Department of Electrical Engineering
Final Assignment
Date: 24/06/2020

Course Details

Course Title:	Linear Circuits Analysis	**Module:**	3
Instructor:		**Total Marks:**	50

Student Details

Name:		**Student ID:**	

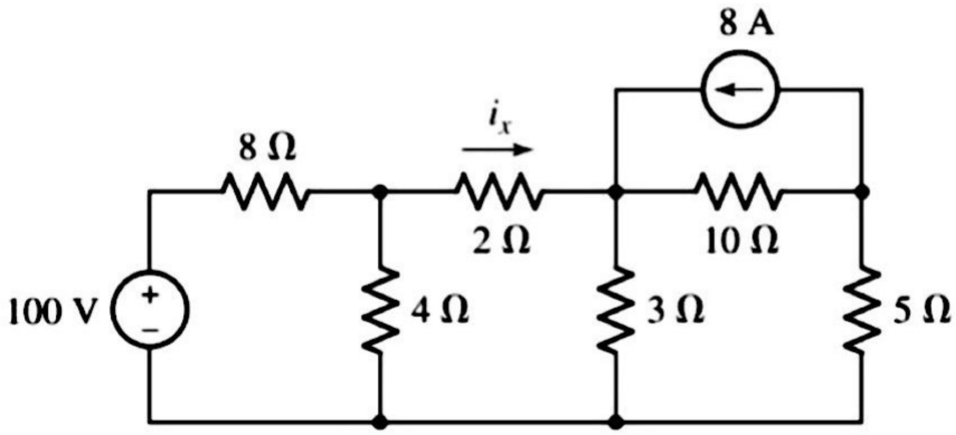
INSTRUCTIONS:

1. The solution must be uploaded before the end of deadline mentioned on the *Online Portal* of subject.

Question 1 **(15)**

Find the Value of i_x for the circuit using

i. Nodal Analysis
ii. Mesh Analysis
iii. Superposition Theorem
iv. Compare the number of steps and degree of easiness of all the three methods with each other



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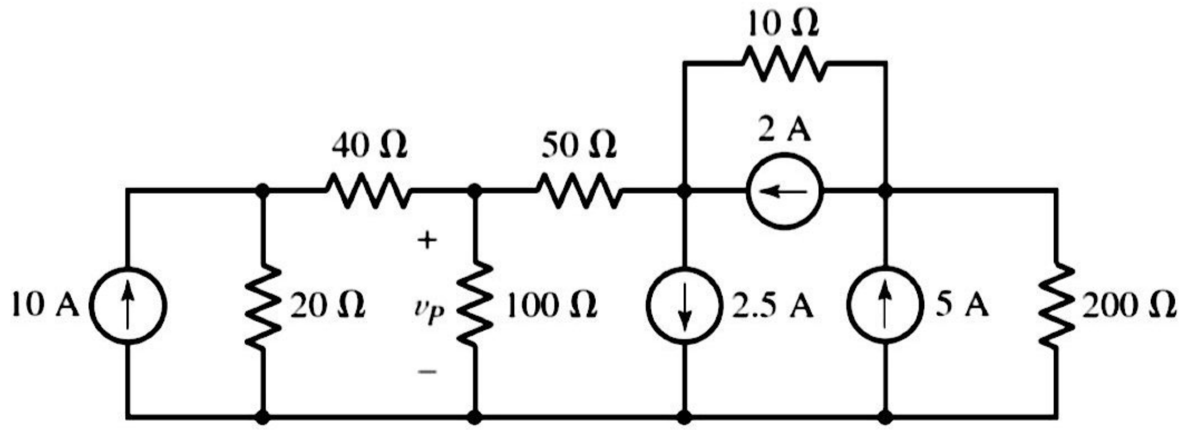
Question 2 **(20)**

