S M T W T F S (1) Date:..........

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Q1: 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.

Ans! Nodal Analysis.

Solution:

(i) Apply (KCL) on node (1) (v_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

i-e v_2

$$\frac{v_2 - v_1}{2} + \frac{v_2}{3} + \frac{v_2 - v_3}{18} = 8$$

$$\frac{30v_2 - 30v_1 + 20v_2 + 3v_2 + 3v_3}{60} = 8$$

$$-30v_1 + 53v_1 - 3v_3 = 480 \quad \text{(ii)}$$

Apply KCL on node (3)

i-e v_3:

$$\frac{v_3 - v_2}{10} + \frac{v_3}{5} = -8$$

$$\frac{v_3 - v_2 + 2v_3}{10} = -8$$

$$\frac{-v_2 + 3v_3}{10} = -8 \qquad -v_2 + 3v_3 = -80 \quad \text{(iii)}$$

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Taking eq (ii)

$-v_2+3v_3 = -80$

$v_3 = \frac{v_2-80}{3}$ —— (c)

Putting eq (a) and (b) on eq (ii)

$-30(0.57v_2/2+14.28)+53v_2$

$-3(0.33v_2-26.67) = 480$

$-17.1v_2-428.4+53v_2-0.99v_2$

$+80.01 = 480$

$34.91v_2 = 828.39$

$v_2 = \frac{828.39}{34.91}$

$\boxed{v_2 = 20.31}$

Putting on eq (a)

$v_2 = \frac{4(20.31)+100}{7}$

$v_2 = 25.89$

$i_x = \frac{v_1-v_2}{2} = \frac{25.89-20.31}{2}$

$\boxed{i_x = 2.79A}$

2:- Mesh analysis

Apply KVL on loops:-

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

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

$12i_1-4i_2 = 100$ —— (1)

Apply KVL on Loop 2:-

$2i_2 + 4(5i_2 - i_2) + 3(i_3 - i_2) = 0$

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

$-4i_2 + 9i_2 - 3i_3 = 0$ ⟵ (2)

Apply KVL on Loop 3:

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

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

As $i_4 = 8$

$-3i_2 + 18i_3 = -80$ ⟵ (3)

Taking eq (1)

$$i_1 = \frac{4i_2 - 100}{12} \quad \text{--- (a)}$$

Taking eq (3)

$-3i_2 + 18i_3 = -80$

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

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

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

$\Rightarrow -1.32i_2 + 33.32 + 9i_2 - 0.48i_2 - 13.21 = 0$

$$i_2 = \frac{20}{7.2} \Rightarrow i_2 = i_x$$

$i_2 = 2.79\,A \Longrightarrow \boxed{i_x\ 2.79\,A}$

3) Super Position Theorem

Apply KCL on Node 1 v_1:

$$\frac{-100 + v_1}{8} + \frac{v_1 - v_2}{2} + \frac{v_1}{4} = 0$$

$$\frac{v_1 - 100 + 4v_1 - 4v_2 + 2v_1}{8} = 0$$

$7v1-4v2=100 \rightarrow (1)$

Apply KCL on node 2:

$$\frac{v2-v1}{2}+\frac{v2}{3}+\frac{v2-v3}{10}=0$$

$$\frac{15v2-15v1+10v2+3v2-3v3}{30}=0$$

$-15v1+23v2-3v3=0 \rightarrow (ii)$

at node 3:-

$$\frac{v3-v2}{10}+\frac{v3}{5}=0$$

$$\frac{v3-v2+2v3}{10}=0$$

$-v2+3v3=0 \rightarrow (iii)$

Now from eq (i)

$7v1-4v2=100$

$7v1=100+4v2$

$$v1=\frac{100+4v2}{7}$$

$$\boxed{v1=\frac{100+4v2}{7}} \rightarrow (2)$$

From eq (2)!

$-v2+3v3=0$

$+v2=-3v3$

$$\boxed{v3=\tfrac{1}{3}v2}$$

Put in eq (4)

$-15v1+23v2-3v3=0$

$$-15\left(\frac{100+4v2}{7}\right)+23v2-\cancel{3}\left(\frac{1}{\cancel{3}}v2\right)=0$$

$-15\,(14.2 + 0.5v_2) + 23v_2 - v_2) = 0$

$-213 - 7.5v_2 + 22v_2$

$-7.5v_2 + 22v_2 = 213$

$14.5v_2 = 213$

$\boxed{v_2 = 14.6v}$

put $v_2 = 14.6v$

$v_3 = 1/3\; v_2$

$v_3 = \frac{14.6}{3}$

$\boxed{v_3 = 4.8v}$

$$v_1 = \frac{100 + 4(14.6)}{7}$$

$$\frac{100 + 58.4}{7}$$

$v_1 = 22.6$ volt.

