Adwait Naravane 19MS151

P-S-2.

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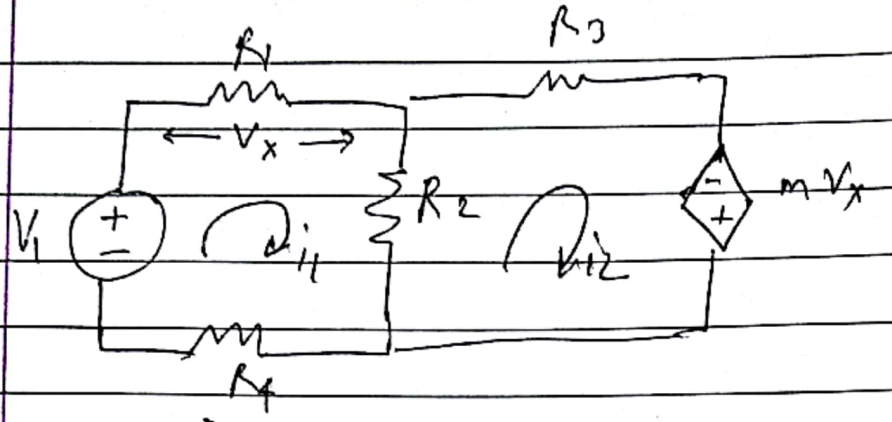
Q1)



Mesh ⇒

$$i_1(R_1+R_2+R_4) - i_2R_2 = V_1$$

$$i_2(R_3+R_2) - i_1R_2 = mV_x = m i_1 R_1$$

$$\Rightarrow i_2 = \frac{(mR_1+R_2)\,i_1}{R_3+R_2}$$

$$i_1\left(R_1+R_2+R_4 - \frac{R_2(mR_1+R_2)}{R_3+R_2}\right) = V_1$$

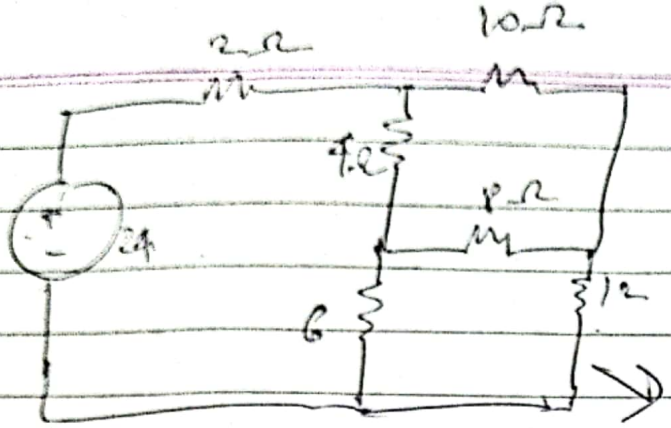
$$\Rightarrow i_1 = \frac{V_1}{R_1+R_2+R_4 - \frac{R_2(mR_1+R_2)}{R_3+R_2}}$$

Current through "R_2",

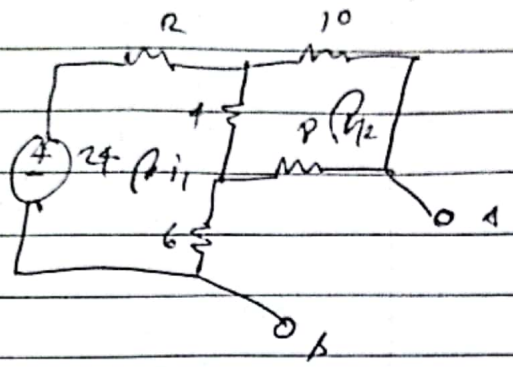
$$= |i_1 - i_2| = i_1\frac{(R_3-mR_1)}{R_3+R_2}$$

$$= \left|\frac{(R_3-mR_1)\,V_1}{(R_1+R_2+R_4)(R_3+R_2) - R_2(mR_1+R_2)}\right| \text{ A}$$

Q2



Thevenin



V_{AB} = ?

