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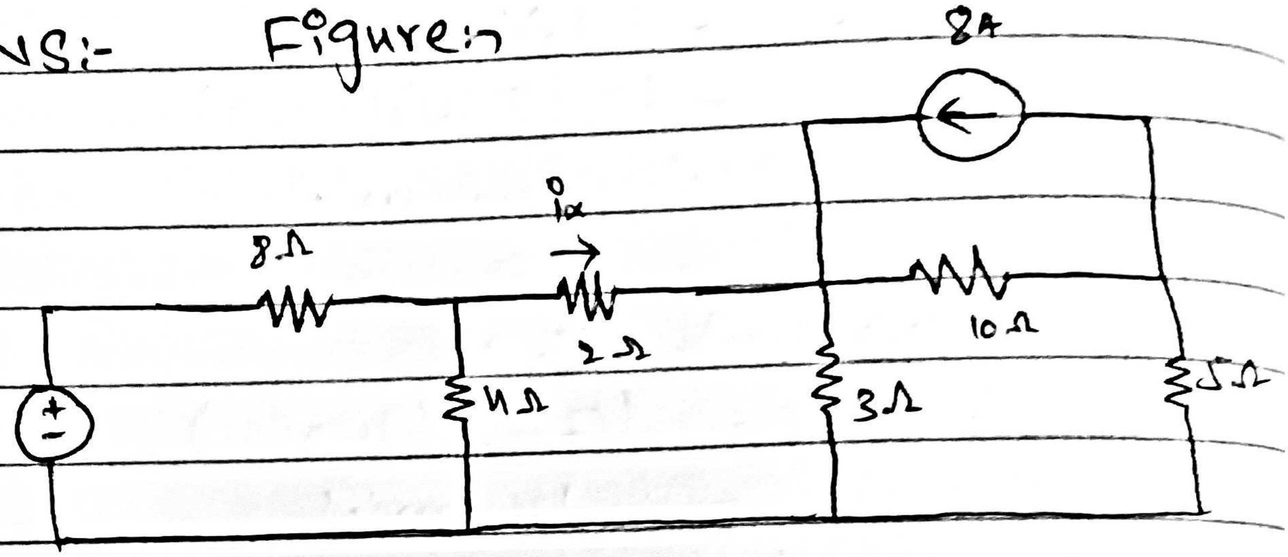
Name	Abdullah
ID NO	10194
Date	24/june/2020
Submitted to	Sir Sohail Imram
Subject	L.C.A

QNO 1

ANS:- Figure:-



Required:-

1. Nodal analysis
2. Mesh analysis
3. Superposition Theorem
4. Compare the number of steps & degree of easiness of all the three method with each.

Solution:-

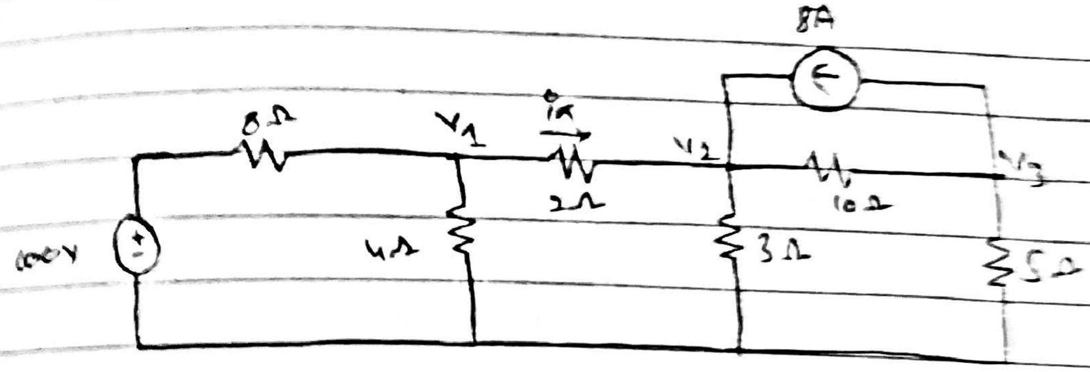
① Nodal analysis:-

For nodal analysis we will first identify nodes in the circuit.