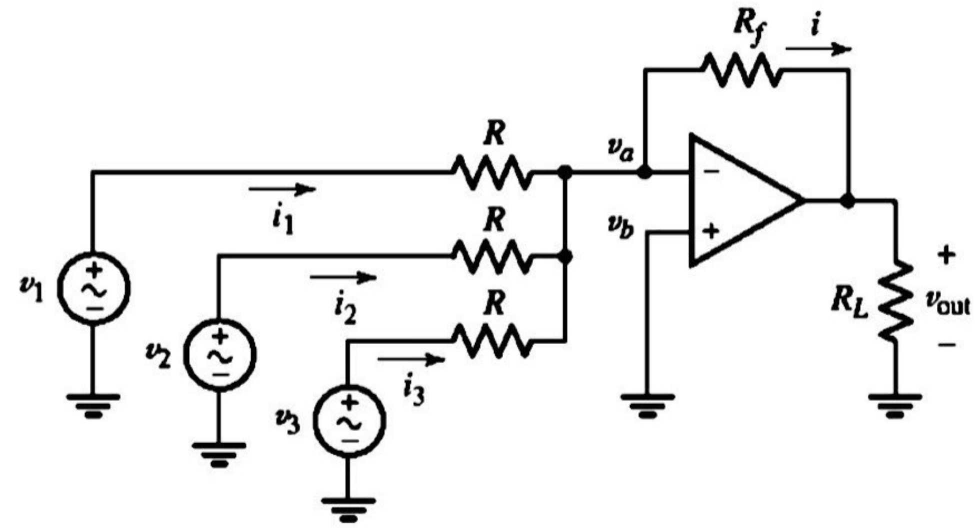
Consider the 200 ohms resistor in figure as load resistor and develop

i. Thevinin equivalent circuit
ii. Norton equivalent circuit.
iii. Find out what value of Thevinin resistance should be used to deliver maximum power to the load



Question 3 **(15)**

Obtain an expression for *Vout* in terms of *v1, v2,* and *v3* for the op amp circuit in figure, also known as a summing amplifier.



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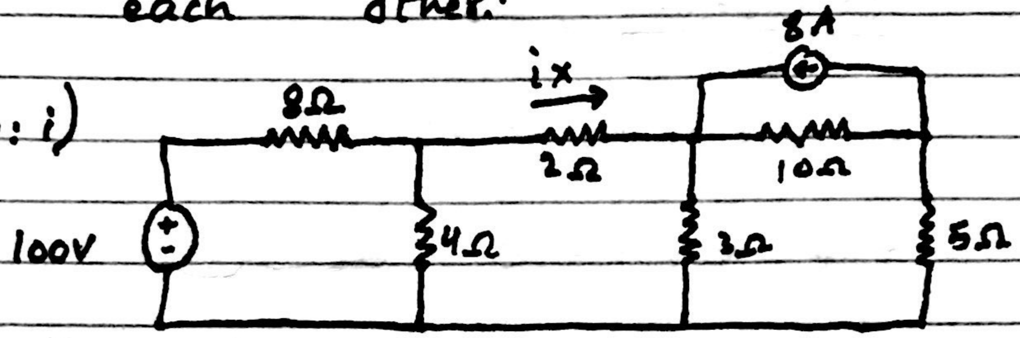
Question 1:-

Find the value of i for the circuit using.

i) Nodal analysis
ii) Mesh analysis
iii) Superposition theorem
iv) Compare the number of steps and degree of easiness of all the three methods with each other.

Solution: i)



⇒ Nodle analysis

Apply kcl on Node 1

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

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

$$7V_1 - 4V_2 = 100 \quad \text{(i)}$$

Apply kcl on Node 2

$$\frac{V_2 - V_1}{2} + \frac{V_2}{3} + \frac{V_2 - V_3}{18} = 8$$

$$\frac{30V_2 - 30V_1 + 20V_2 + 3V_2 - 3V_3}{60} = 8$$

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$-30V_1 + 53V_2 - 3V_3 = 480$ ~ (2)

Apply KCL on Node 3

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

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

$V_3 - V_2 + 2V_3 = -80$

$-V_2 + 3V_3 = -80$ — (3)

Taking eq (1)

$7V_1 - 4V_2 = 100$

$V_1 = \frac{4V_2 + 100}{7}$ ~ (a)

Taking eq (2)

$-V_2 + 3V_3 = -80$

$V_3 = \frac{V_2 - 80}{3}$ — (b)