Now from Figure -

$$I_x' = \frac{v_1 - v_2}{2}$$

$$= \frac{22.6 - 14.6}{2}$$

$I_x' = 4A \longrightarrow$ ~~8/2~~

~~Now we~~

$I_4 = 8A$

Apply KVL at loop 1

$8I_1 + 4(I_1 - I_2) = 0$

$12I_1 - 4I_2 = 0$

$3I_1 = I_2 = 0 \rightarrow (i)$

at Loop 2:

$2I_2 + 3(I_2 - I_3) + 4(I_2 - I_1) = 0$

$2I_2 + 3I_2 - 3I_3 + 4I_2 - 4I_1 = 0$

$-4I_1 + 9I_2 - 3I_3 = 0 \rightarrow (ii)$

at Loop 3 =

$10I_3 - 14 + 5I_3 + 3(I_3 - I_2) = 0$

$10I_3 - \cancel{10}(8) + 5I_3 + 3I_3 - 2I_2 = 0$

$10I_3 - 80 + 5I_3 + 3I_3 - 3I_2 = 0$

$-3I_2 + 18I_3 = 80 \rightarrow (iii)$

From eq (i)

$3I_1 - I_2 = 0$

$$\boxed{I_1 = 1/3\, I_2 - a}$$

From eq (3)

$-3I_2 + 18I_3 = -80$

$$\boxed{I_3 = \frac{3I_0 - 80}{18}} \rightarrow (b)$$

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

$-4(1/3\, I_2) + 9I_2 - 3\left(\frac{3I_2 - 80}{18}\right) = 0$

$-4/3\, I_2 + 9I_2 - \cancel{3}(1/6\, I_2 - 4.4)^8 = 0$

$-1.3I_2 + 9I_2 - 0.5I_2 + 13.2 = 0$

$7.2I_2 = +13.2$

$$\boxed{I_2 = +1.8A}$$

Now $I_1 = -1/3\, I_2$

$$\boxed{I_1 = +0.6}$$

Now $I_x'' = I_1 + I_2$

$I_x'' = +0.6 - 1.9$

$\boxed{I_x'' = \cancel{*} -1.21} \rightarrow$

From

$\therefore I_x = I_x' + I_x''$

$= 4 - 1.21$

$\boxed{I_x = 2.79}$ → Ans

Q No. 3

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.

Ans:

Solution=

The goal is to obtain an expression for vout in terms of the inputs (v1, v2 and v3)

Since

No current can flow into the inverting input terminals.

we can write

$$i = i_1 + i_2 + i_3$$

Therefore, we can write this following equation at the node labeled va:

$$0 = \frac{va - vout}{Rf} + \frac{va - v_1}{R} + \frac{va - v_2}{R} + \frac{va - v_3}{R}$$

As this equation containg both vout and the input voltages but unfortunately it also contains the nodal voltage va:

Now

we need to write an additional equation that related va to vout, the input voltages, Rf and R.

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At this point we have not yet used ideal op amp rule 2. and that we will almost certainly require the use of both rules when analyzing an op amp circuit. Thus!

Since $va = vb = 0$

we can ~~writ~~ write following

$$0 = \frac{vout}{Rf} + \frac{v1}{R} + \frac{v2}{R} + \frac{v3}{R}$$

by Rearranging

we obtain the following expression for vout.

$$vout = -\frac{Rf}{R}(v1 + v2 + v3)$$

In This case, where $v2 = v3 = 0$

we see that our result agrees, which was derived for essentially the same circuit.

Q = (2)

Ans:

(i) Solving for Thevinin:

we will find R_{TH} for which current source el short circuit the load resistor. Redrawing the circuit.

adding all resistor

$20+40 \parallel 100 + 15 + 10$

$60 \parallel 100 + 15$

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

$37.5 + 15$

$R_{TH} = 52.5$

adding all resistor

$20+40 \parallel 100 + 15 + 10$

$60 \parallel 100 + 15$

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

$37.5 + 15$

$R_{Th} = 52.5$.

for finding in applying nodal anlysis.

applying KCL on v1

$\frac{v_1 - v_2}{40} + \frac{v_1}{20} = 10$

$\frac{v_1 - v_2 + 2v_2}{40} = 0$

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applying KCL on node 2

$$\frac{v2-v1}{40}+\frac{v2}{100}+\frac{v2-v3}{5}$$

$$\frac{50v2-50v1+20v2+400v3-400v3}{2000}$$

$$\frac{-50v1+70v2-400v3}{2000}=0$$

$$-0.05v1+0.035v2-0.2v3=0 \longrightarrow (3)$$

Applying KCL on node (3)

$$\frac{v3-v2}{5}+\frac{v3-v4}{10}=2.5+2$$

$$\frac{2v3-2v2+v3-v4}{10}=4.5$$

$$-2v2+3v3-v4=45 \longrightarrow (3)$$

Applying KCL on node (4)

$$\frac{v4-v3}{10}=5-2$$

$$v4-v3=30 \longrightarrow (4)$$

solving by using calculator.

$v1=75.7$

$v2=-124.9$

$v3=-87.5$

$v4=-57.5$

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$I_{TH} = \frac{5.1}{525+200}$

$I_{TH} = 0.02$

(ii) for Norton Theorem.

for RN will be the same

$R_N = R_{in}$

$R_N = 52.5$

find $I_N = \frac{V_{in}}{R_N}$

$I_N = 0.09$

As The circuit are same so we find the directly

(iii) using Their for finding power we know that

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

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

$P = 0.08\,W$