Idetifying nodes:

Date: / /

(2)



(1) Applying KCL on node 1 :-

$$\frac{V_1-100}{8}+\frac{V_1}{4}+\frac{V_1-V_2}{2}=0$$

$$\frac{V_1-100+2V_1+4V_1-4V_2}{8}=0$$

$$\frac{7V_1-4V_2-100}{8}=0$$

$$0.875V_1-0.5V_2=12.5 \quad (1)$$

(2) Applying KCL on node 2 :-

$$\frac{V_2-V_1}{2}+\frac{V_2}{3}+\frac{V_2-V_3}{10}=-8$$

$$\frac{15V_2-15V_1+10V_2+3V_2-3V_3}{30}=-8$$

$$\frac{-15V_1+28V_2-3V_3}{30}=-8$$

$-0.5V_1 + 0.933V_2 - 0.1V_3 = 8$ — (2)

(3) Applying KCL on node (3)

$$\frac{V_3 - V_2}{10} + \frac{V_3}{5} = -8$$

$$\frac{V_3 - V_2 + 2V_3}{10} = -8$$

$-0.1V_2 + 0.3V_3 = -8$ — (3)

Taking eq (1)

$0.875V_1 - 0.5V_2 = 12.5$

$$V_1 = \frac{12.5 + 0.5V_2}{0.875}$$

$V_1 = 14.286 + 0.571V_2$ — (a)

Taking eq (3)

$-0.1V_2 + 0.3V_3 = -8$

$$V_3 = \frac{0.1V_2 - 8}{0.3}$$

$V_3 = 0.33V_2 - 26.67$ — (b)

Date: / /

4

Putting eq (a) & (b) in eq (2)

$$-0.5(0.57V_2 + 14.286) + 0.933V_2 - 0.1(0.33V_2 - 26.67) = 8$$

$$-0.285V_2 - 7.143 + 0.933V_2 - 0.03V_2 + 2.667 = 8$$

$$\cancel{1.248V_2 = 12.476}$$

$$0.618V_2 = 12.476$$

$$V_2 = 20.18V$$

Putting V_2 in eq (a)

$$V_1 = 14.286 + 0.571(20.18)$$

$$\boxed{V_1 = 25.80V}$$

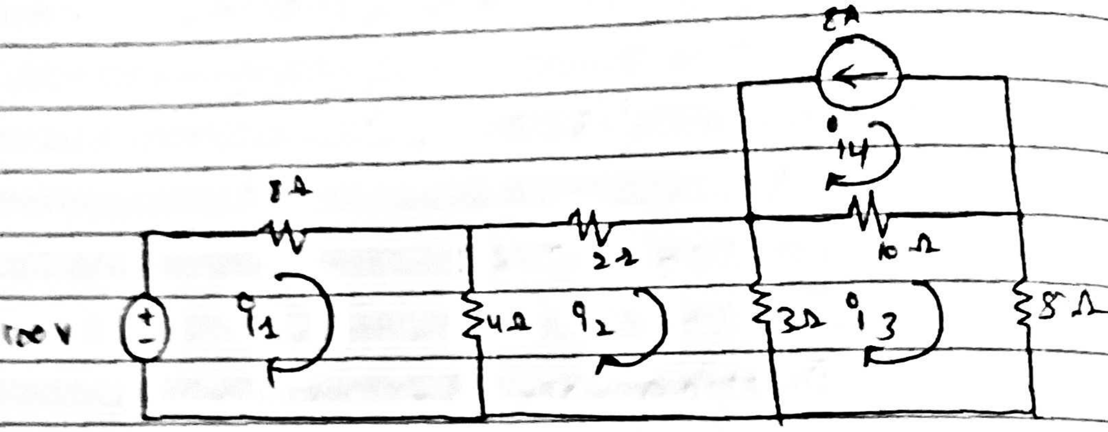
$$\boxed{V_2 = 20.18V}$$

for $i_x = \frac{V_1 - V_2}{2}$

$$= \frac{25.80 - 20.18}{2}$$

$$\boxed{i_x = 2.79A}$$

(ii) Mesh analysis:- In mesh analysis first we have to identify a loop in the circuit



(i) Applying KVL on loop 1:

$$8i_1 + 4(i_1 - i_2) = 100$$

$$8i_1 + 4i_1 - 4i_2 = 100$$

$$12i_1 - 4i_2 = 100 \quad \text{—— (1)}$$

(ii) Applying KVL on loop 2:

$$2i_2 + 4(i_2 - i_1) + 3(i_3 - i_2) = 0$$

$$2i_2 + 4i_2 - 4i_1 + 3i_3 - 3i_2 = 0$$

$$-4i_1 + 9i_2 - 5i_3 = 0 \quad \text{—— (2)}$$

Date: / /

(6)

