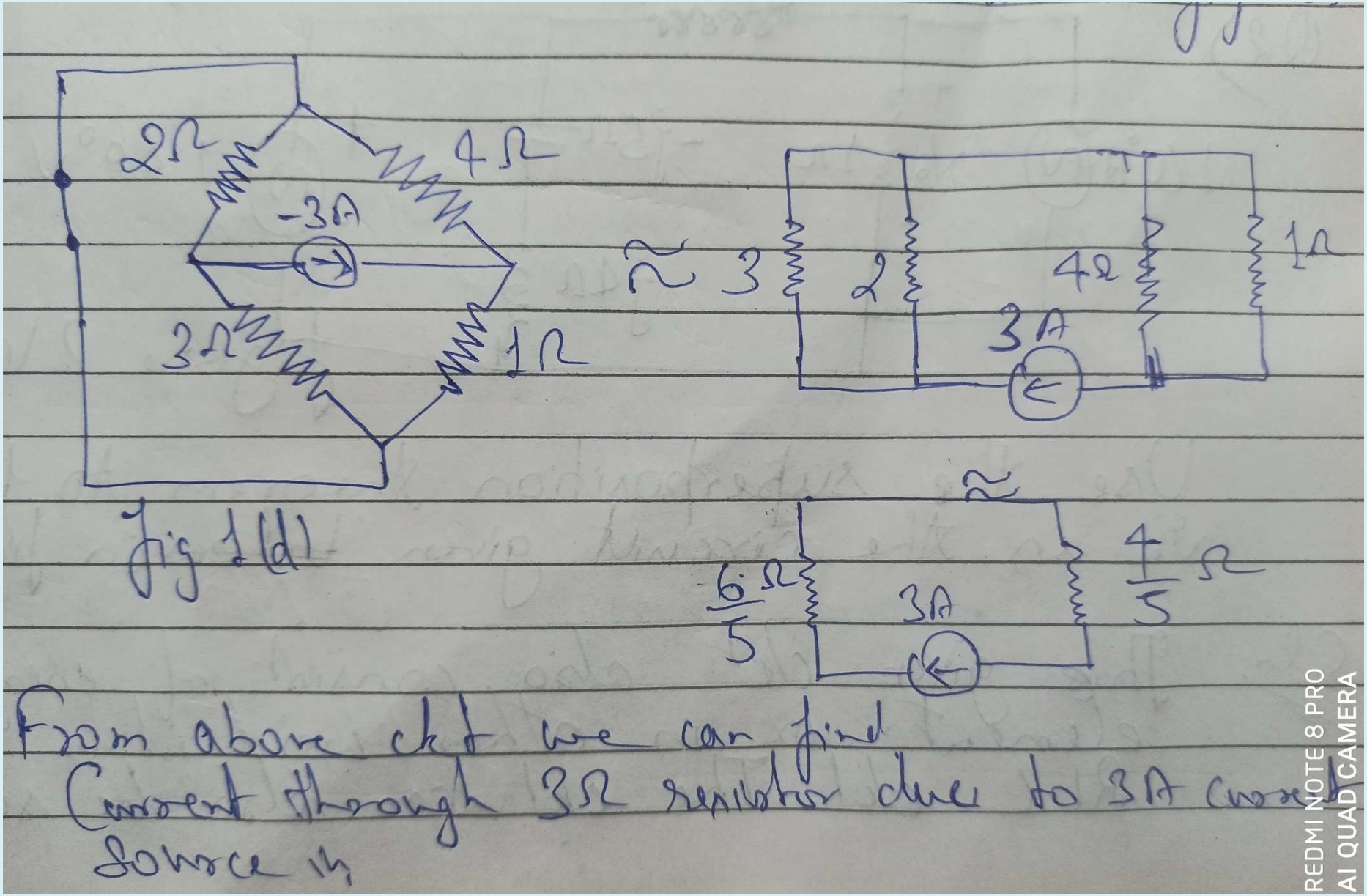
$= \frac{5\,V}{5\Omega \| 5\Omega} = \frac{5V}{2.5\Omega}$

$= 2A.$

So the current through through 3Ω resistor due to 5V voltage source is 1A and voltage across the 3Ω resistor is 3V.