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

$-30(0.57V_2 + 14.28) + 53V_2 - 3(0.33V_2 - 26.67) = 480$

$-17.1V_2 - 428.4 + 53V_2 - 0.99V_2 + 80.01 = 480$

$34.91V_1 = 828.39$

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$$V_2 = \frac{828.39}{34.91}$$

$$\boxed{V_2 = 20.31}$$

putting V_2 in eq (a)

$$V_2 = \frac{4(20.31) + 100}{7}$$

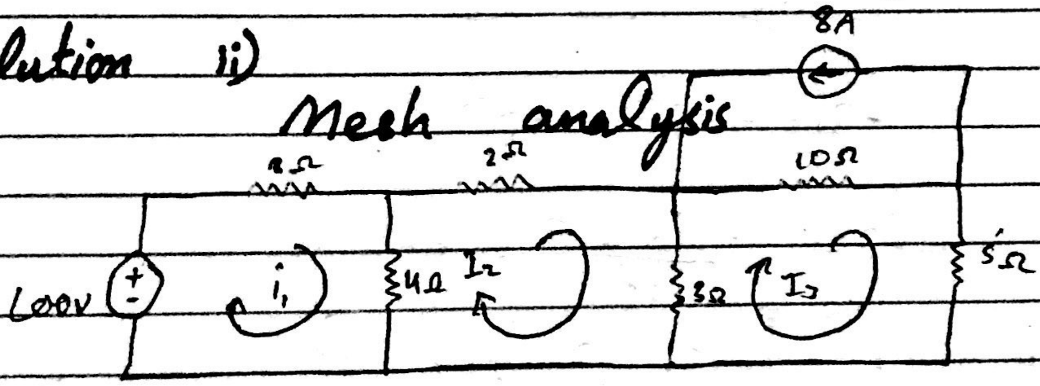
$$V_2 = 25.89$$

$$ix = \frac{V_1 - V_2}{2} = \frac{25.89 - 20.31}{2}$$

$$\boxed{ix = 2.79\,A}$$

Solution ii)

Mesh analysis



Apply KVL on loop 1

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

$$12i_1 - 4i_2 = 100 \quad (1)$$

Apply KVL on loop 2

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

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

Apply KVL on Loop 3

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

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

$-3i_2 + 18i_3 = -80$ ~ 2

Taking eq (i)

$i_1 = \frac{4i_2 - 100}{12}$ ~ a

Taking eq 3

$-3i_2 + 18i_3 = -80$

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

putting eq a and b in eq 2

$-4(0.33i_2 - 8.33) + 9i_2 - 3(0.16i_2 + 4.44) = 0$

$-1.32i_2 + 33.32 + 9i_2 - 0.48i_2 - 13.32 = 0$

$-1.32i_2 + 9i_2 - 0.48i_2 + 33.32 - 13.32 = 0$

$7.2i_2 + 120 = 0$

$7.2i_2 = -120$

$i_2 = -120/7.2$

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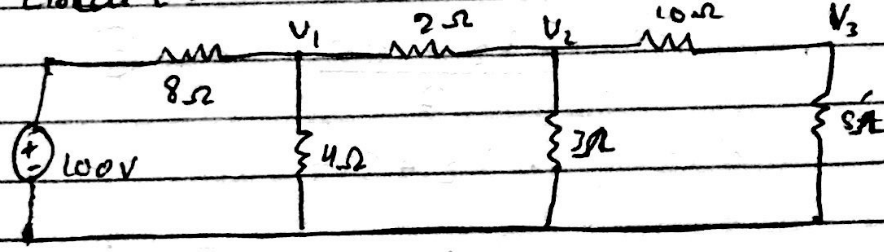
$I_2 = I_x$

$I_2 = 2.79A$

$\boxed{i_x = 2.79A}$

iii) Superposting theorem :

First we remove the current source and then making it an open circuit Re drawing the ciriuit.



Apply KCL on Node 1

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

$$\frac{V_1 - 100 + 4V_1 - 4V_1 + 2V_3}{8} = 0$$

$7V_1 - 4V_2 + 100$ —— (1)

Apply kcl on Node 2

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

$-30V_1 + 57V_2 - 3V_3 = 0$

Apply kcl on node 3

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

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

$$-V_2 + 2V_3 = 0 \sim ②$$

Now taking eq ① and ②

$$7V_1 - 4V_2 = 100$$

$$V_1 = \frac{4V_2 + 100}{7} \sim ⓐ$$

Now $-V_2 + 3V_3 = 0$

$$V_3 = 1/3\ V_2 \sim ⓑ$$

putting on eq ⓐ

$$-30(0.5 + V_2 + 14.28) - 4V_2 + 2(0.33V_2) = 0$$

$$-17.1V_2 - 48.4 - 4V_2 + 0.60V_2 = 0$$

$$V_2 = -20.95$$

putting in eq ⓐ

$$V_2 = 2.31$$

$$ix = \frac{2.81 + 20.95}{2}$$

$$\boxed{ix = 11.63}$$

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iv) Compare the number of steps and degree of easiness of all the three methods with each other.

iv)

Sol:- The number of Steps in nodal and mesh analysis are almost equal but in Superposition the number of steps are almost of mesh and nodal analysis

Degree of easiness

As according to openion mesh analysis is easyer than the nodle anysis and Superposition anylisis.

