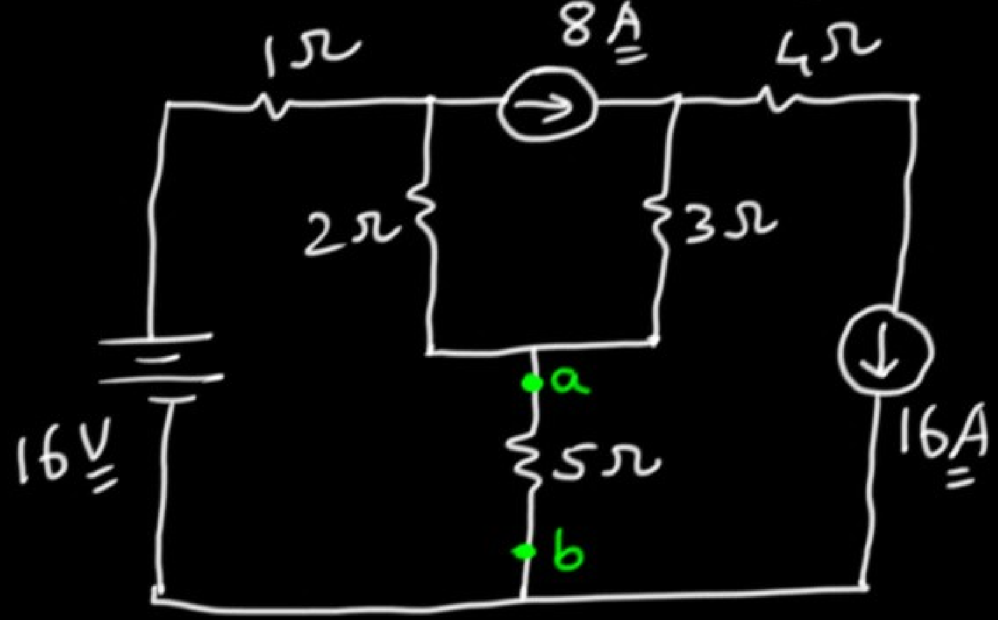
TVS

Network Analysis

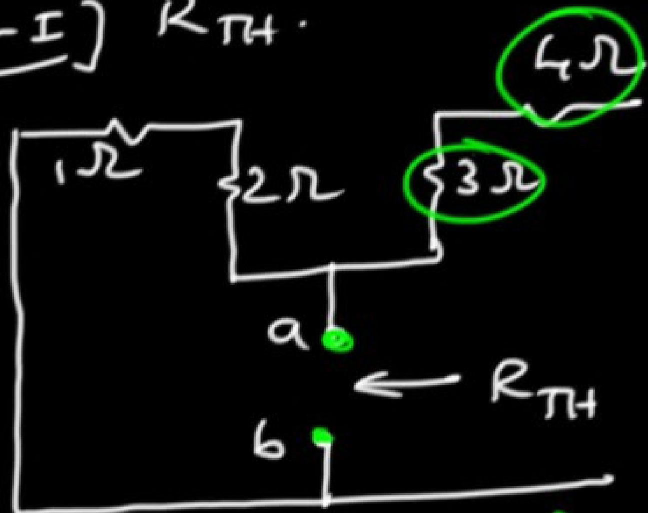
[Day - 10]

1] Determine power absorbed by 5Ω resistance using Thevenin's & Nortons Theorem.



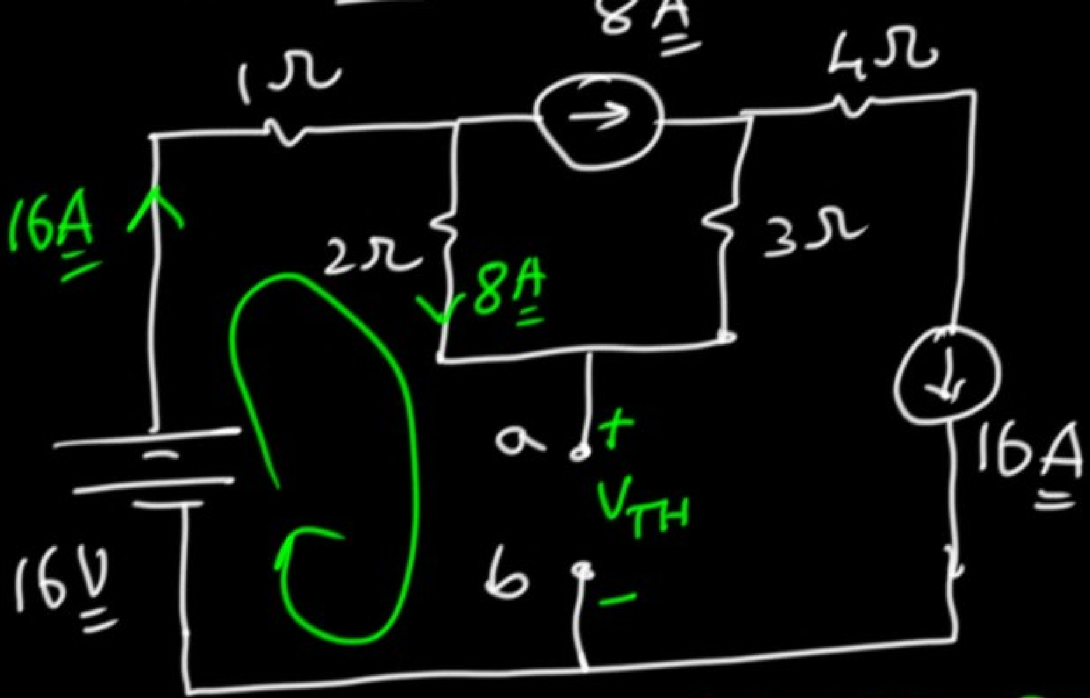
a) T.T

S-I] R_{TH}.



$R_{TH} = 1 + 2 = 3\,\Omega$

S – π] V_{TH}

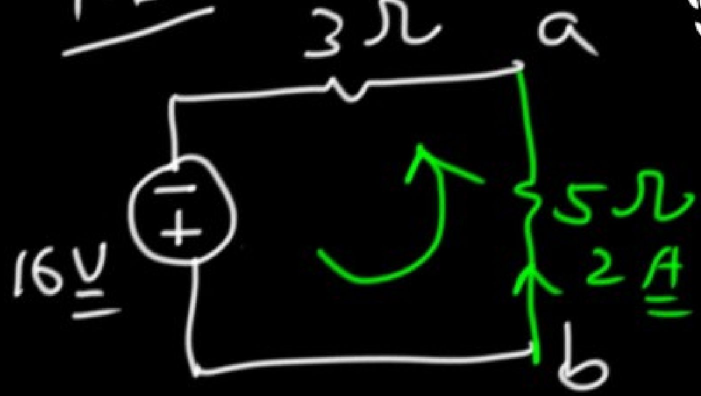


KCL+KVL

$$-16+16(1)+8(2)+V_{TH}=0$$

$$V_{TH}=-16 \text{ volts}$$

T.E



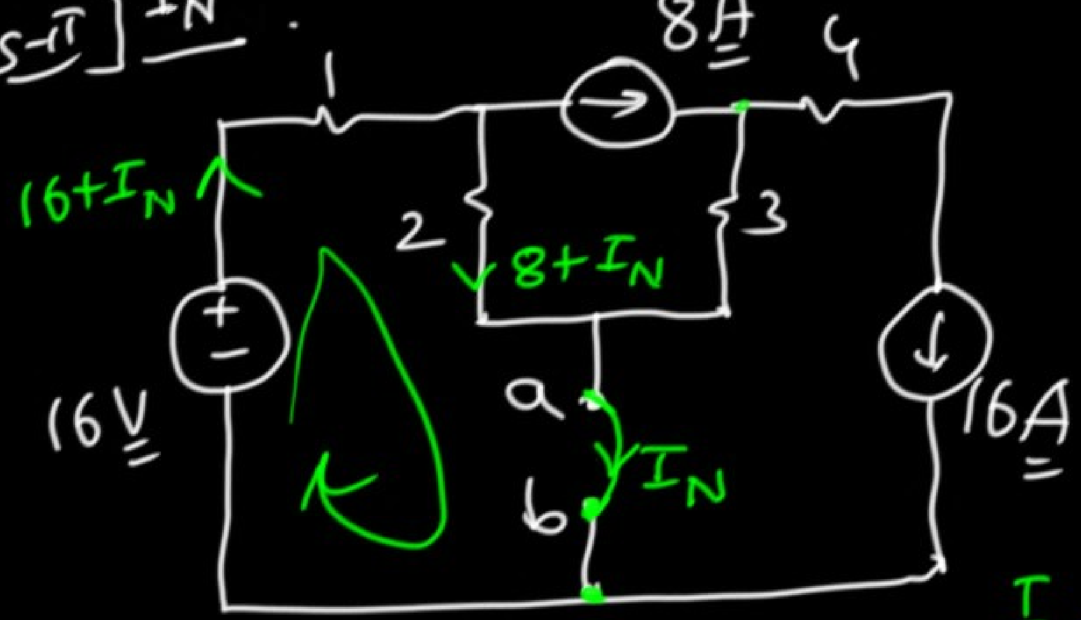
$$P_{abs}=(2)^2(5)$$

$$=20W$$

(b) Nortons

S-I] $R_N = R_{TH} = 3\Omega$

S-II] I_N



KCL + KVL

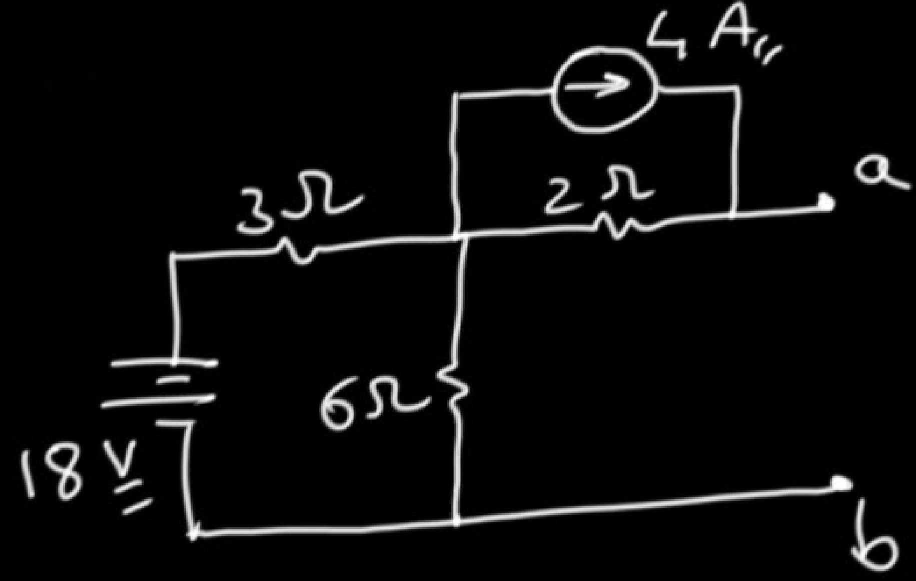
$$-16 + 1[16 + I_N] + 2[8 + I_N] = 0$$

$$I_N = -\frac{16}{3}\,A$$

$$I_{5\Omega} = \frac{16}{3} \times \frac{3}{8} = 2A \uparrow$$

$$P_{abs} = 2^2(5) = 20W$$

GATE/IM: Determine T·E & N·E across terminals a-b.