Mesh →

$\Rightarrow 22 i_2 = 4 i_1$

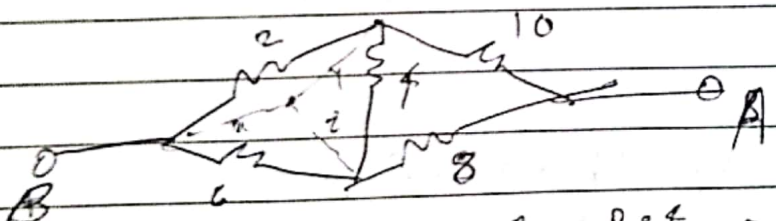
$12 i_1 - 4 i_2 = 24.$

$\Rightarrow i_1 = \frac{66}{31} A, \quad i_2 = \frac{12}{31} A$

$V_{AB} = V_A - V_B = 8 i_2 + 6 i_1 =$

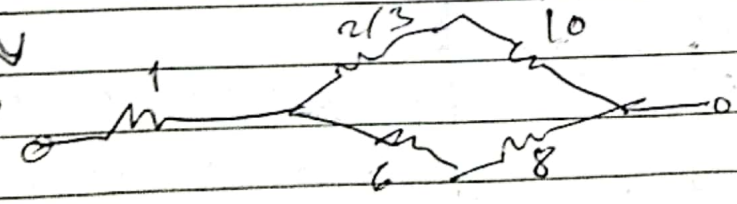
$= \frac{8 \times 12}{31} + \frac{6 \times 66}{31} = 15.87 V.$

Short the voltage source



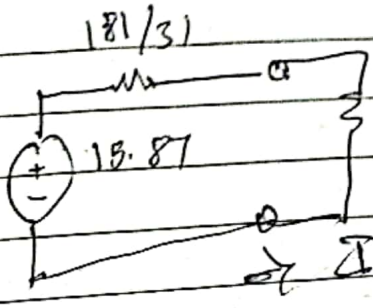
We can do a delta-star on it.

$R_x = \frac{2 \times 6}{2+4+6} = 1, \quad R_y = \frac{2 \times 4}{2+4+6} = \frac{2}{3} \Omega, \quad R_z = 2 \Omega.$



$\Rightarrow R_{th} = 1 + \frac{1}{\frac{3}{2} + 10 + 6 + 8}$

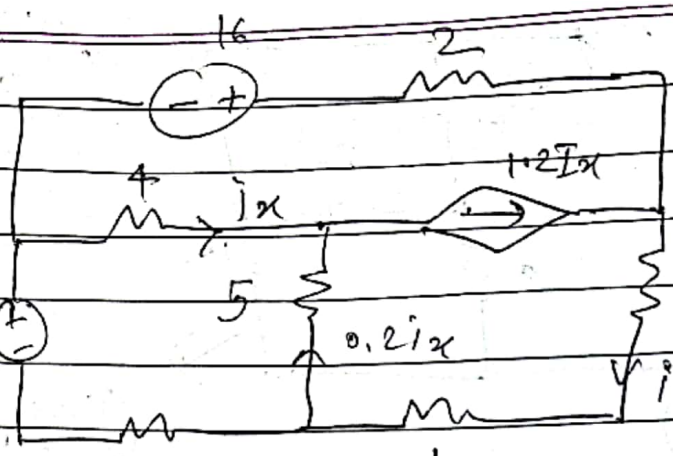
$= \frac{191}{31} \Omega$



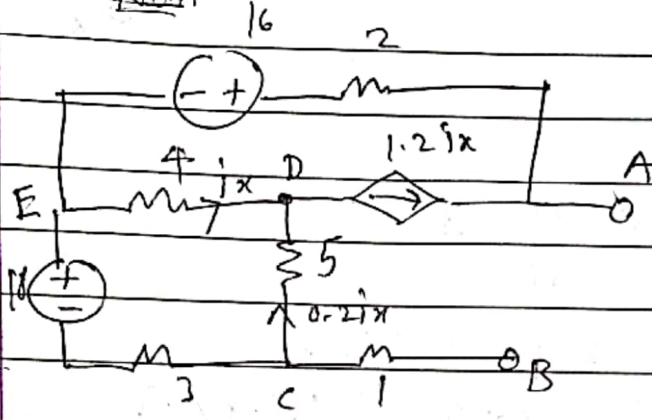
current through 12Ω.

$\Rightarrow I_1 = \frac{15.87}{\frac{181}{31} + 12} = 0.874 A$

Q3



current through 6Ω = ?