(iii) Applying KVL on loop 3:

$$3(i_3 - i_2) + 10(i_3 - i_4) + 5i_3 = 0$$

$$3i_3 - 3i_2 + 10i_3 - 10i_4 + 5i_3 = 0$$

As $i_4 = 8$

$$-3i_2 + 18i_3 - 10(8) = 0$$

$$-3i_2 + 18i_3 = -80 \quad \text{—— (3)}$$

(iv) AND we know from the Circuit that 8 A a Current is flowing in loop 4

So

$$i_4 = 8A$$

Now Taking eq (1)

$$12i_1 - 4i_2 = 100$$

$$i_1 = \frac{100 + 4i_2}{12}$$

$$i_1 = 8.33 + 0.33V_2$$

Date: / /

7

Taking eq 3

$$-3i_2 + 18i_3 = -80$$

$$i_3 = \frac{-80 + 3i_2}{18}$$

$$i_3 = -4.44 + 1.67 i_2 \quad \text{—— (b)}$$

Putting in eq 2 the eq (a) & (b)

$$-4(8.33 + 0.33 i_2) + 9i_2 - 3(-4.44 + 1.67 i_2) = 0$$

$$-33.32 - 1.32 i_2 + 9i_2 + 13.32 - 5.01 i_2 = 0$$

$$\cancel{7}.167 i_2 = 20$$

$$i_2 = 2.790 \text{ A}$$

AS $i_2 = i_x$

So

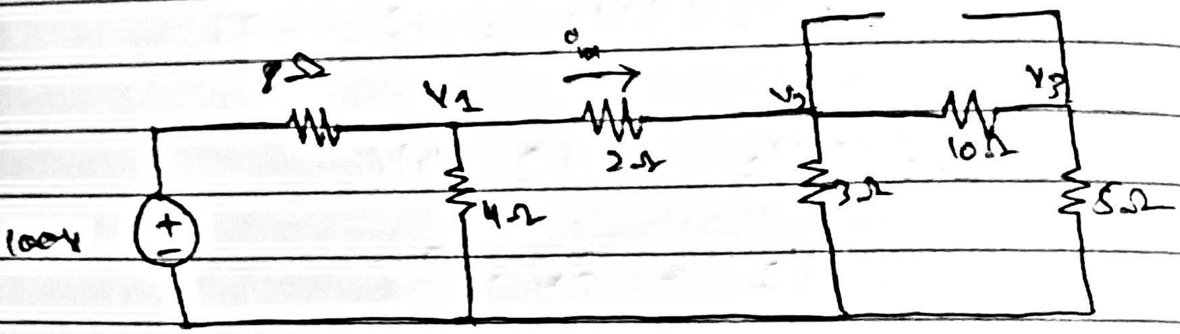
$$i_x = 2.790 \text{ A}$$

8

Date: / /

(iii) By Superposition theorem:

removing the Current Source & will make it as open circuit & the voltage will be active drawing circuit & identifying node



applying KCL on node 1:

$$\frac{V_1 - 100}{8} + \frac{V_1}{4} + \frac{V_1 - V_2}{2} = 0$$

$$\frac{V_1 - 100 + 2V_1 + 4V_1 - 4V_2}{8} = 0$$

$$\frac{7V_1 - 4V_2 - 100}{8} = 0$$

$$0.875V_1 - 0.5V_2 = 12.5 \quad \text{— (1)}$$

Date: / /

9

(ii) Applying KCL on node (2)

$$\frac{V_2 - V_1}{2} + \frac{V_2}{3} + \frac{V_2 - V_3}{10} = 0$$

$$\frac{15V_2 - 15V_1 + 10V_2 + 3V_2 - 3V_3}{30} = 0$$

$$\frac{-15V_1 + 28V_2 - 3V_3}{30} = 0$$

$$-0.5V_1 + 0.933V_2 - 0.1V_3 = 0 \quad (2)$$

(iii) Applying KCL on node 3 :-

$$\frac{V_3 - V_2}{10} + \frac{V_3}{5} = 0$$

$$\frac{V_3 - V_2 + 2V_3}{10} = 0$$

$$\frac{-V_2 + 3V_3}{10} = 0$$

$$-0.1V_2 + 0.3V_3 = 0 \quad (3)$$

Date: / /

10

AS we know from ~~mesh~~ nodal analysis part that

eq (a) is ~~...~~

$$V_1 = 14.286 + 0.571V_2$$

Taking eq (3)