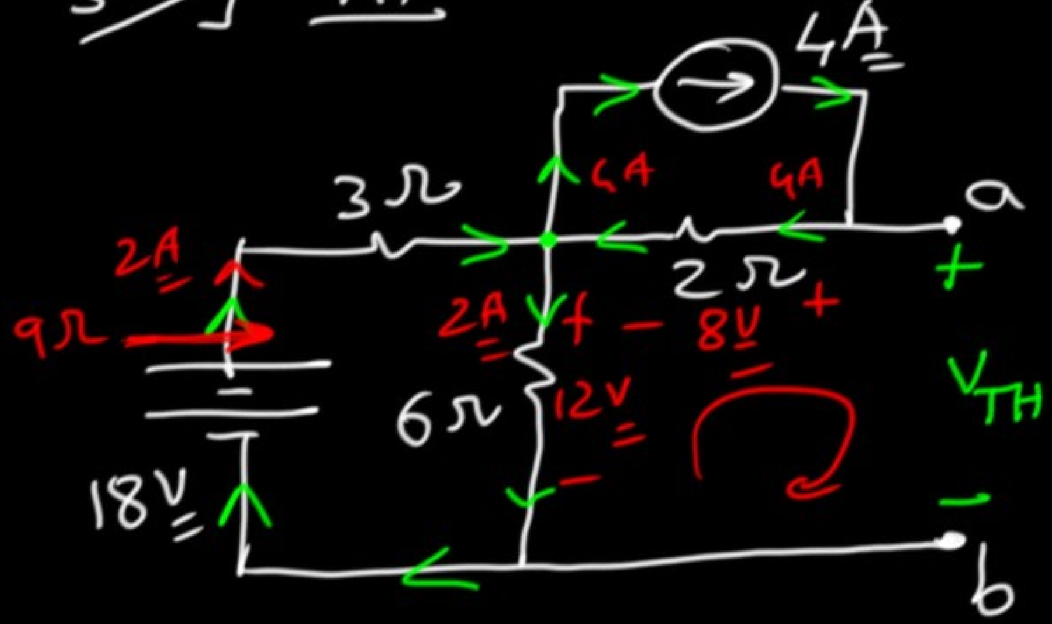


@ T·T

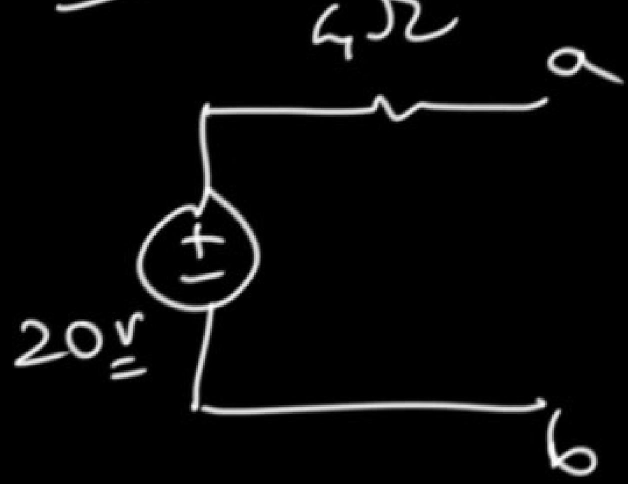
S-I) $\underline{R_{TH} = R_{TH}}$

$= \underline{\underline{4\Omega}}$

S-II] V_{TH}:



T.E

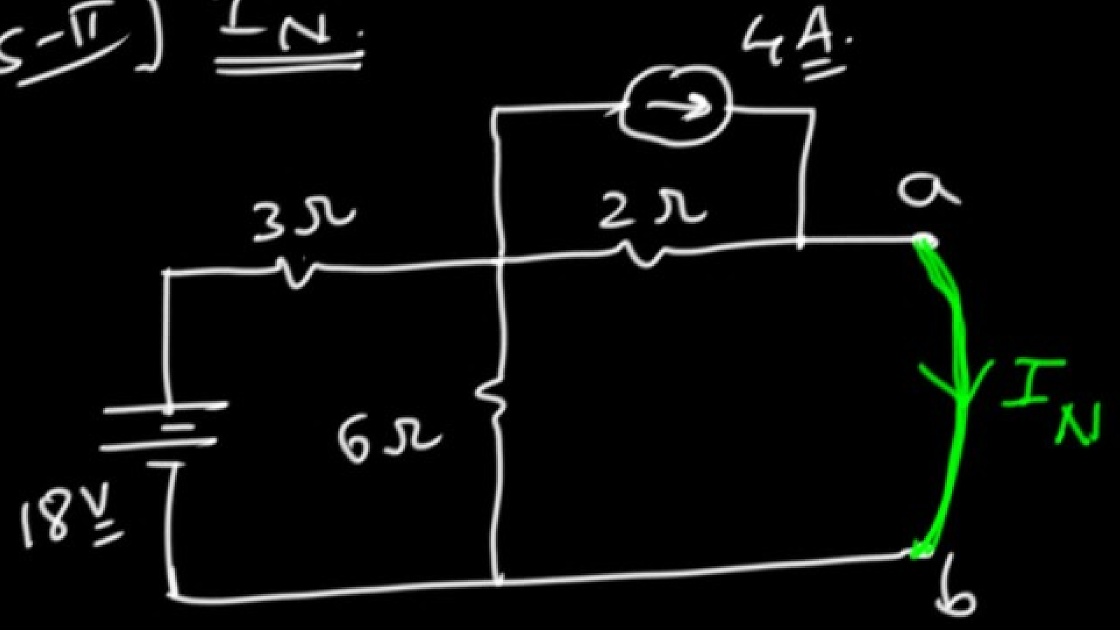


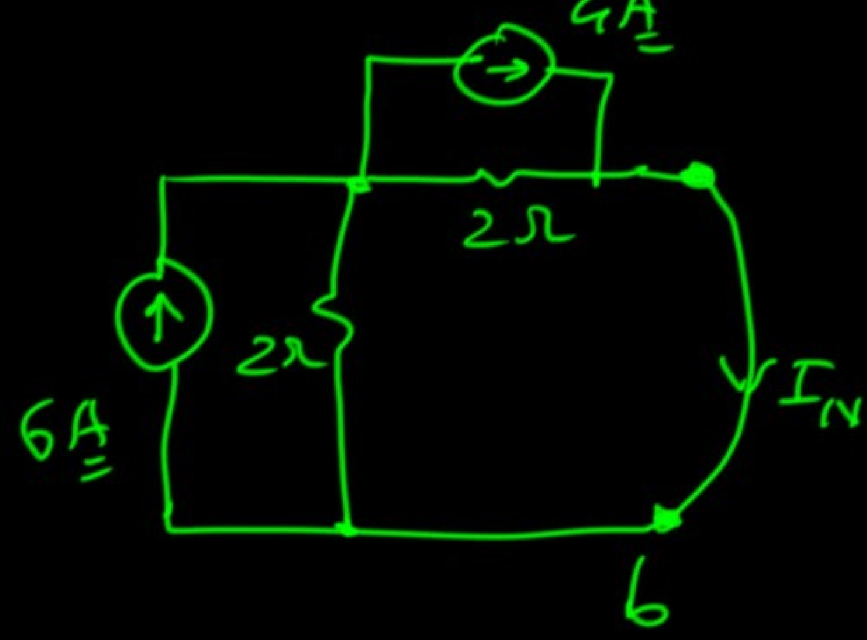
KVL $-12 - 8 + V_{TH} = 0$

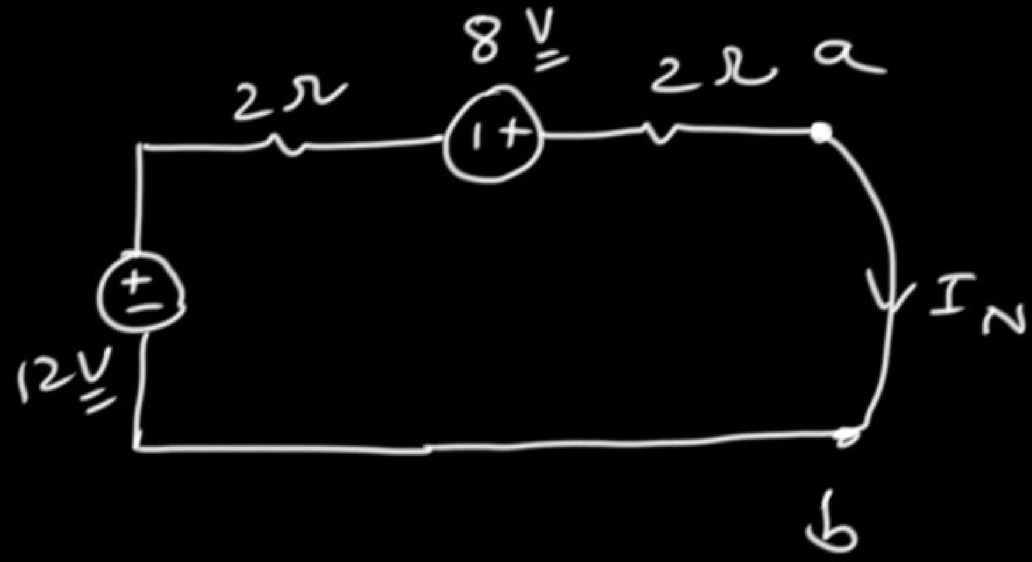
$$V_{TH} = +20\ V$$

⑥ N.T S-I] $R_N = R_{Th} = 4\Omega$

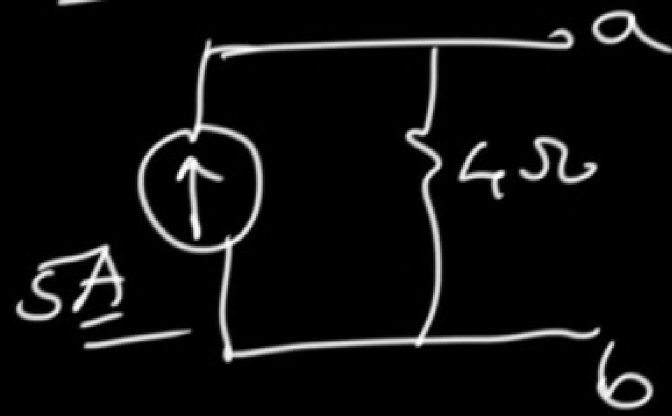
S-II] I_N.







N.E



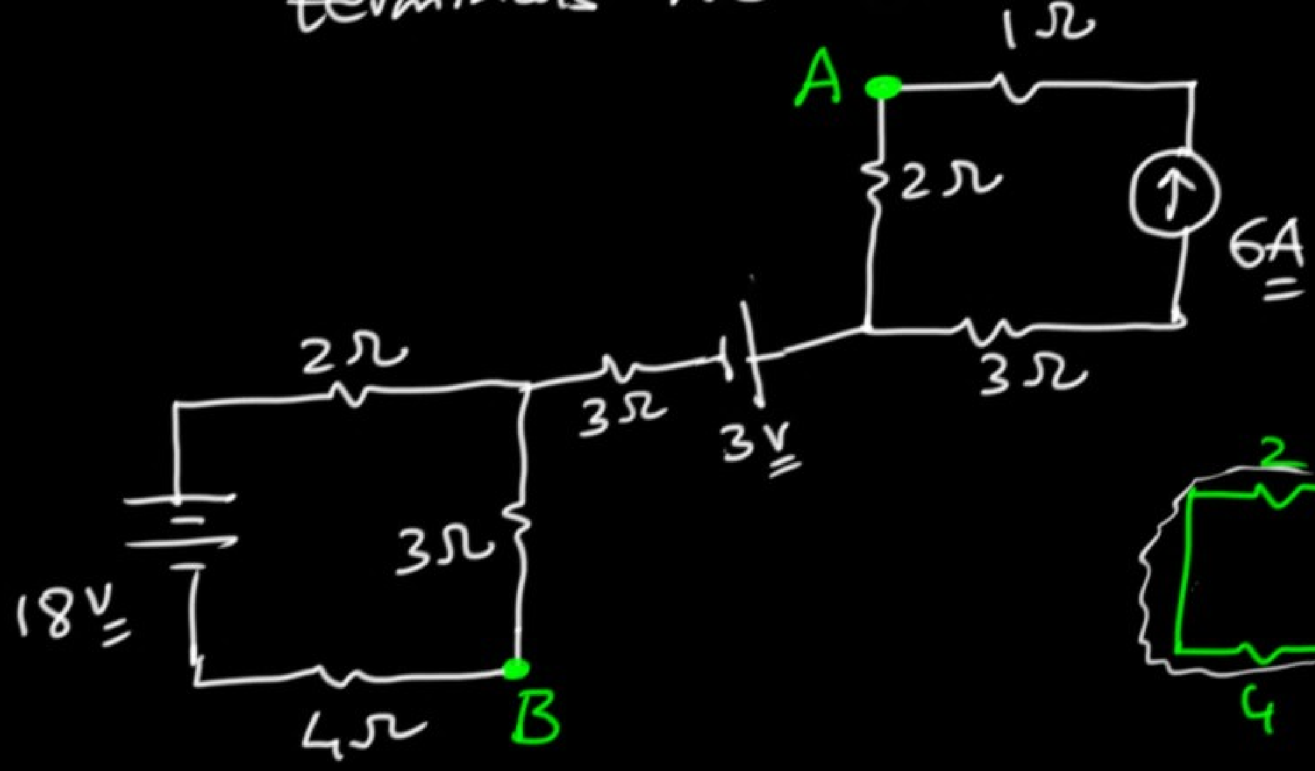
KVL

$$-12+2I_N-8+2I_N=0$$

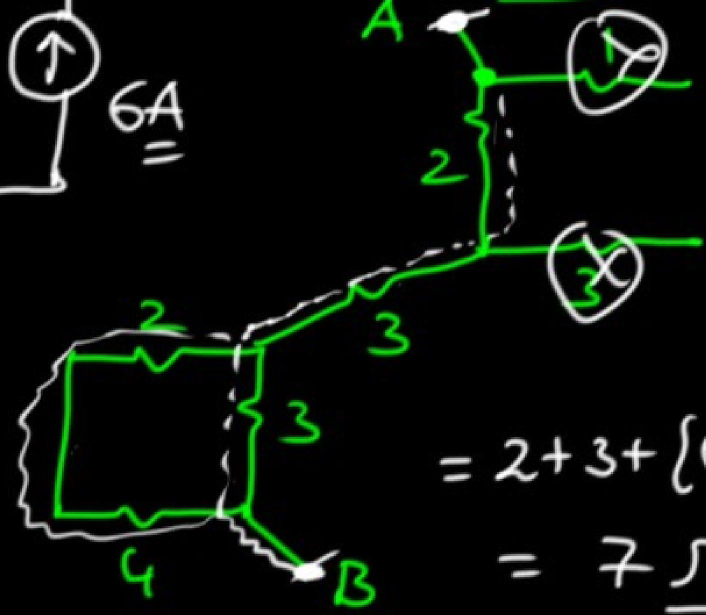
$$I_N=5A$$

GATE/2M.