$V_{AB} = ?$

$V_B = V_C$

$18 + 0.6ix + ix - 4ix = 0$

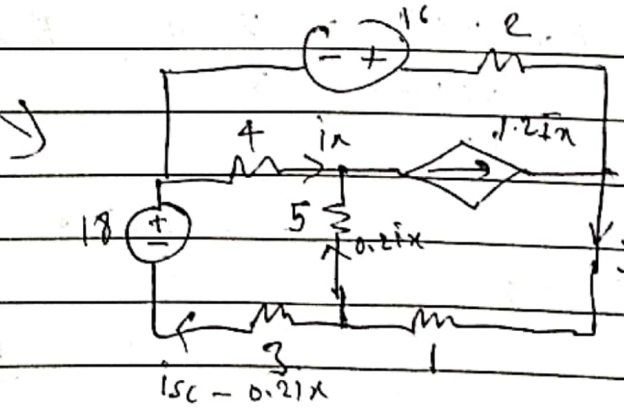
$\Rightarrow ix = 7.5$

$V_E - V_A = 16 + 2 \times 1.2 \times 7.5 = 16 + 18$

$V_D - V_E = 30$

$V_C + 7.5 = V_D$

$\Rightarrow V_C - V_A = V_B - V_A = V_{BA} = 56.5\ V.$



$2(i_{SC} - 0.2ix) + 4ix - ix - 18 = 0.$

$2.4ix + 3i_{SC} = 18.$

$-V_x + i_{SC} + ix = 0$

$V_x = i_{SC} + ix$

$2(1.2ix - i_{SC}) + 16 + 4ix - V_x = 0.$

$\Rightarrow 2.4ix + 3i_{SC} = 18$

$\Rightarrow ix = 0.256, \quad i_{SC} = 5.795.$

$\Rightarrow \eta_N = \frac{5.795}{56.5} = 0.1025$

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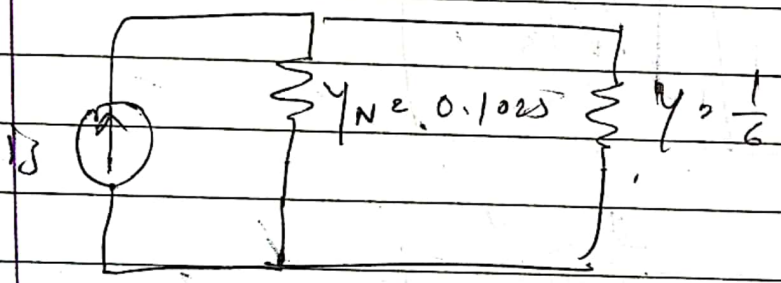
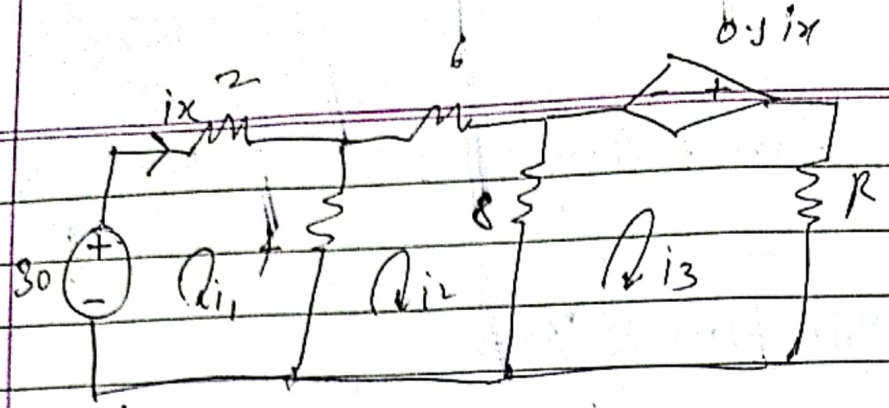
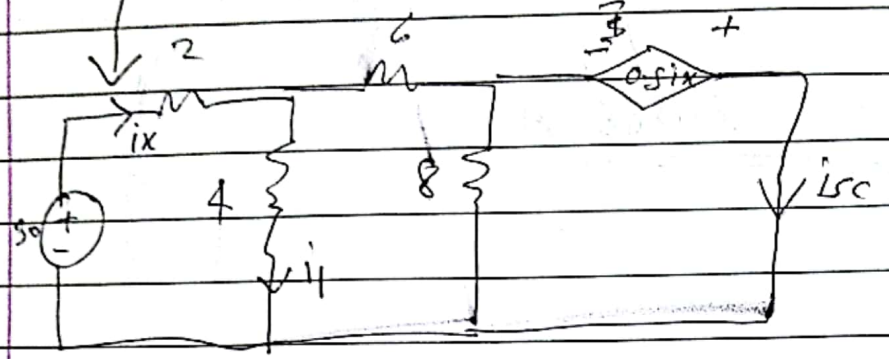
⇒ $I_{6\Omega}$ current through $6\Omega = 5.795 \times \frac{\frac{1}{y_n}}{\frac{1}{y_n} + 6}$