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Q2
Sol:- Concider the 200 ohm resistor in the figure and load resistor are develope.

Thevenin equivalent circuit
Norton equivalent circuit

i) Find out what value of thevinin resistance should be used to deliver maximum power to the load

Thevenin's and Norton's Equivalent Circuit Tutorial:

Thevenin's Theorem state that we can replace entire network by an equivalent circuit that contains only an independent voltage source in series with an resistor such that the current-voltage relationship at the load is uncharged.

Norton's theorem is identical to Thevenins theorem except that the equivalent circuit is a independent current source in parallel with an impedance (resistor).

Therefor, the Norton equivalent

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circuit is a source transformation of the Thevenin's equivalent circuit

if the circuit contains / you should do

a) **Resistor and independent source**

1) Connect an open circuit b/w (a) and (b)
2) Find the voltage across the open circuit which is Voc. Voc = Vth
3) Deactivate the independent sources
voltage source ⇒ open circuit
current source ⇒ short circuit
4) Find Rth by circuit resistance reduction.

b) **Resistors and dependent sources or independent sources:**

1) Connet an open circuit b/w a and b
2) Find the voltage across the open circuit which is Voc. Voc = Vth

* if there are both dependent and independent sources.

3) Connect a short circuit b/w a and b

4) Determine the current between (a) and (b)

5) $R^{th} = Voc / Iab$

if there are only dependent Sources

6) connect 1 ampere current source flowing from terminal b to a. it = 1 [A]

7) Then $Rth = Voc / It = Voc / 1$

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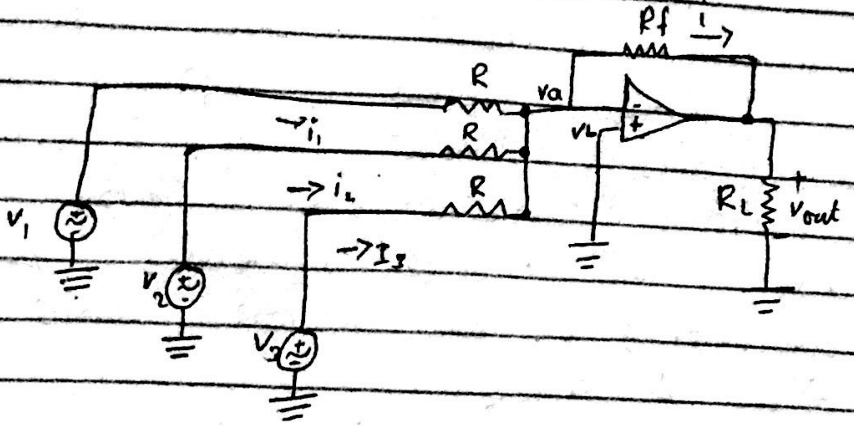
Q3
Solution:-



The goal is to obtain an expression for Vout (which appear across a load resistor R_L) in terms of the input V_1, V_2 and V_3)

No current can flow into the inverting input terminal

$$i = i_1 + i_2 + i_3$$

There for we can write the following equation at the node labled as

$$0 = \frac{V_a - V_{out}}{R_f} + \frac{V_a - V_1}{R} + \frac{V_a - V_2}{R} + \frac{V_a - V_3}{R}$$

The equation contain both vout and the input voltage but unfortunately it also contain the node voltage Va to remove this unknown quantity from out expression we need to write an addational equation that relates Va to Vout

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The input voltages R_f and for R At this point we remember that we have next yet used ideal op amp rule 2. and that we will almost cetainly require the use of both rules when analyzing an op amp circuit thus since

$va = vb = 0$ we can write the equation as following.

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

Now Rearrange we obtain the following expression for vout

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

In the special case where $V_2 = V_3 = 0$ we see that our result agrees with eq-3 ~~the~~ which was derived for ~~es~~ essentially the same Circuit.