Find Thevenin's equivalent across terminals AB.



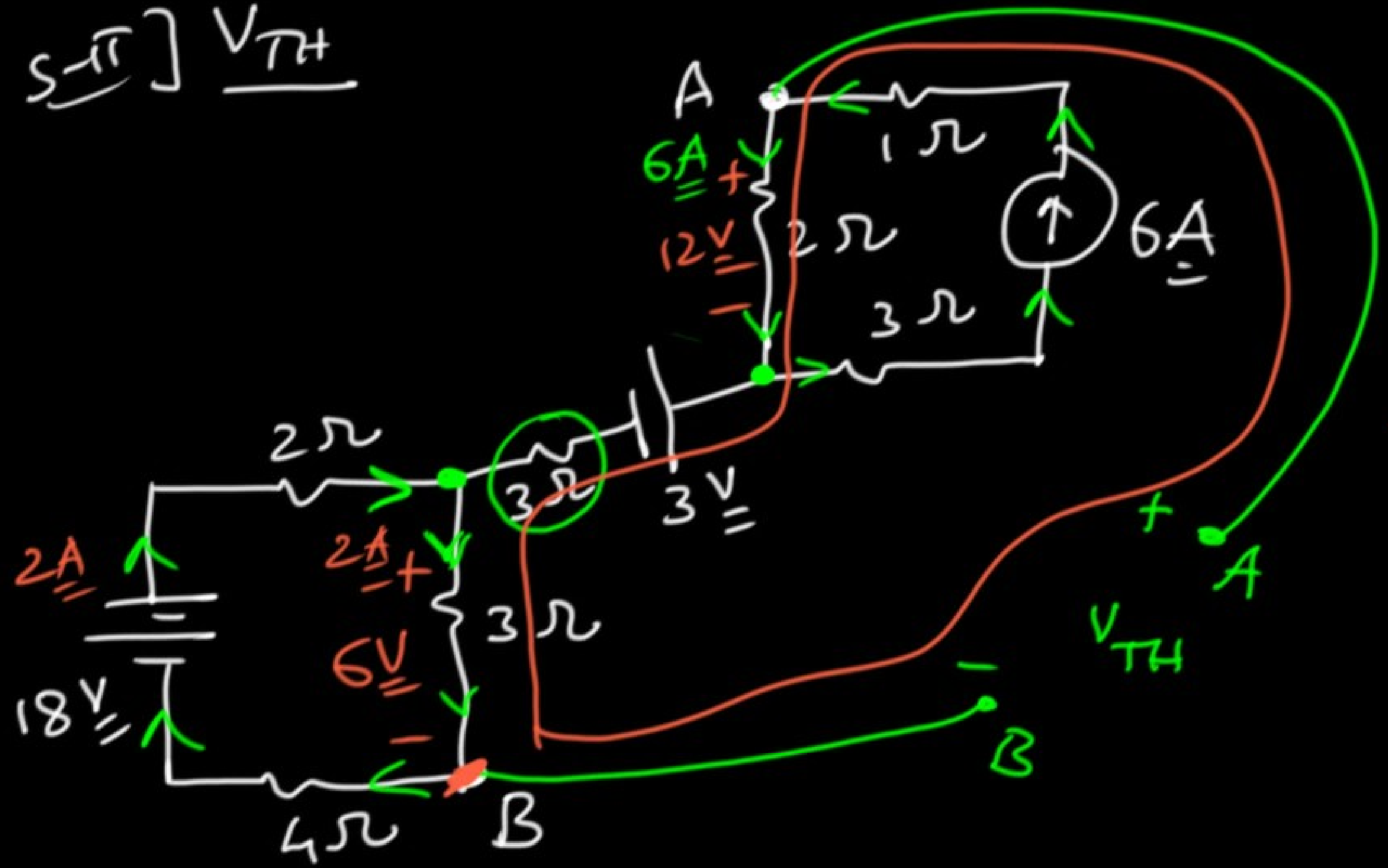
S-E] R_{TH}



$$= 2 + 3 + [6 // 3]$$

$$= 7\,\Omega$$

S-II] V_{TH}

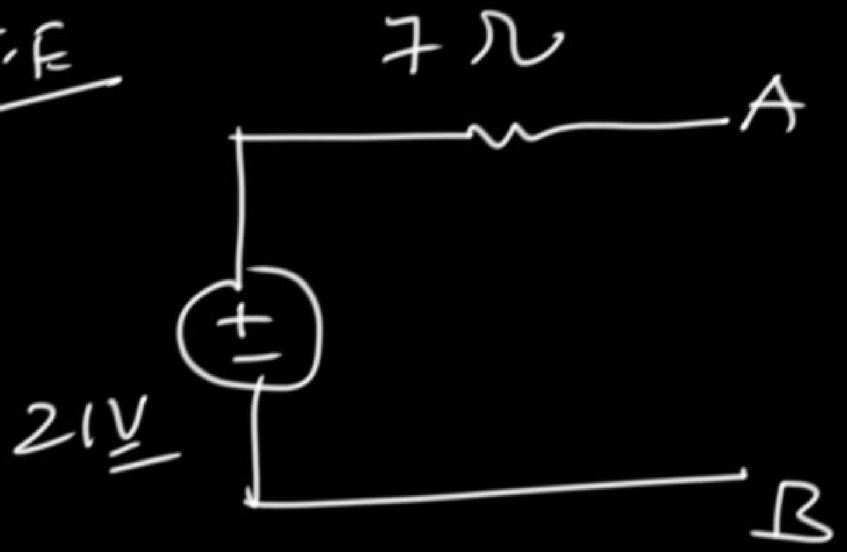


KVL

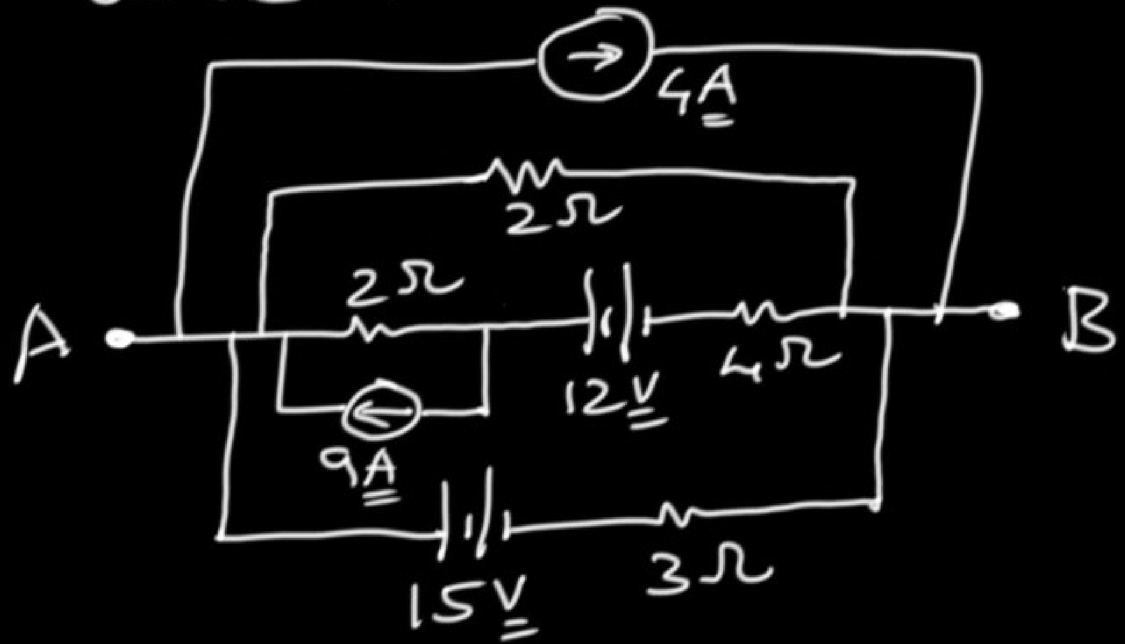
$-6-3-12+V_{TH}=0$

$V_{TH}=+21V$

T.E



Q] GATE/1M Determine Norton's Equivalent across terminals A – B.

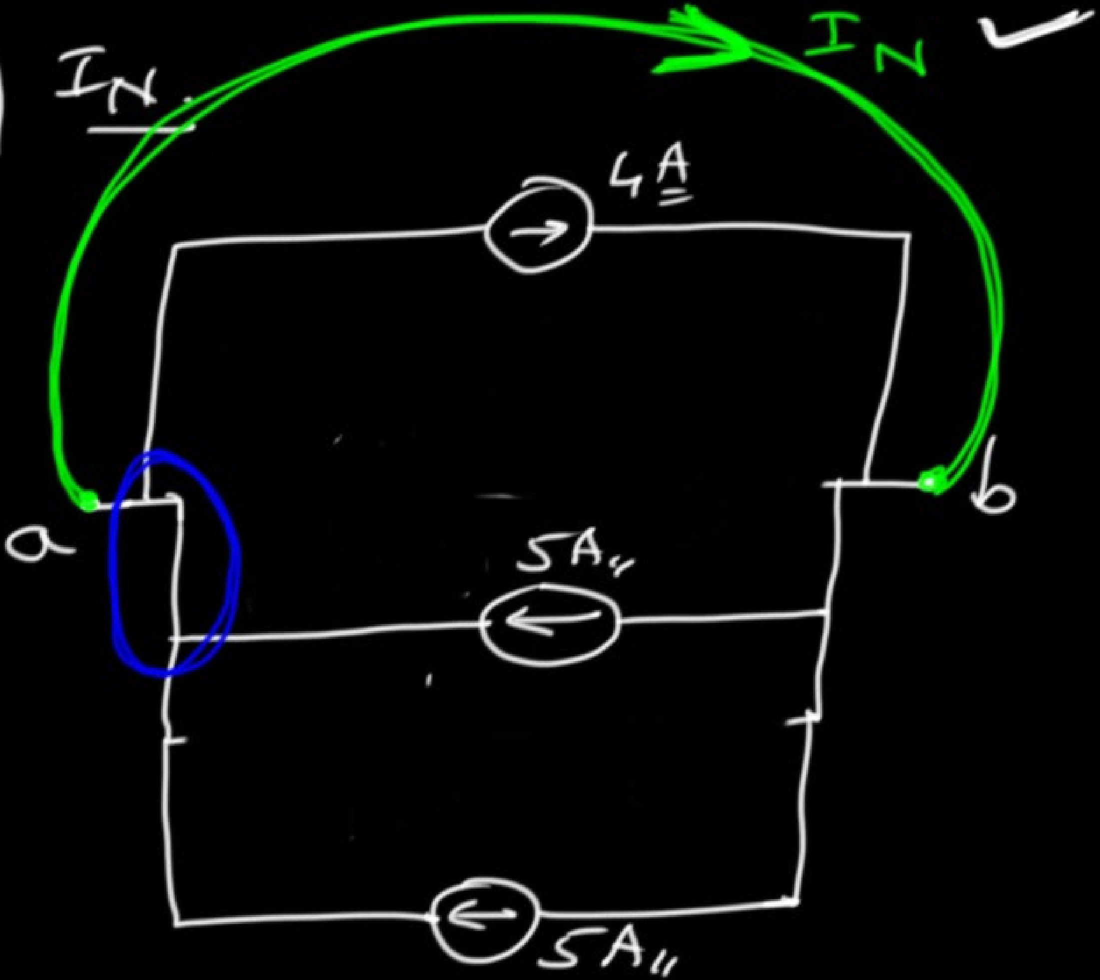


S-I] R_N.

$= 2 \| 6 \| 3$

$= 1\Omega$

S-II] I_N.