$$-0.1V_2 + 0.3V_3 = 0$$

$$V_3 = \frac{0.1V_2}{0.3}$$

$$V_3 = 0.33V_2 \quad — (b)$$

putting eq (a) & (b) in eq (2)

$$-0.5(14.286 + 0.571V_2) + 0.933V_2 - 0.1(0.33V_2) = 0$$

$$-0.285V_2 - 7.143 + 0.933V_2 - 0.03V_2 = 0$$

$$0.618V_2 = 7.143$$

$$V_2 = 11.56$$

Putting in eq A

$V_2 = 14.286 + 0.57(11.56)$

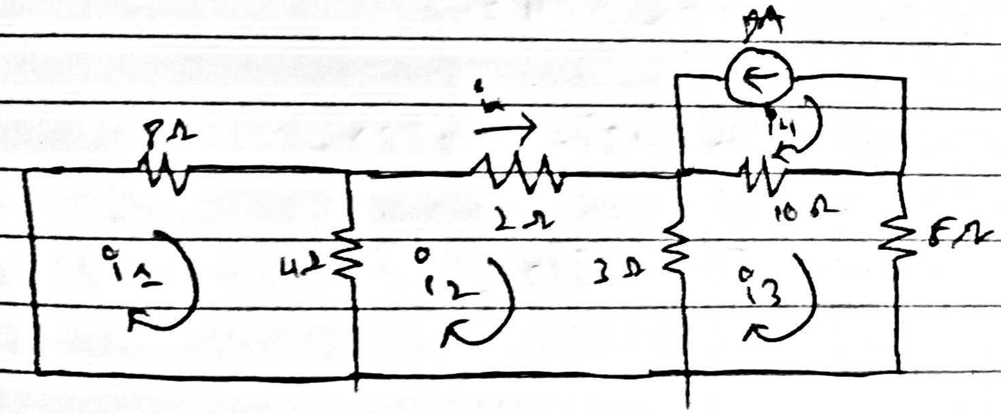
$V_1 = 20.87$

$i_1 = \dfrac{V_1 - V_2}{R}$

$i_1 = \dfrac{20.87 - 11.56}{2}$

$i_1 = 4.65\,A$

Now making Current Source active and removing Voltage Source making as Short Circuit



1. Applying KCL on loop 1

$8i_1 + 4(i_1 - i_2) = 0$

$8i_1 + 4i_1 - 4i_2 = 0$

$12i_1 - 4i_2 = 0$ —— (1)

applying KVL on loop 2:

$$2i_2 + 4(i_2 - i_1) + 3(i_3 - i_2) = 0$$

$$2i_2 + 4i_2 - 4i + 3i_3 - 3i_2 = 0$$

$$-4i_1 + 9i_2 - 3i_3 = 0 \quad \text{—} \quad 2$$

Appling KVL on loop 3

$$3(i_3 - i_2) + 10(i_3 - i_4) + 5i_3 = 0$$

$$3i_3 - 3i_2 + 10i_3 - 10i_4 + 5i_3 = 0$$

As $i_4 = 8$

$$-3i_2 + 18i_3 - 10(8) = 0$$

$$-3i_2 + 18i_3 = -80 \quad \text{—} \quad 3$$

Now taking eq 1

$$12i_1 - 4i_2 = 0$$

$$i_1 = \frac{4i_2}{12}$$

$$i_1 = 0.33\, i_2$$

Date: / /

13

And from mesh analysis part we know that

eq (B) is

$i_1 = -4.44 + 1.67i_2$ — (b)

Putting eq (a) & (b) in eq (2)