Now let us take current source & remove voltage source by its ~~equivalent~~ internal resistance. So the ckt. redrawn in fig 1(

Circuit Theorem – Superposition Theorem



Circuit Theorem – Superposition Theorem

$$I_{3\Omega(CA)} = \frac{3 \times 2}{(2+3)} = \frac{6}{5} A$$

So, Voltage is $V_{3\Omega(c)} = 3 \times \frac{6}{5} = \frac{18}{5} V$

Total current I through the 3Ω resistor due to both voltage & current sources connected in ckt, is,

$$I_{3\Omega} = \left(\frac{6}{5} + 1\right) A = \left(\frac{11}{5}\right) A = 2.2 A,$$

and So total voltage across 3Ω resistor is given by.

$$= (2.2 \times 3) V$$

$$= 6.6 V$$

Circuit Theorem – Superposition Theorem

(Q2)

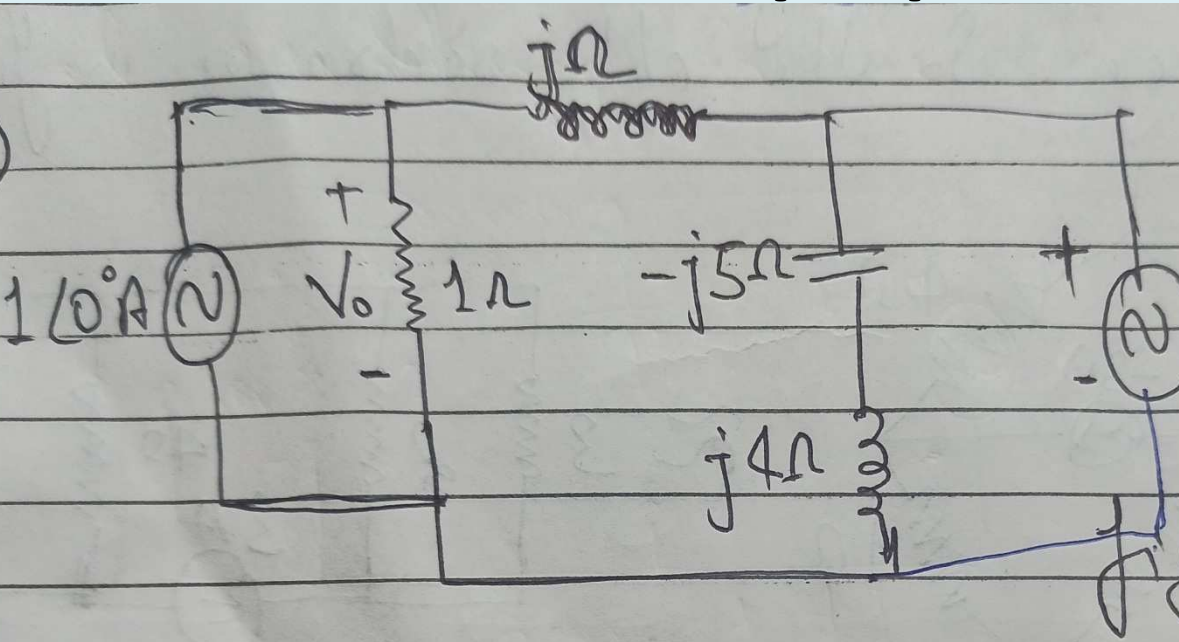


figure 2(a)

Use the superposition theorem to find v_o in the circuit given ~~below~~ in figure 2(a).

Soln. The given ckt. also consist of energy storing element or in other word it is a RLC ckt. The ckt can also be solved

Circuit Theorem – Superposition Theorem

using superposition ~~position~~ theorem in the same way as discussed earlier problems on superposition theorem.

So first consider current source connected in left of the ckt; and removing voltage source by it's equivalent (internal) resistance