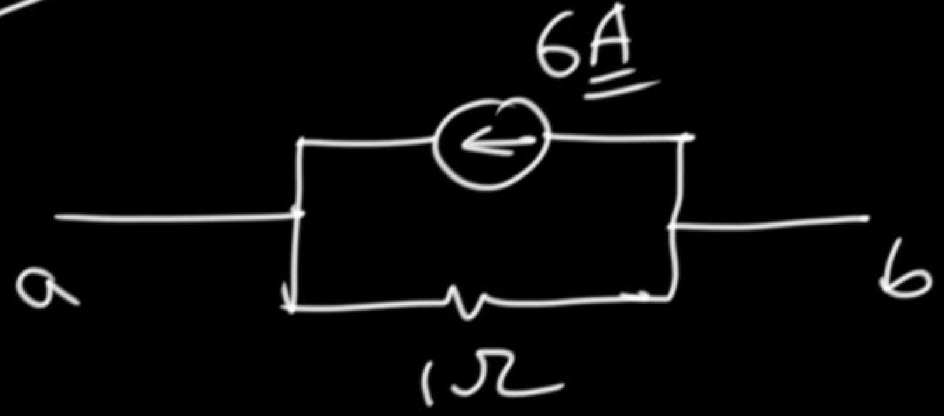


KCL

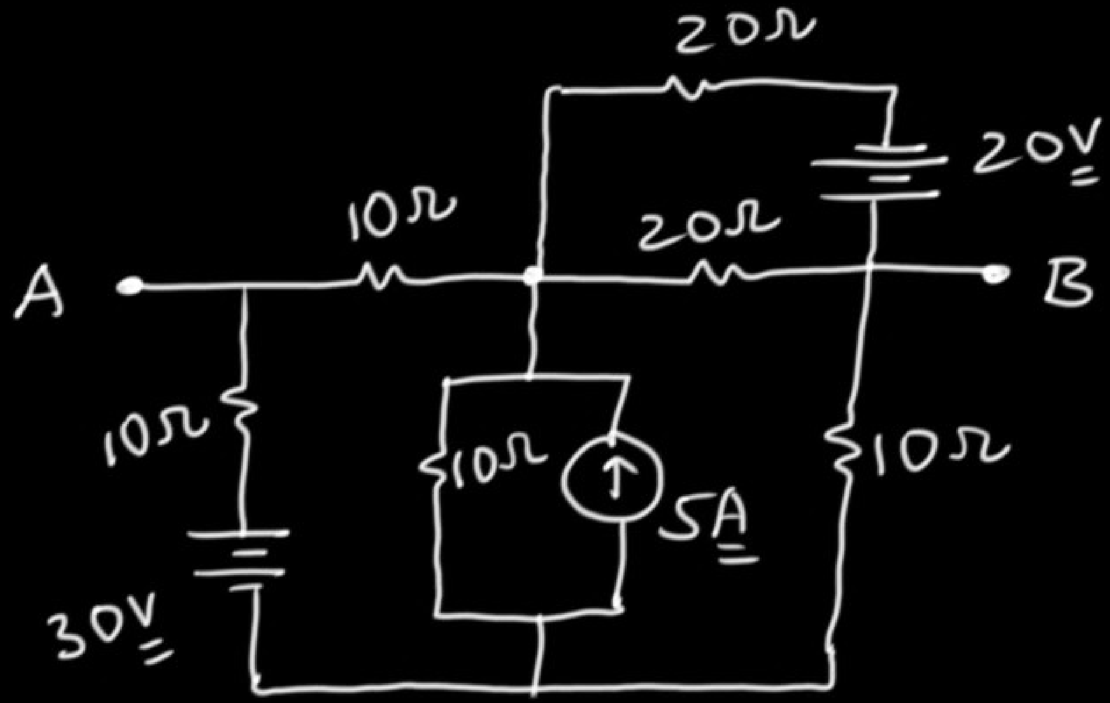
$$5+5 = 4 + I_N$$

$$I_N = 6A$$

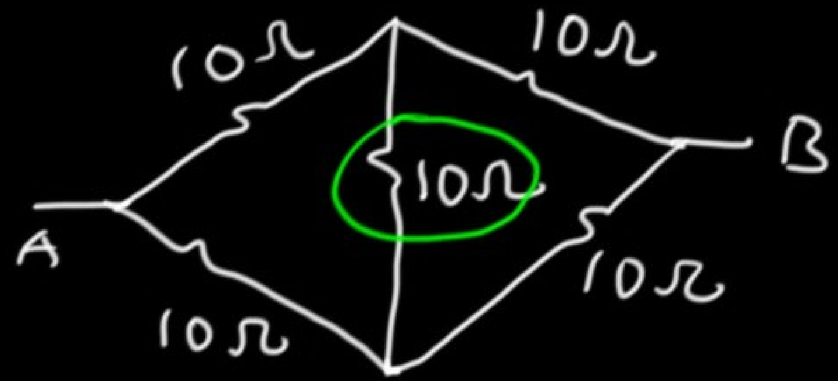
N-E



IES [C] Determine Thevenin's & Norton's equivalent across A – B

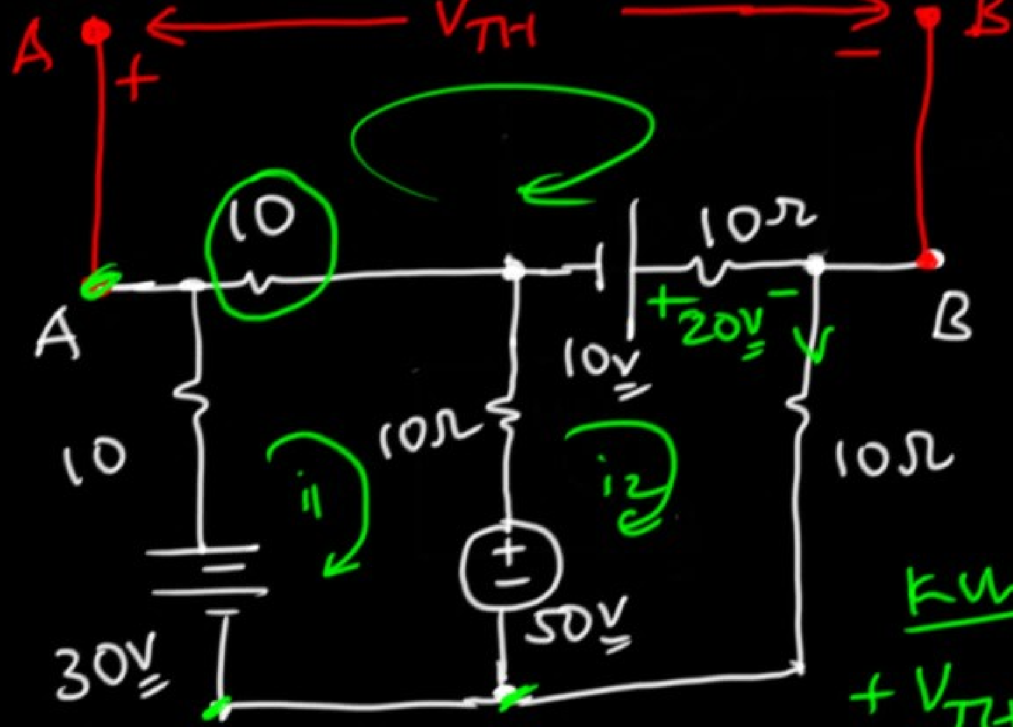


S-I) $R_{TH} = R_N$



$= 20 // 20 = 10\Omega$

S-II] V_{TH}.



Mesh

$$-30+20i_1+10[i_1-i_2]+50 = 0$$

$$3i_1 - i_2 = -2 \quad \text{— (1)}$$

$$-50+10[i_2-i_1]-10+20i_2=0$$

$$-i_1+3i_2 = 6 \quad \text{— (2)}$$

$$8i_2 = 16 \rightarrow \boxed{i_2 = 2A}$$

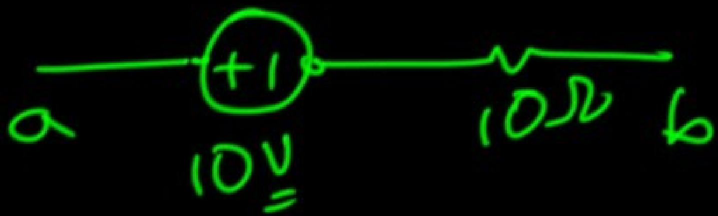
$$\boxed{i_1 = 0A}$$

KVL

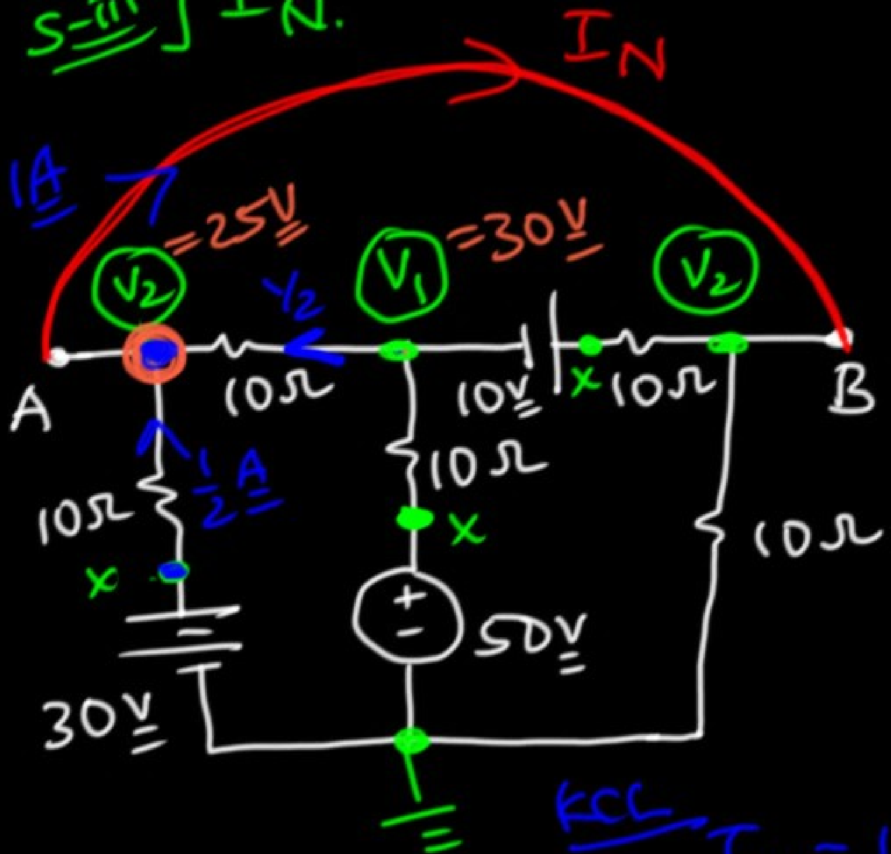
$$+V_{TH}-20+10=0$$

$$\boxed{V_{TH} = +10 \text{ volts}}$$

T.E



S-III] I_N.