$-4(0.33i_2) + 9i_2 - 3(-4.44 + 1.67i_2) = 0$

$-1.32i_2 + 9i_2 + -5.07i_2 + 4.96 = 0$

$2.67i_2 = -4.96$

$i_2 = -1.867$

Now

$i_x = i_1 + i_2$

$= 4.65 - 1.867$

$i_x = 2.783\,A$

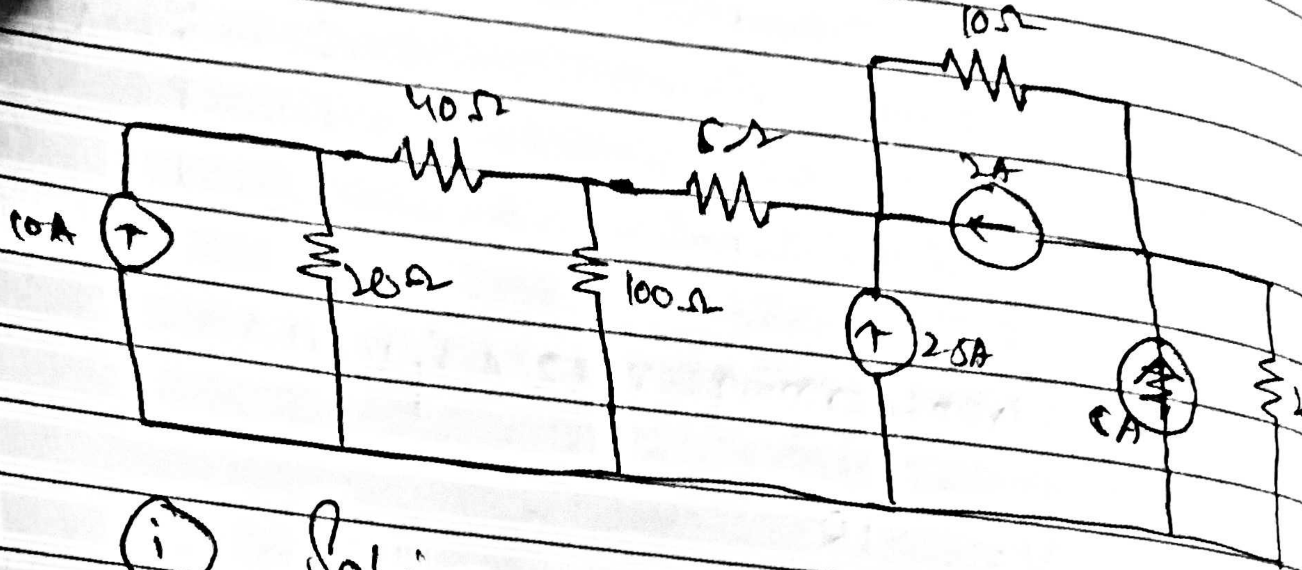
(iv) The number of Steps in nodal and mesh analysis are almost equal but in Superposition the number of Steps are almost of of mesh and nodal analysis.

Degree of easinessn

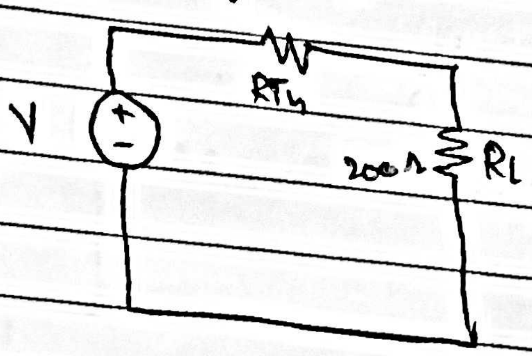
According to my opicion mesh analysis is easyar than nodal analysis & superposition theorem.