$I_{6\Omega} = 3.588\ A.$

Q4





$2i_x + 4i_1 = 30$

$6(i_x - i_1) + 8(i_x - i_1 - i_{sc}) = 4i_1$

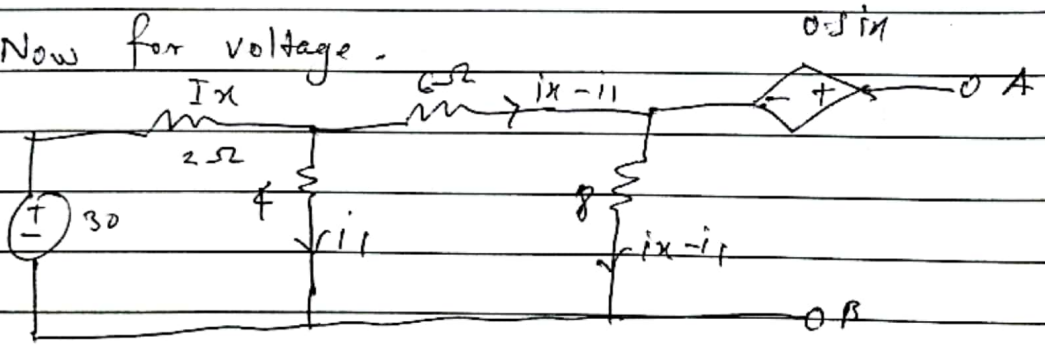
$0.5i_x + 8(i_x - i_1 - i_{sc}) = 0.$

$i_x = 7.143\ A.$

$i_1 = 3.93\ A.$

$i_{sc} = 3.66\ A.$

Now for voltage.



$V_{AB} = ?$

$2i_x + 4i_1 = 30,$

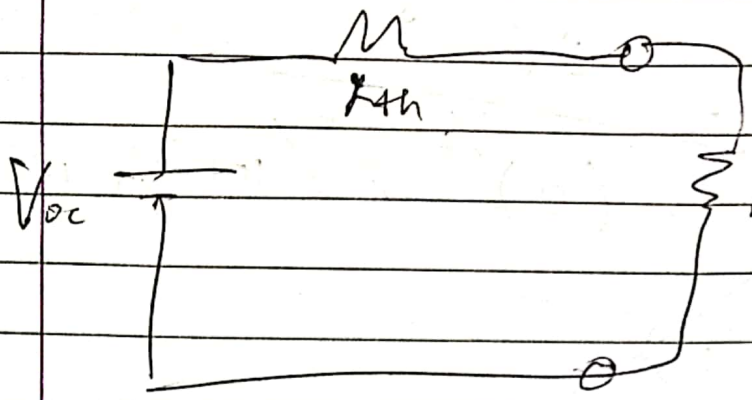
$i_x + 2i_1 = 15$

$6(i_x - i_1) + 8(i_x - i_1) = 4i_1$

$i_x = \frac{9 \times 15}{23}, \quad i_1 = \frac{7 \times 15}{23}$

$V_{oc} = (i_x - i_1) \times 8 + 0.5 i_x = 13.37\ V.$

$\Rightarrow R_{thev} = \frac{V_{oc}}{I_{sc}} = 3.6523\ \Omega.$



Power through $P = \dfrac{V_{oc}^2 R}{(R + R_{Th})^2}$

Maximum power $\Rightarrow \dfrac{dP}{dR} = 0 = \dfrac{2(R - R_{Th})}{(R_{Th} + R)^3} = 0$

$\Rightarrow R = R_{Th}$.

$R = 3.6523\ \Omega$ is for maximum power

$P = \dfrac{V^2 R}{(R + R_{Th})^2} = \dfrac{V^2}{4R} = 12.18\ W$