KCL $I_N = 1A$

Nodal

$$\frac{(V_1 - V_2)}{10} + \frac{(V_1 - 50)}{10} + \frac{(V_1 - V_2 + 10)}{10} = 0$$

$$3V_1 - 2V_2 = 40 \quad (1)$$

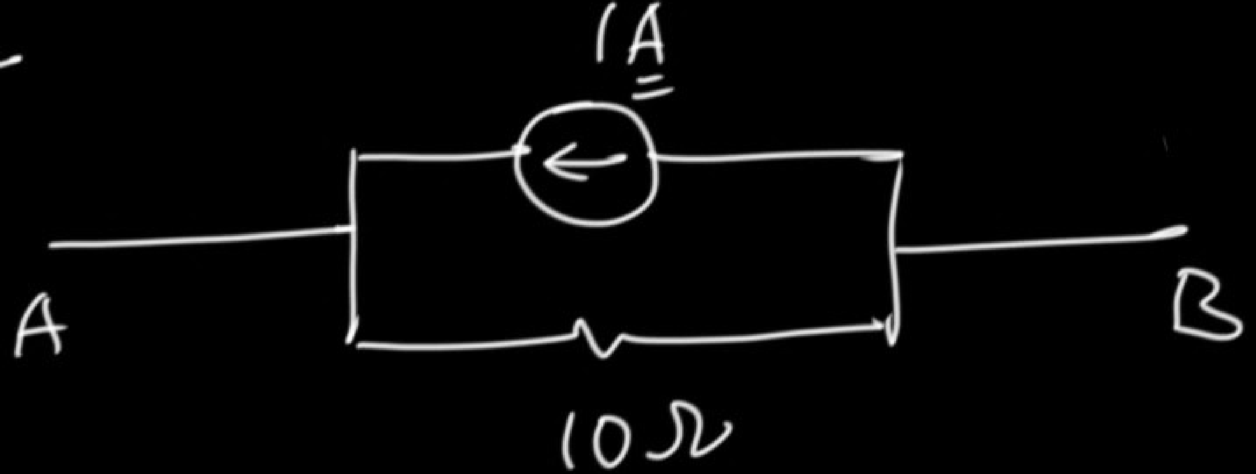
$$\frac{(V_2 - V_1)}{10} + \frac{(V_2 - 30)}{10} + \frac{V_2}{10} + \frac{(V_2 - V_1 - 10)}{10} = 0$$

$$-2V_1 + 4V_2 = 40$$

$$-V_1 + 2V_2 = 20 \quad (2)$$

$$\boxed{V_1 = 30\ V}, \quad V_2 = 25\ V$$

N.E

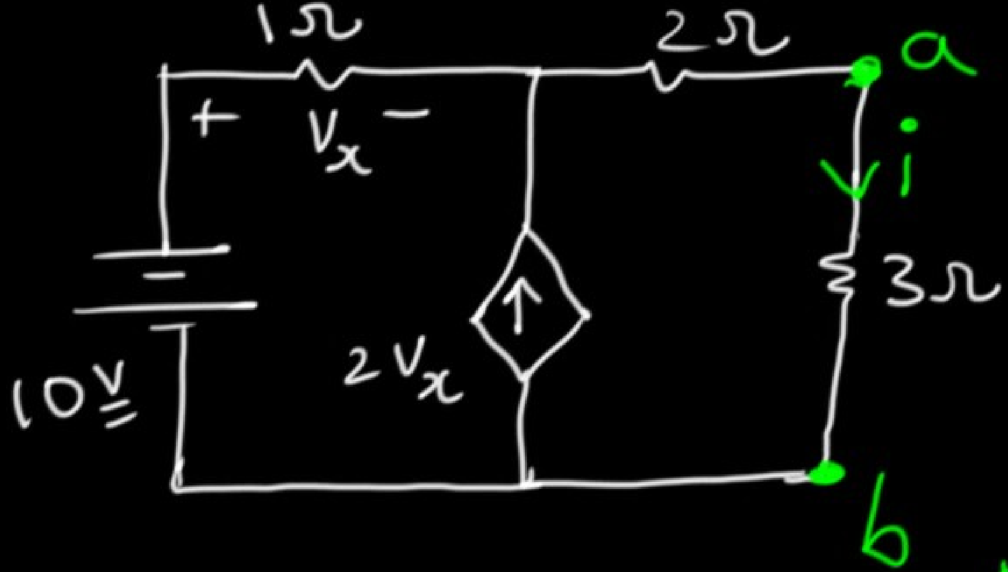


Cat-II] Problem's with both independent & dependent sources

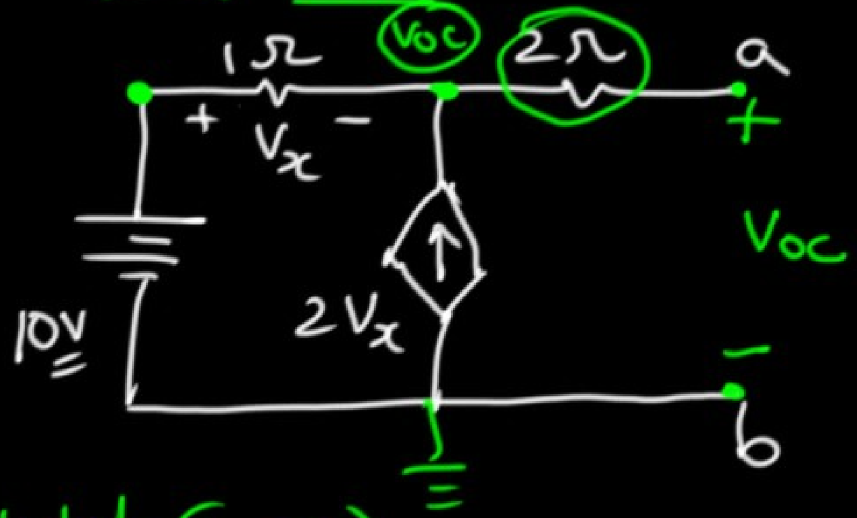
→ In such networks determining R_{TH} (or) R_N is not possible directly due to the presence of dependent sources, moreover the N/w is already active & working due to the presence of independent source in it. in such N/w's we use OHM's Law to indirectly find resistance, where

$$R_{TH} = R_N = V_{OC}/I_{SC}$$ at the target terminals

(P) Find Current 'i' in the circuit by using Thevenin's & Norton's Theorem



S-I] V_{oc}



Nodal $\dfrac{(V_{oc}-10)}{1} - 2V_x = 0$ — (1)

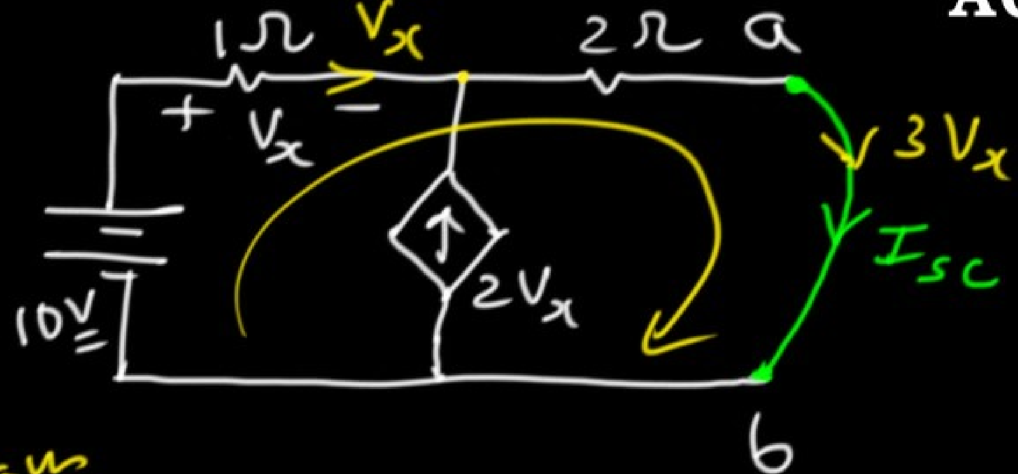
$$V_x = 10 - V_{oc} \quad \text{—} \; ②$$

$$V_{oc} - 10 - 20 + 2V_{oc} = 0$$

$$3V_{oc} = 30$$

$$\boxed{V_{oc} = 10\ \text{V}}$$

S-II] I_{sc}



KVL

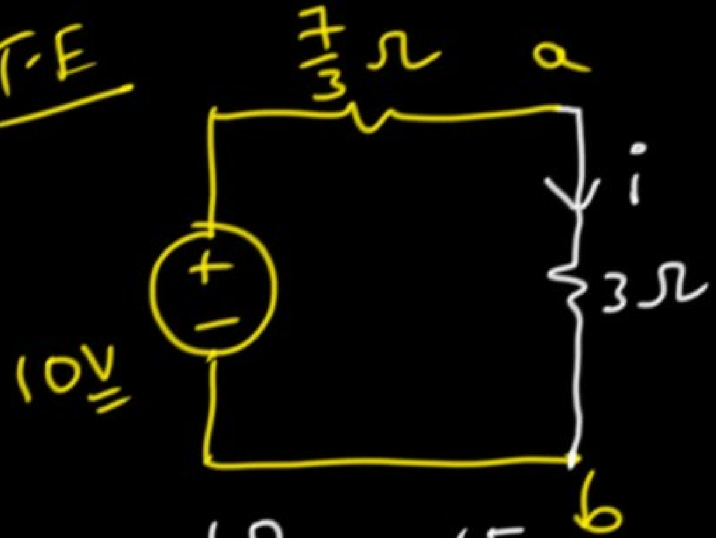
$$-10 + V_x + 2[3V_x] = 0 \rightarrow V_x = \frac{10}{7}\ \text{V}$$

Then $I_{sc} = 3V_x = \dfrac{30}{7}\ \text{A}$

Now

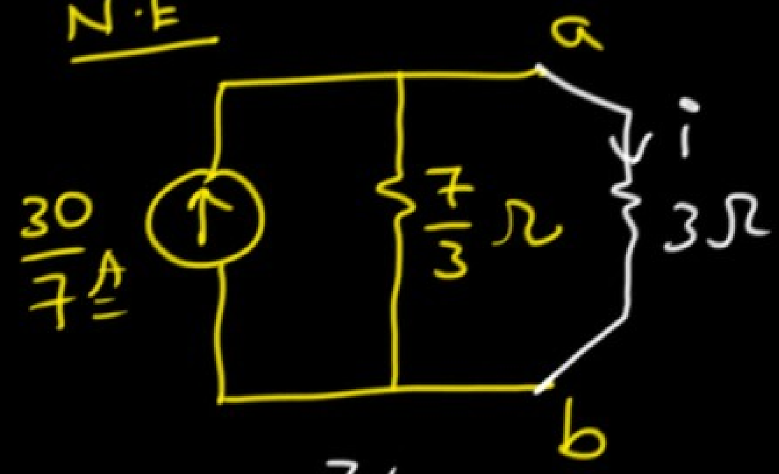
$$R_{TH} = R_N = \frac{V_{oc}}{I_{sc}} = \frac{10}{30/7} = \frac{7}{3}\,\Omega$$

T.E



$$i = \frac{10}{3+\frac{7}{3}} = \frac{15}{8}\,A$$

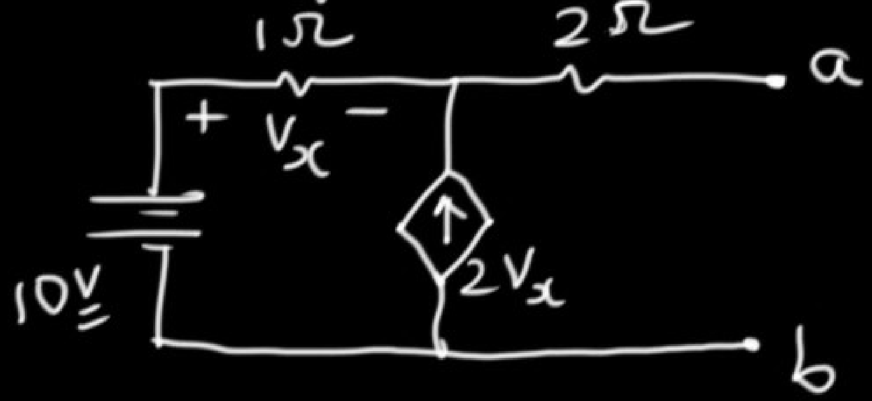
N.E

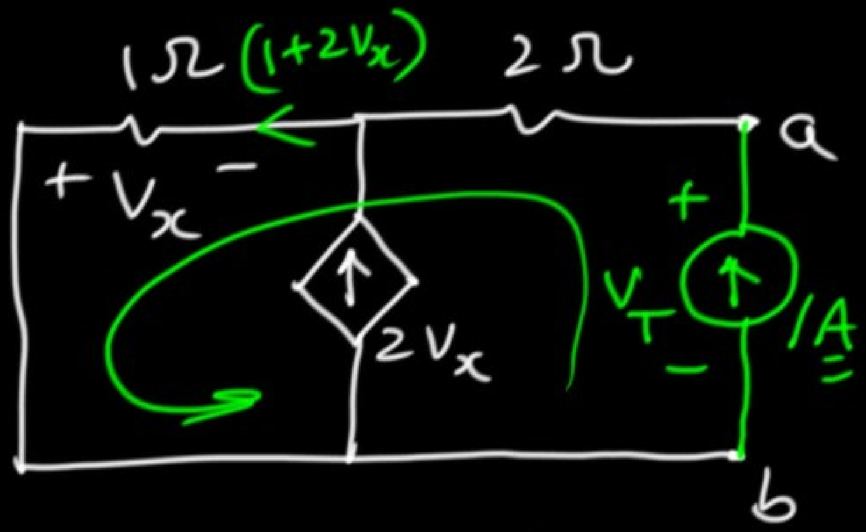


$$i = \frac{30}{7}\left[\frac{7/3}{\frac{7}{3}+3}\right] = \frac{15}{8}\,A$$

Note: In this category-II problems sometimes if it is required only to find resistance but not equivalent then de-activate N/w & apply Ohm's Law directly.