Q NO 2

ANSn figure:-

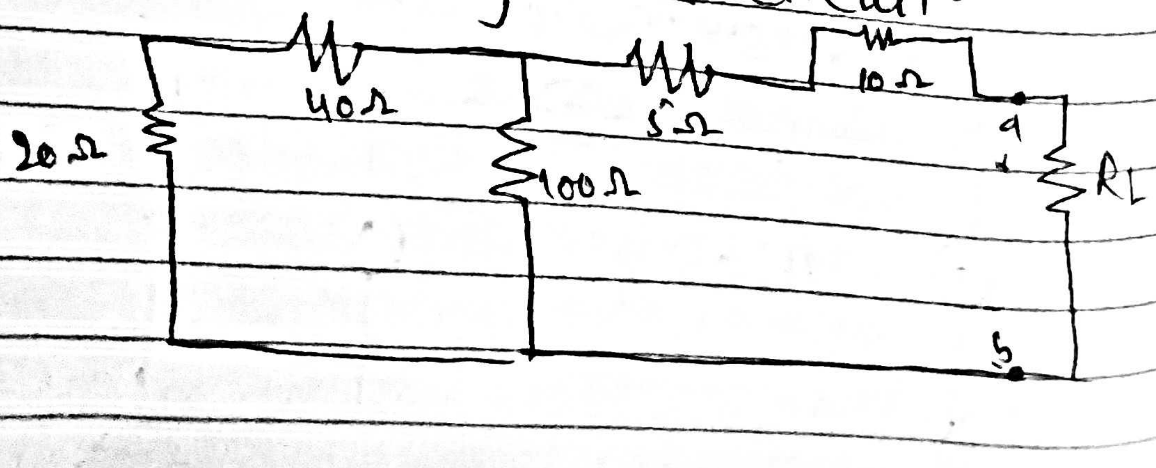


(i) Solving for thevinen:-



We will find R_{TH} for which we will remove all the Current Source & Short Circuit the load resistor.

Redrawing the Circuit



adding all resistor.

$$20+40 \parallel 100 + 5 + 10$$

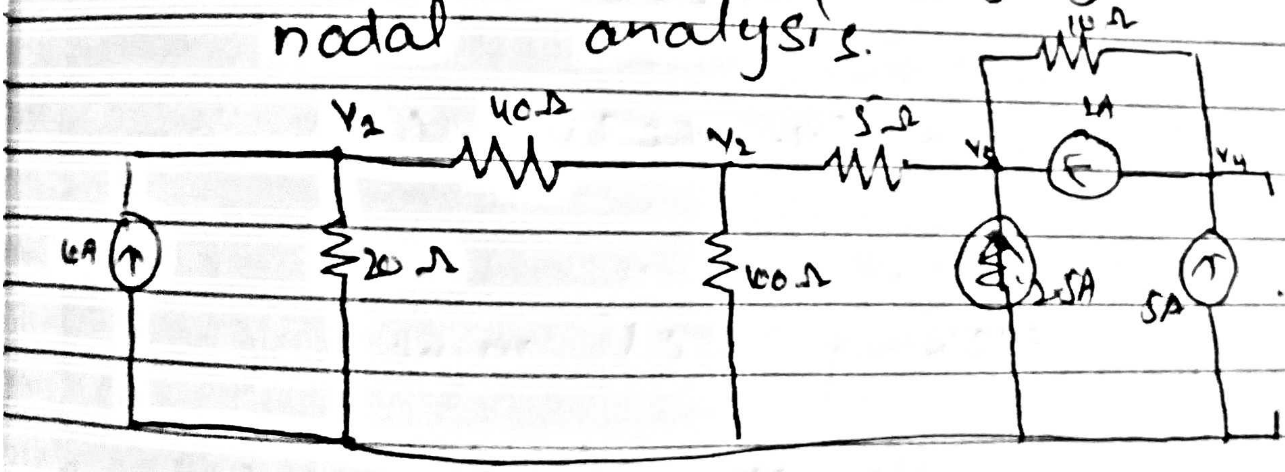
$$60 \parallel 100 + 15$$

$$\frac{60 \times 100}{60+100} + 15$$

$$37.5 + 15$$

$$R_{Th} = 52.5$$

for finding V_{Th} applying nodal analysis.



applying KCL on V_1

$$\frac{V_1 - V_2}{40} + \frac{V_1}{20} = 10$$

$$\frac{V_1 - V_2 + 2V_1}{40} = 10$$

$$V_1 - V_2 = 400 \quad \text{—} (1)$$

Date: / /

applying KCL on node 2

$$\frac{V_2 - V_1}{40} + \frac{V_2}{100} + \frac{V_2 - V_3}{5}$$

$$\frac{50V_2 - 50V_1 + 20V_2 + 400V_2 - 400V_3}{2000}$$

$$\frac{-50V_1 + 70V_2 - 400V_3}{2000} = 0$$

$$-0.05V_1 + 0.035V_2 - 0.2V_3 = 0 \quad (2)$$

Applying KCL on node 3

$$\frac{V_3 - V_2}{5} + \frac{V_3 - V_4}{10} = 2.5 + 2$$

$$\frac{2V_3 - 2V_2 + V_3 - V_4}{10} = 4.5$$

$$-2V_2 + 3V_3 - V_4 = 45 \quad (3)$$

Applying KCL on node 4

$$\frac{V_4 - V_3}{10} = 5 - 2$$

$$V_4 - V_3 = 30 \quad \text{--- (4)}$$

Solving by using Calculator.