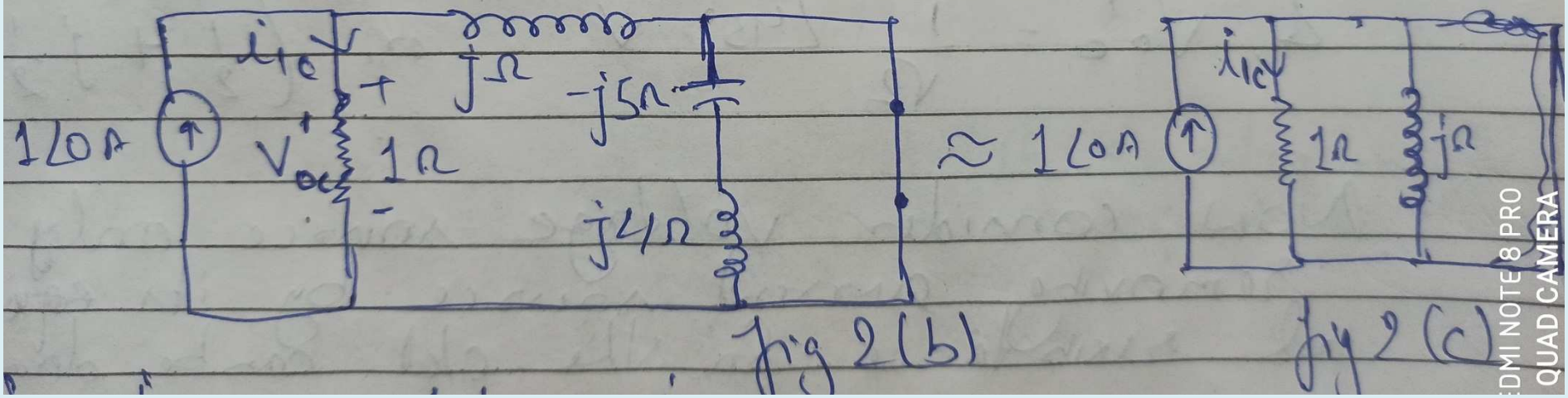


fig 2(b) fig 2(c)

Circuit Theorem – Superposition Theorem

$$\therefore I_{1c} = \frac{1\angle 0 \times j}{1+j\Omega}$$

angle

$$\text{phase of } j = \tan^{-1}\left(\frac{1}{0}\right) = \tan^{-1}(\infty) = 90^\circ$$

$$\text{Magnitude of } j = \sqrt{0^2+1^2} = \sqrt{1} = 1$$

$$j = 1\angle 90^\circ$$

Also, $1+j\Omega$ in polar form written as,

$$= \sqrt{1^2+1^2}\ \tan^{-1}\left(\frac{1}{1}\right) = \sqrt{2}\ \tan^{-1} 1 = \sqrt{2}\angle 45^\circ$$

Circuit Theorem – Superposition Theorem

So, $i_{1c} = \frac{1\angle 0 \times 1\angle 90^\circ}{\sqrt{2}\angle 45^\circ} = \frac{1}{\sqrt{2}}\angle 90^\circ - 45^\circ$

$= \frac{1}{\sqrt{2}}\angle 45^\circ$ A

In cartesian form, $i_{1c} = \frac{1}{\sqrt{2}}\cos 45^\circ + j\frac{1}{\sqrt{2}}\sin 45^\circ$

$= \left(\frac{1}{2} + j\frac{1}{2}\right)$ A

$\therefore V_{o'c} = \frac{1}{\sqrt{2}}\angle 45^\circ$ V or $\left(\frac{1}{2} + j\frac{1}{2}\right)$ V

Now consider voltage source only removing current source by its equivalent resistance. So the ckt can be drawn