→ Modify previous Q only to find $\boxed{R_{TH}/R_N}$





KVL $-V_T + 2 + 1[1+2V_x] = 0$

$V_T = 3 + 2V_x$ — (1)

Link $V_x = -1[1+2V_x]$

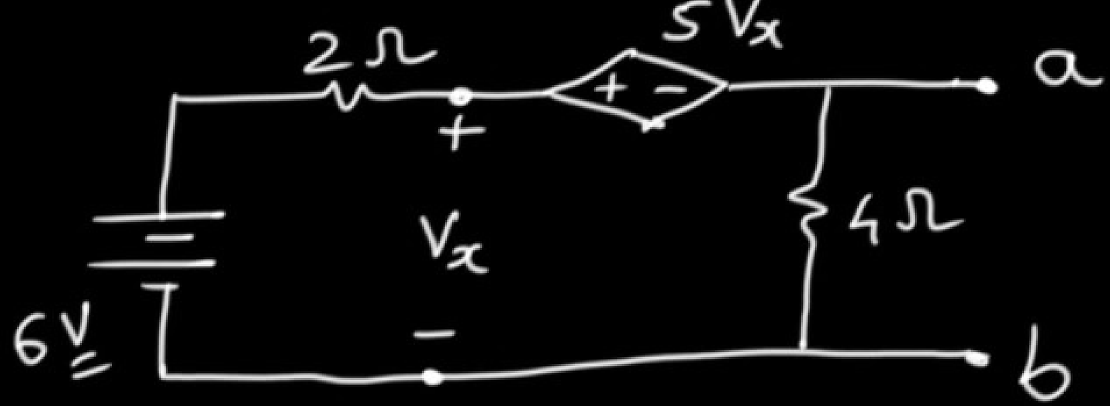
$3V_x = -1$ — (2)

$V_T = 3 + 2\left[-\frac{1}{3}\right]$

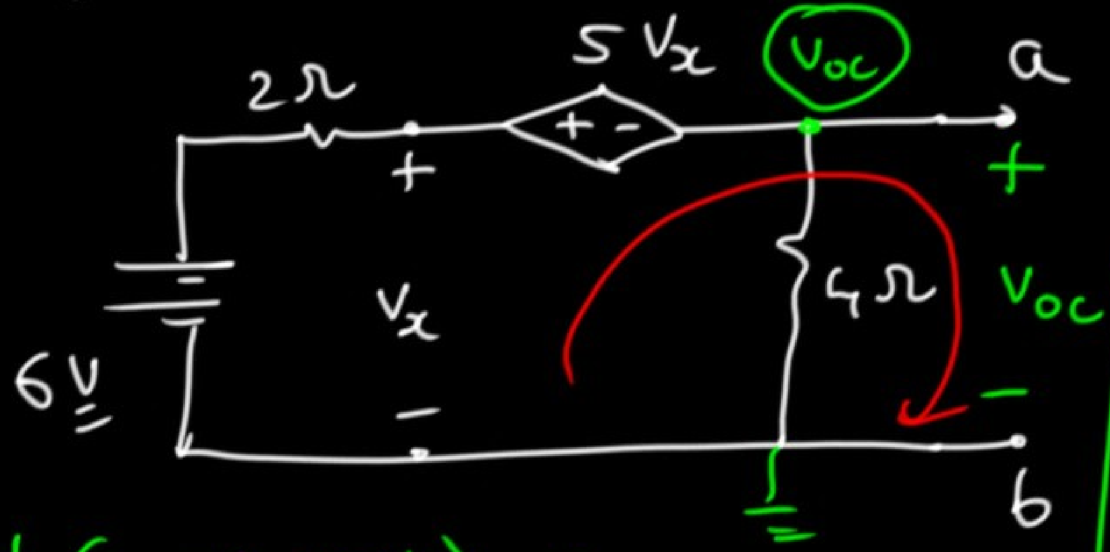
$V_T = \frac{7}{3}$ volt

$R_{TH} = R_N = \frac{V_T}{1} = \frac{7}{3}\ \Omega$

GATE/2M Determine Norton's equivalent between a – b.



S-I] $\underline{V_{oc}}$



Nodal $\dfrac{V_{oc} - 6 + 5V_x}{2} + \dfrac{V_{oc}}{4} = 0$

$3V_{oc} + 10V_x = 12 \quad (1)$

KVL

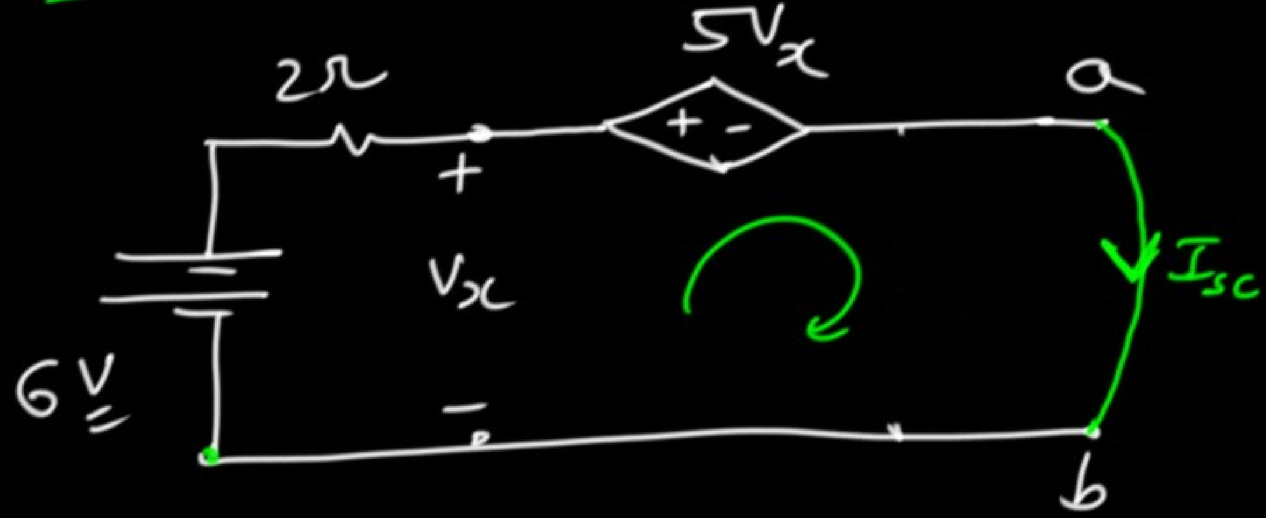
$-V_x + 5V_x + V_{oc} = 0$

$V_{oc} = -4V_x \quad (2)$

$3V_{oc} + \cancel{10}^{5}\left[\dfrac{-V_{oc}}{\cancel{4}_{2}}\right] = 12$

$\boxed{V_{oc} = 24}\ \underline{V}$

S-II] I_{sc}



Mesh $-6+2I_{sc}+5V_x=0$ — (1)

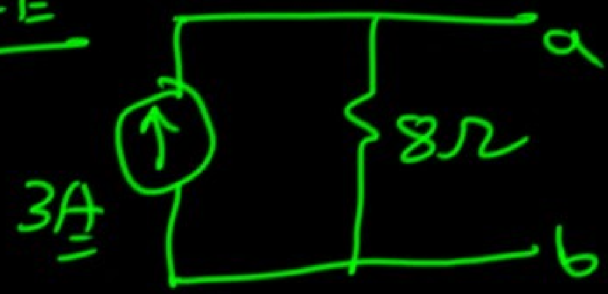
KVL $-V_x+5V_x=0 \rightarrow V_x=0$ — (2)

$2I_{sc}=6$

$I_{sc}=3\,A$

$R_N=\dfrac{V_{oc}}{I_{sc}}=\dfrac{24}{3}=8\Omega$

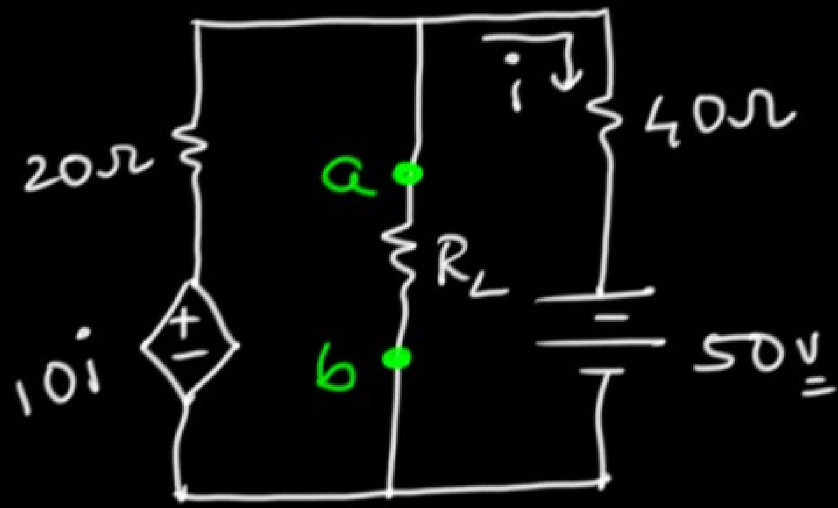
N.E

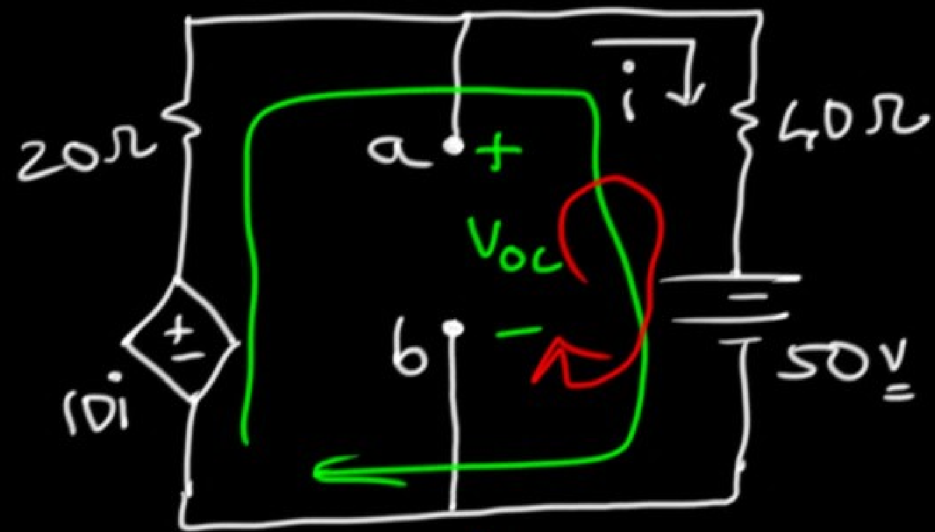


GATE / 2M

Determine Thevenin's equivalent across the Load.