$V_1 = 275$

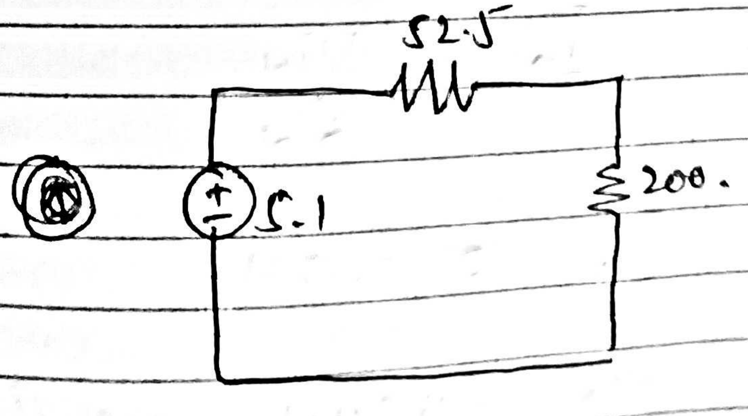
$V_2 = -124.9$

$V_3 = -87.5$

$V_4 = -57.5$

$V_{TH} = 275 - 124.9 - 87.5 - 57.5$

$V_{TH} = 5.1$



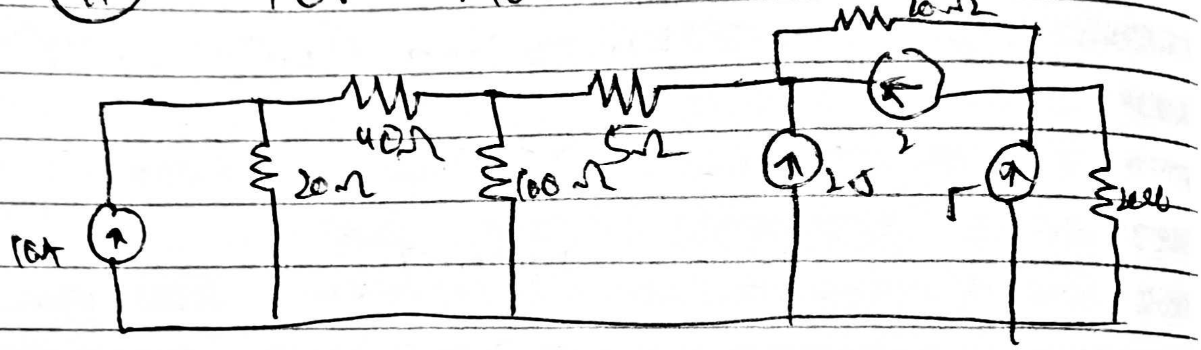
$$I_{th} = \frac{V_{TH}}{R_{TH} + R_L} = \text{[illegible]}$$

Date: / /

$$I_{TH} = \frac{5-1}{52.5+200}$$

$$I_{TH} = 0.02$$

(ii) For Norton Theorem



for R_N will be the same

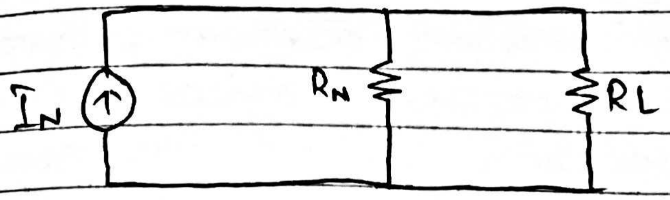
$R_N = R_{TH}$
$R_N = 52.5$

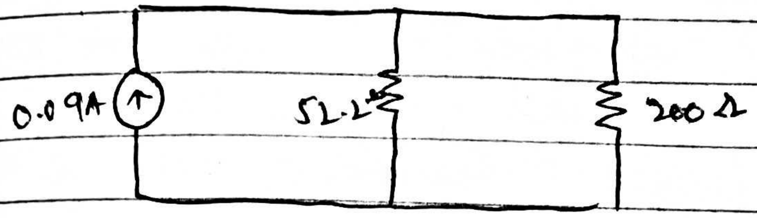
find $I_n = \frac{V_{TH}}{R_N}$

$I_n = 0.09$

As the circuit are same so we find it directly.