Circuit Theorem – Superposition Theorem

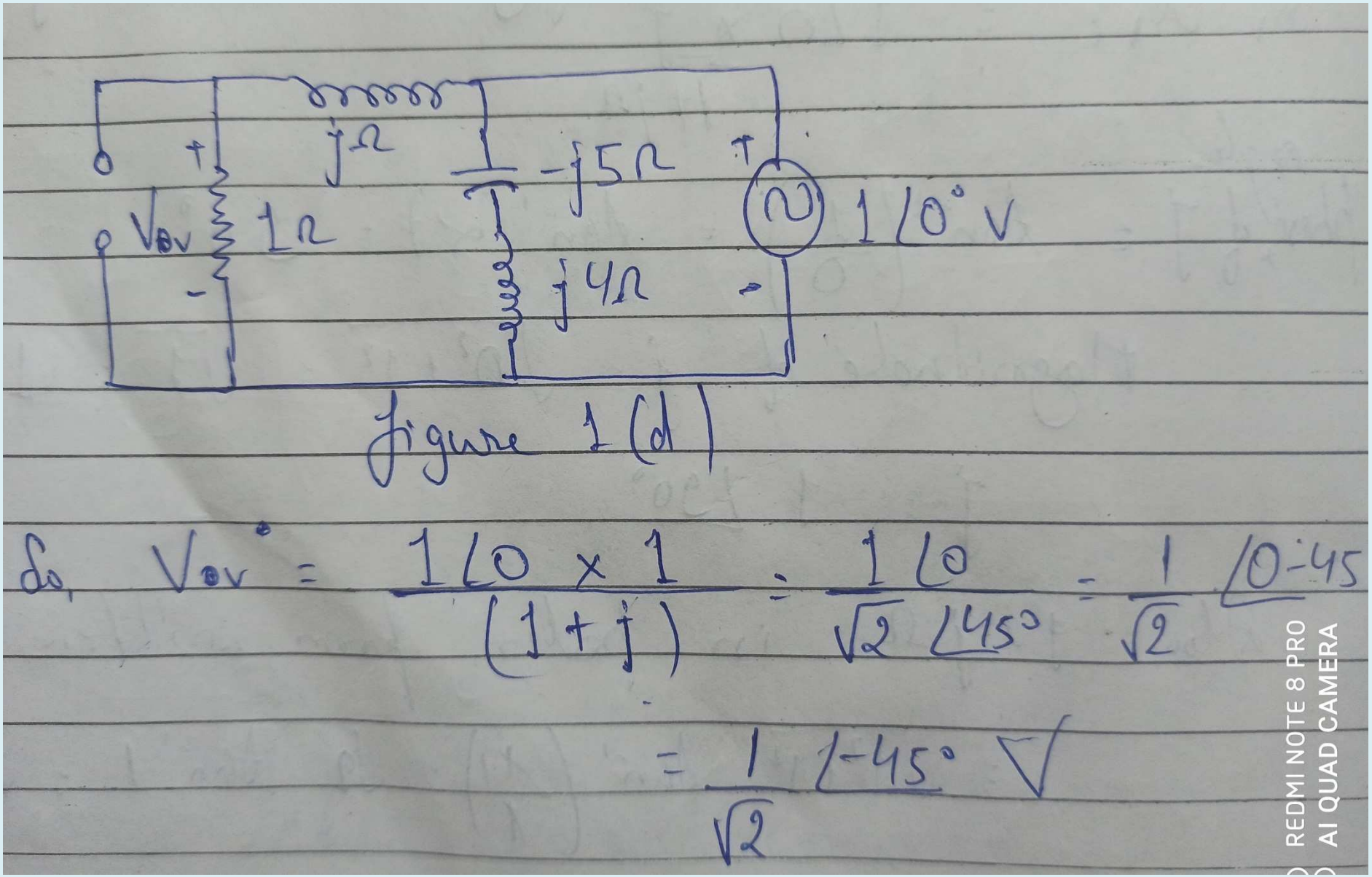


figure 1(d)

$$\text{So, } V_{ov}' = \frac{1\angle 0 \times 1}{(1+j)} = \frac{1\angle 0}{\sqrt{2}\angle 45^\circ} = \frac{1}{\sqrt{2}}\angle 0-45$$

$$= \frac{1}{\sqrt{2}}\angle -45^\circ \text{ V}$$

Circuit Theorem – Superposition Theorem

$$V_{ov} = \frac{1}{\sqrt{2}} \angle -45^\circ \approx \frac{1}{\sqrt{2}} \cos(-45^\circ) + j \frac{\sin(-45)}{\sqrt{2}}$$

$$= \frac{1}{\sqrt{2}} \times \frac{1}{\sqrt{2}} - j \frac{1}{\sqrt{2}} \times \frac{1}{\sqrt{2}} = \frac{1}{2} - j \frac{1}{2}$$

So total Voltage across 1Ω resistor is

$$V_o = \left(\frac{1}{2} + j\frac{1}{2}\right) + \left(\frac{1}{2} - j\frac{1}{2}\right)$$

$$= 1 \angle 0$$

Q Find current through $j4\Omega$ inductor in the ckt. shown below using superposition theorem

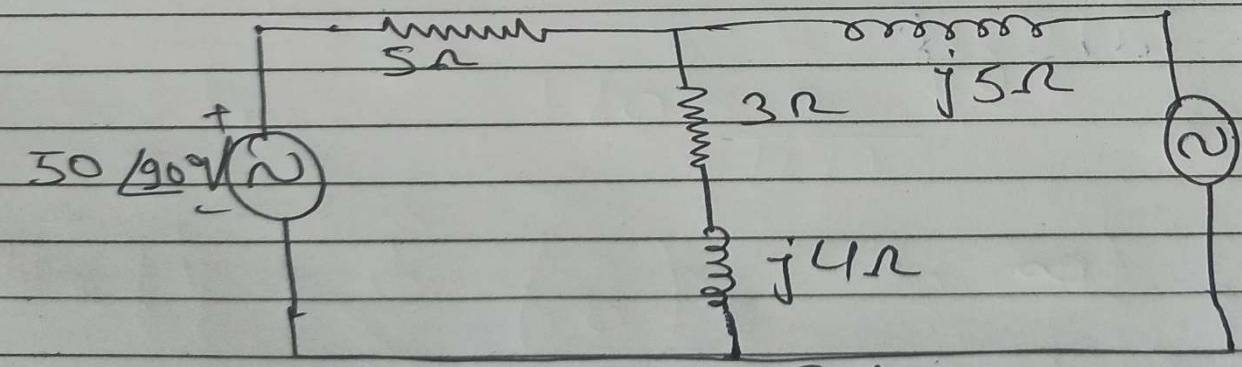


figure 3(a)

Circuit Theorem – Superposition Theorem

For any query contact at “9771474020”.

Thank You