S-I) V_{oc}





Mesh $-10i + 20i + 40i + 50 = 0$

$i = -1\ A$ → 1

KVL

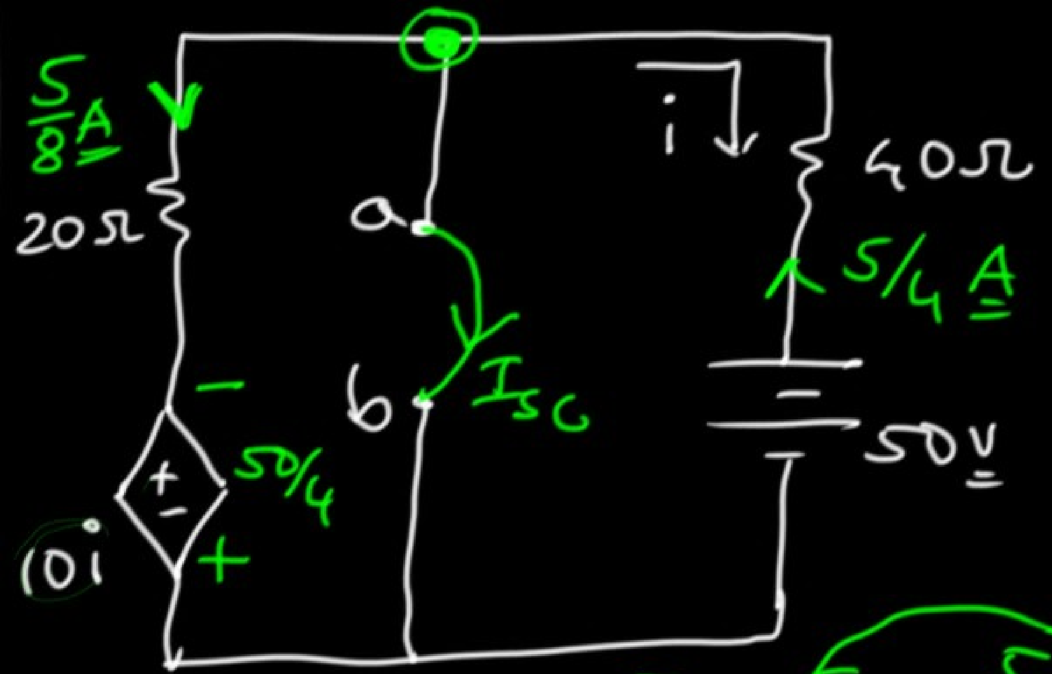
$$-V_{oc}+40i+50=0$$

$$V_{oc}=50+40i \quad (2)$$

$$V_{oc}=50+40(-1)$$

$$\boxed{V_{oc}=10\,V}$$

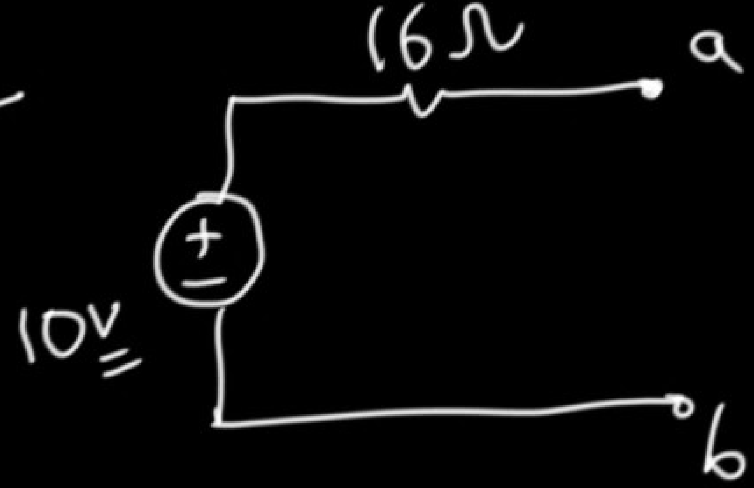
S-II] I_{sc}



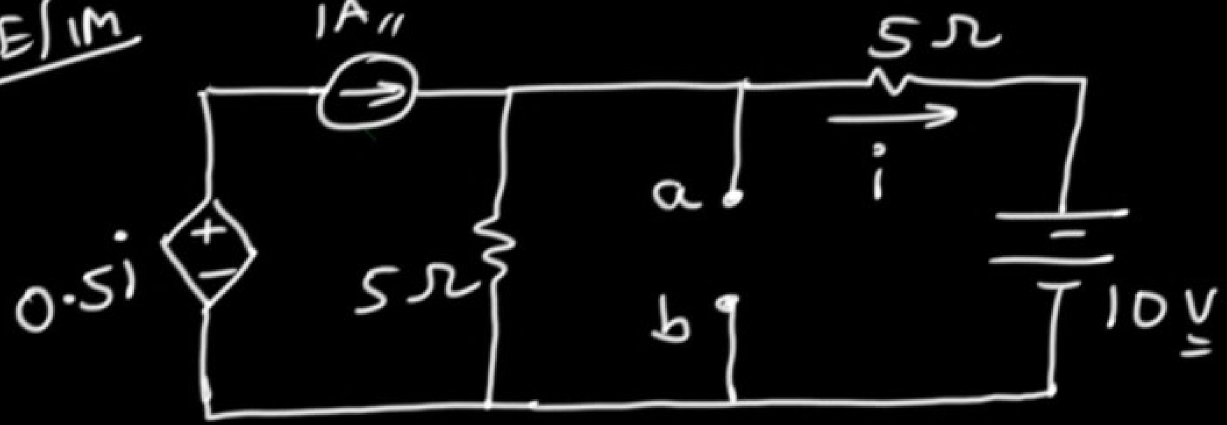
KCL, $\frac{5}{4}=I_{sc}+\frac{5}{8} \Rightarrow I_{sc}=\frac{5}{8}$

$$R_{TH} = \frac{V_{oc}}{I_{sc}} = \frac{10}{5/8} = \underline{\underline{16\,\Omega}}$$

<u>T.E</u>



GATE/IM



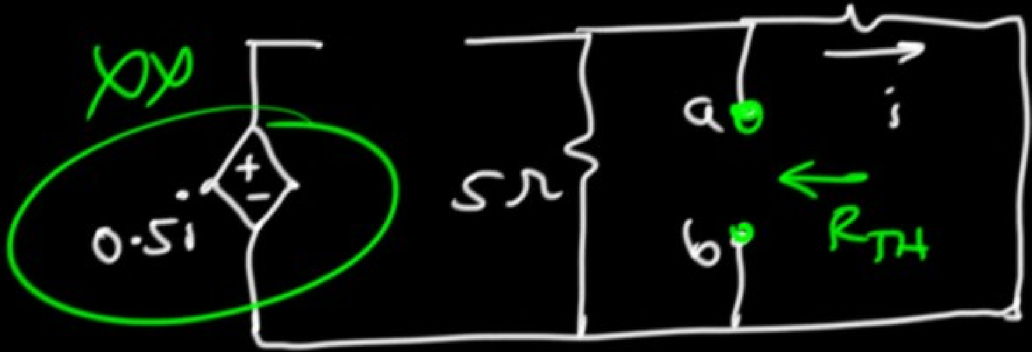
The Thevenins resistance across terminals a-b is ___

a) 0Ω

b) 2.5Ω

c) 5Ω

d) 7.5Ω



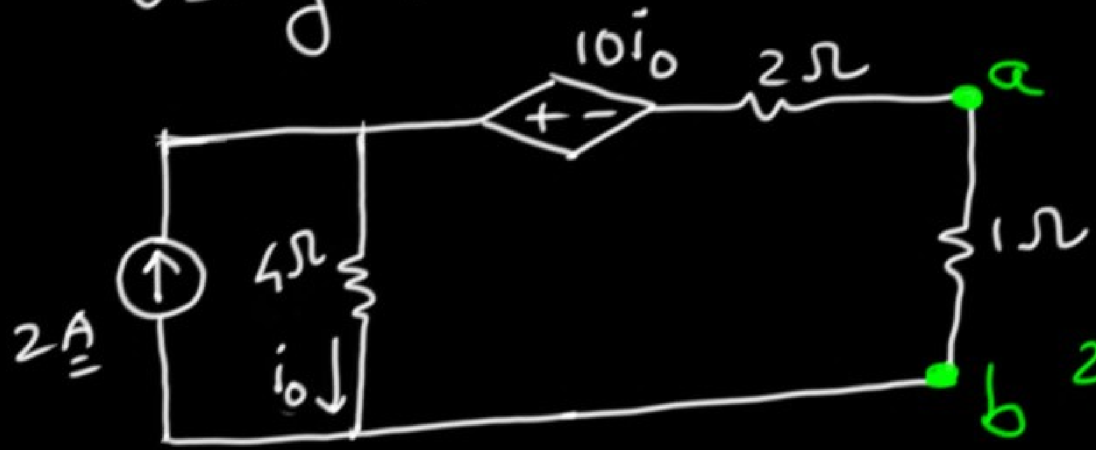
so

$R_{TH} = 5 // 5$

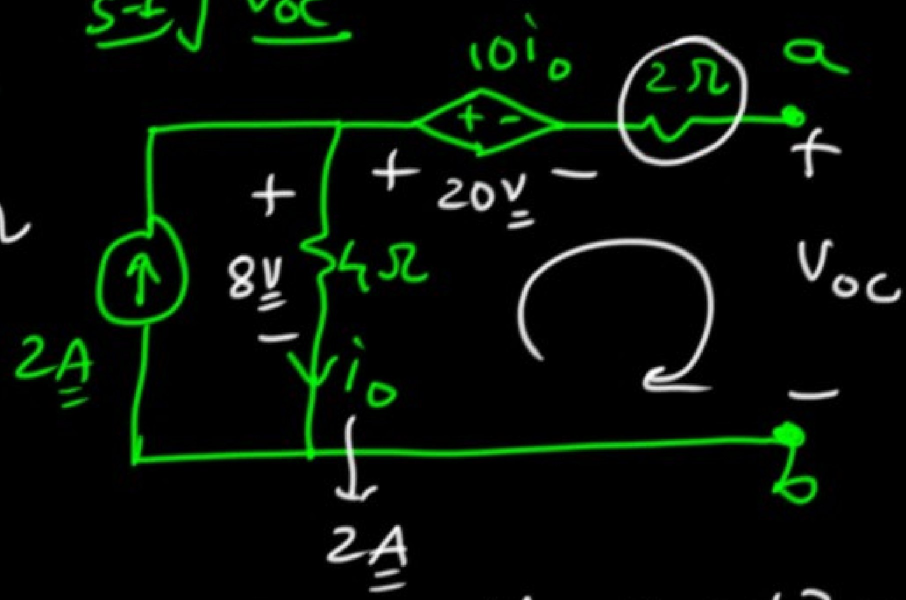
$= \underline{\underline{2.5\,\Omega}}$

Application → special.

Q] Determine current through 1Ω resistance using Norton's Theorem.

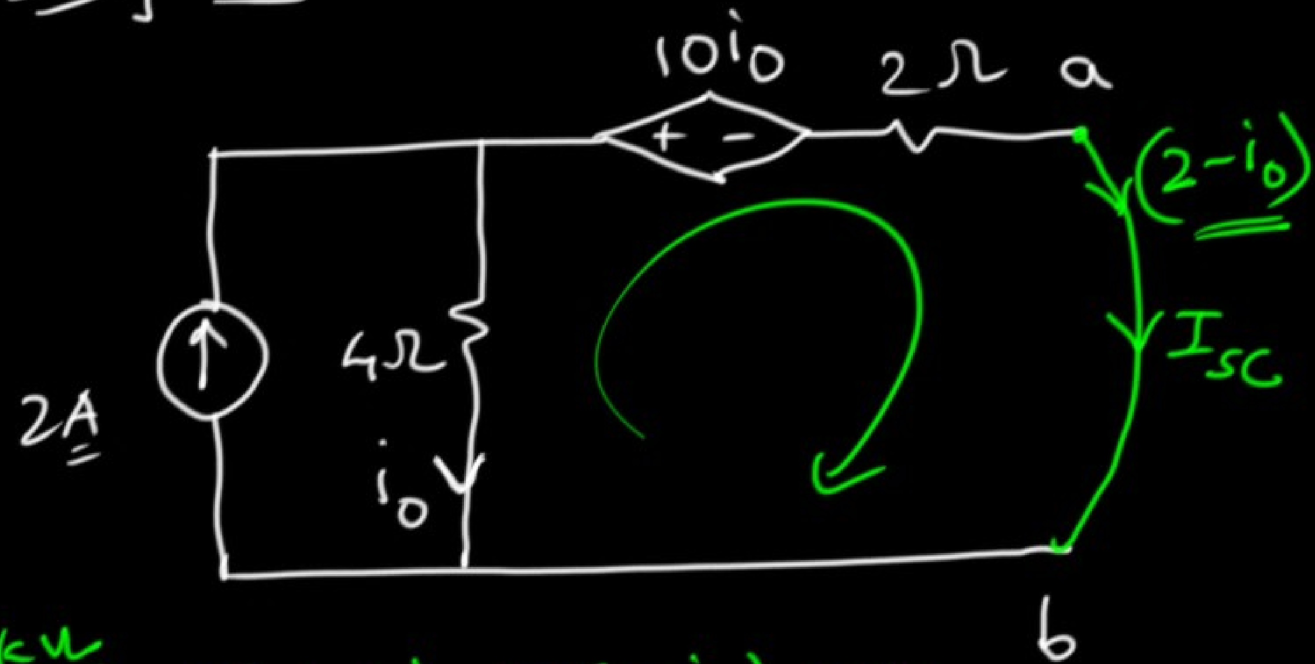


S-I] V_{oc}



KVL $-8+20+V_{oc}=0 \longrightarrow V_{oc}=-12$ volts

S-II } I_{sc}



KVL

$$-4i_0 + 10i_0 + 2(2 - i_0) = 0$$

$$i_0 = -1$$

But

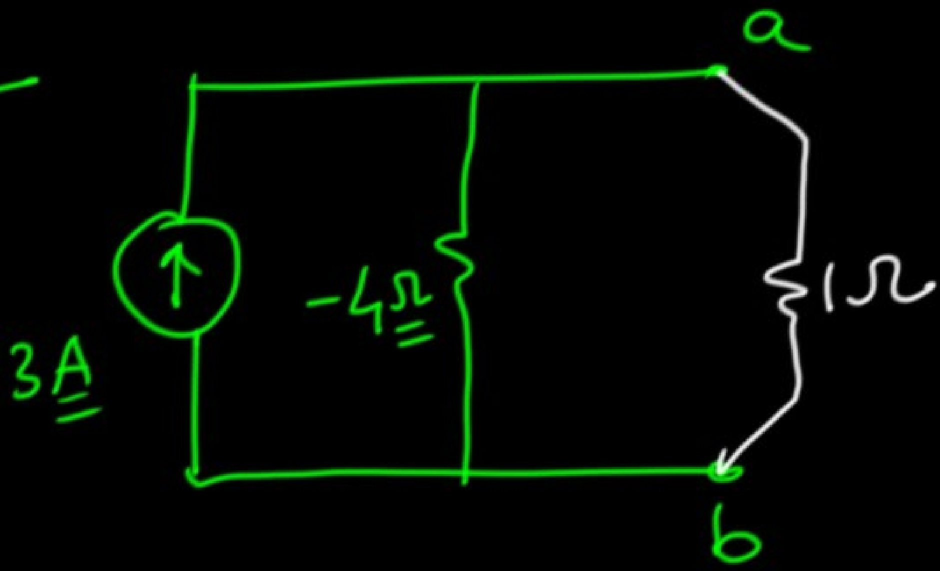
$$I_{sc} = 2 - i_0$$

$$I_{sc} = 2 - (-1)$$

$$= +3A$$

$$R_N = \frac{V_{oc}}{I_{sc}} = \frac{-12}{+3} = \underline{\underline{-4\,\Omega}}$$