AS for ~~th~~ Northen





$$I_L = \frac{V_{TH}}{R_{TH} + R_L}$$

$$V_{TH} = I_N R_N$$
$$= (0.09)(52.2)$$
$$V_{TH} = 4.7\,V$$

$$R_{TH} = R_N = 52.2$$

Putting in eq

$$I_L = \frac{4.7}{52.2 + 200}$$

$$I_L = 0.019A$$

Date: / /

22

iii Using thevin for finding power:

we know that

$$P = \left(\frac{V_{TH}}{R_{TH}+R_L}\right)^2 R_L$$

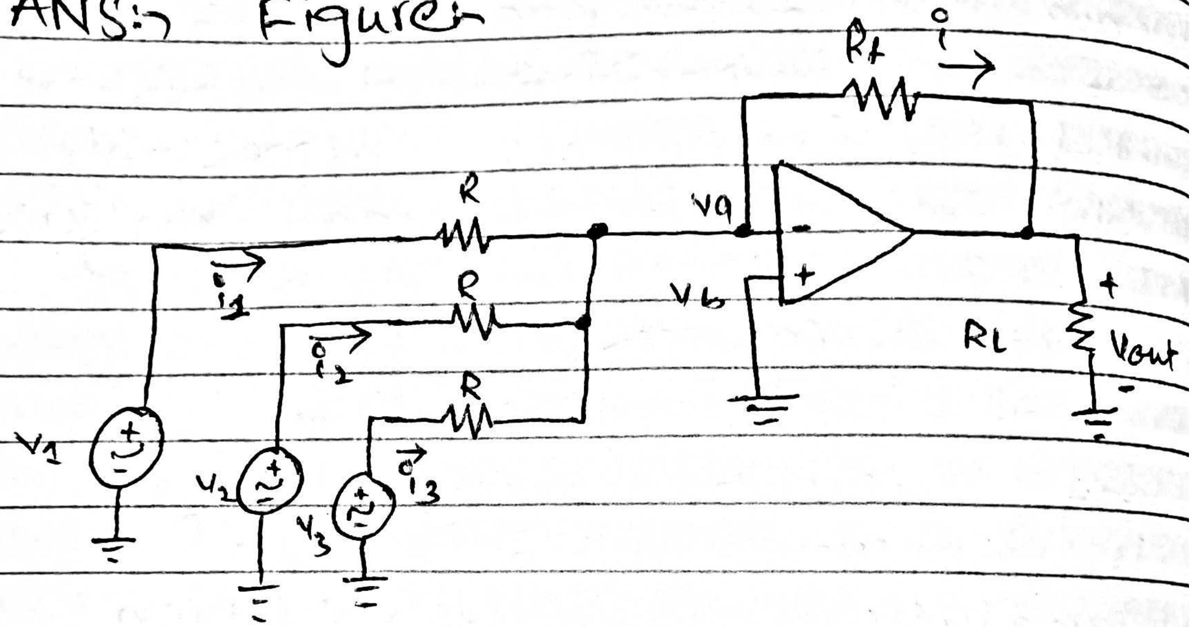
$$= \left(\frac{5.1}{52.5+200}\right)^2 200$$

$$P = 0.08W$$

Date: / /

Q NO 3

ANS:- Figure:-



Solution:-

We know that all the Current is entring to the inverting terminal & we know that the Current enter to inverting or non-inverting are vertually zero

So $i = i_1 + i_2 + i_3 = 0$

Therefore we are taking node va: As mantion in the Circuit above

Date: / /

As current I is flowing from Va to Vout as Va will be at high potential writing equation

$$0 = \frac{Va - Vout}{R_f} + \frac{Va - V_1}{R} + \frac{Va - V_2}{R} + \frac{Va - V_3}{R}$$

Now know that the potential b/w inverting & non-inverting terminal is zero so

$$Va = Vb = 0$$

$$Va = 0$$

So the equation will become

$$0 = \frac{Vout}{R_f} + \frac{V_1}{R} + \frac{V_2}{R} + \frac{V_3}{R}$$

$$\frac{-Vout}{R_f} = \frac{V_1}{R} + \frac{V_2}{R} + \frac{V_3}{R}$$

$$-Vout = R_f\left(\frac{V_1}{R} + \frac{V_2}{R_2} + \frac{V_3}{R}\right)$$

$$\boxed{Vout = -\frac{R_f}{R}\left(V_1 + V_2 + V_3\right)}$$