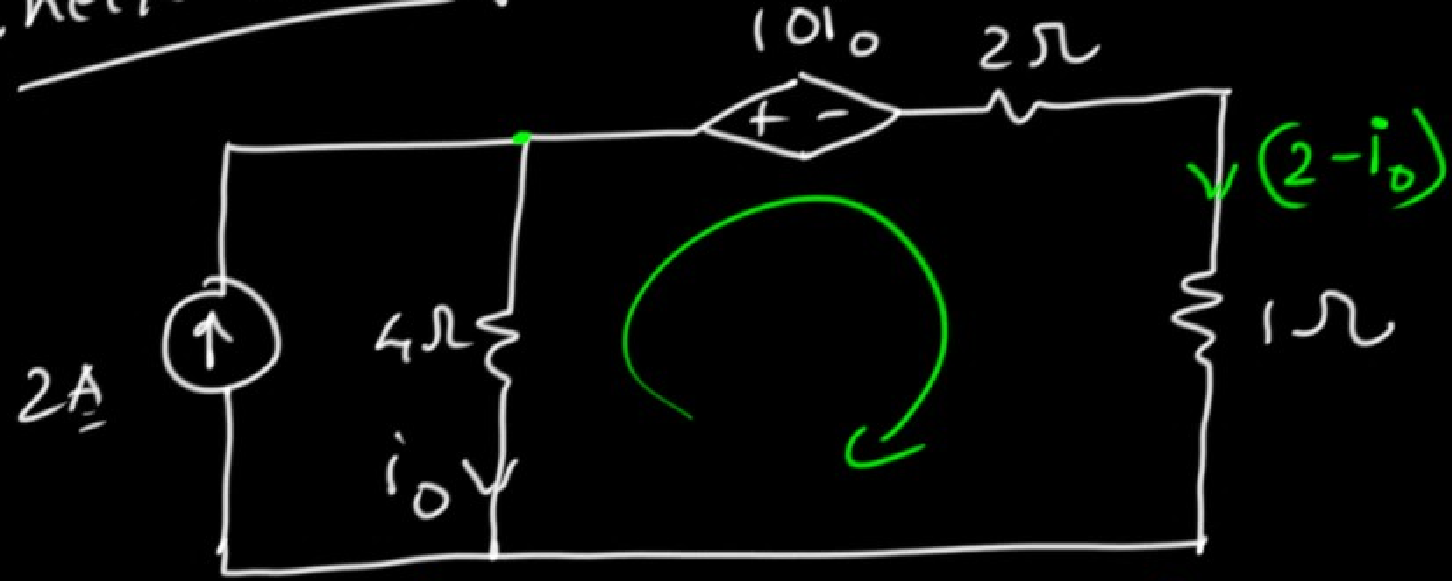
N.E



$$I_{1\Omega} = 3\left[\frac{-4}{-4+1}\right]$$

$$I_{1\Omega} = \underline{\underline{4\,A}}$$

Check directly



$$-4i_0+10i_0+3[2-i_0]=0$$

$$i_0=-2\,A$$

$$I_{1\Omega}=2-i_0=2-(-2)=+4\,A$$

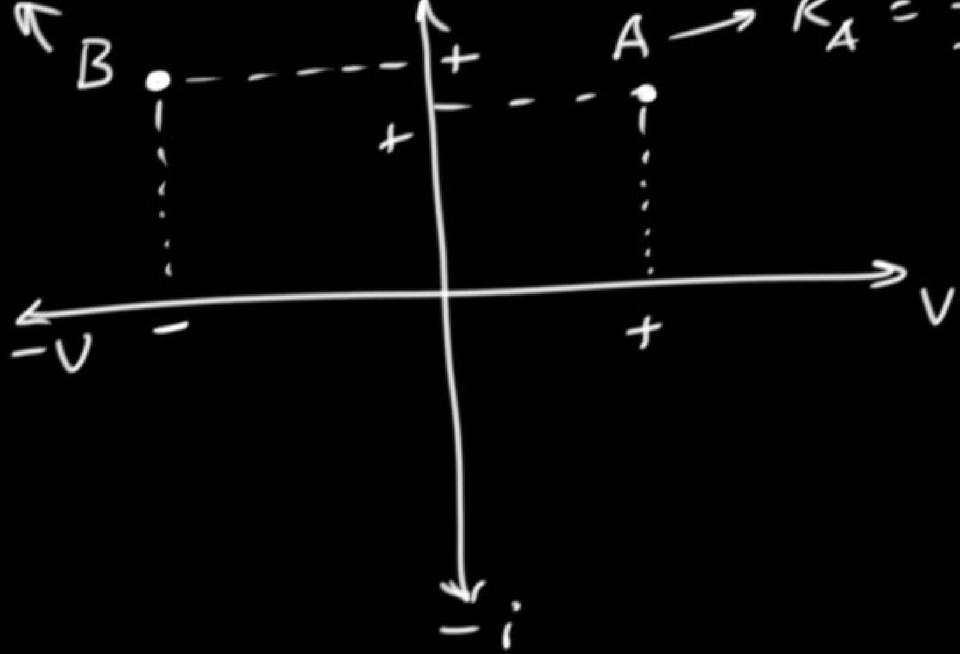
Note: In the above problem R_N (or) R_{TH} is $-ve$, $(-ve)$ resistance is a characteristic way to model active regenerative N/w in electrical engineering whose operating V–i characteristics appears in Q–II (or) Q–IV

Ex: High gain amplifiers, photo transistors, solar cells, +ve feedback networks [oscillators]

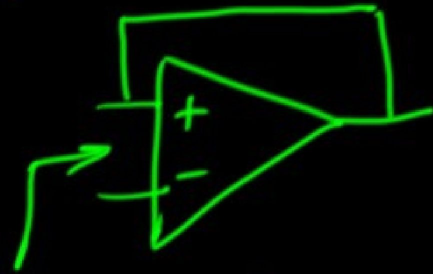
Note: However, $(-ve)$ Resistance is not a physically realizable Quantity.

$R_B = \frac{-V}{+i} = \ominus\ \Omega$

$R_A = \frac{+V}{+i} = \oplus\ \Omega$



Ex:



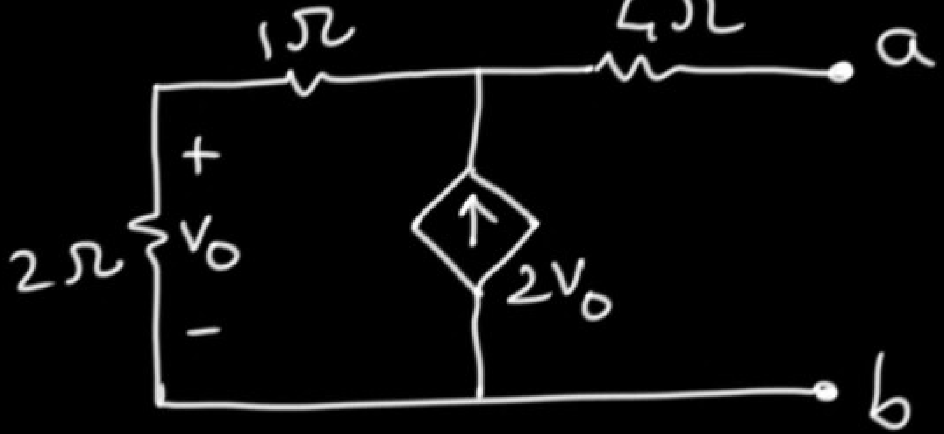
$\underline{R_{in} = (-ve)}$

Cat-III] Problems with only dependent sources

→ Such networks cannot work on their own, as there is no independent active element to drive them. In such N/w's ($V_{TH} = 0\,V$) & ($I_N = 0\,A$), however they have resistance. This resistance can be indirectly determined by Ohm's Law by externally exciting them, where

$$R_{TH} = R_N = \frac{1\ \text{volt}}{i_T} = \frac{V_T}{1\ \text{amp}}$$

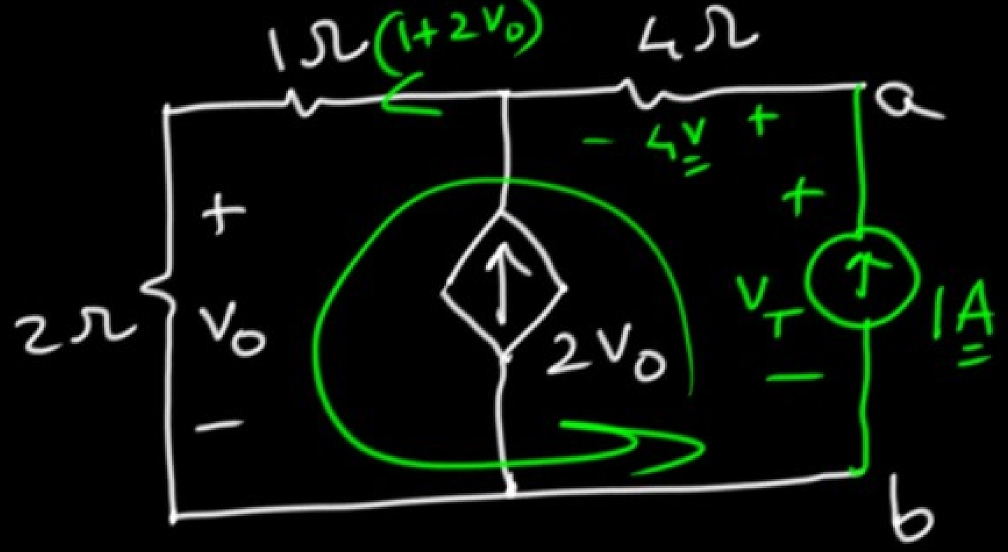
GATE Find Thevenin's & Norton's equivalent across terminals a – b.



$V_{TH} = 0$ volts

$I_N = 0$ Amps

find 'R_{TH}' by Ohm's Law



KVL

$$-V_T + 4 + 3[1+2V_0] = 0$$

$$V_T = (7+6V_0) \quad (1)$$

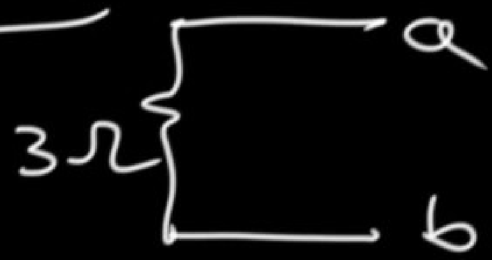
$$V_0 = 2[1+2V_0] \Rightarrow 3V_0 = -2 \quad (2)$$

$$V_T = 7 + 6\left[-\frac{2}{3}\right]$$

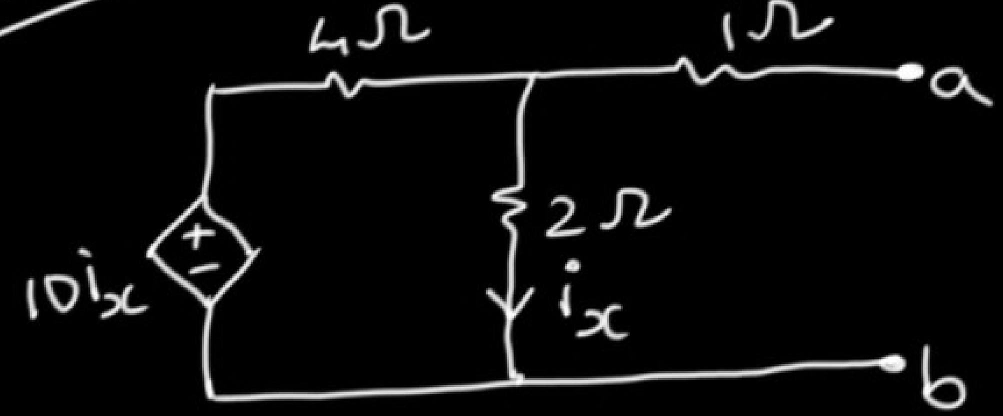
$$\underline{\underline{V_T = 3}}$$

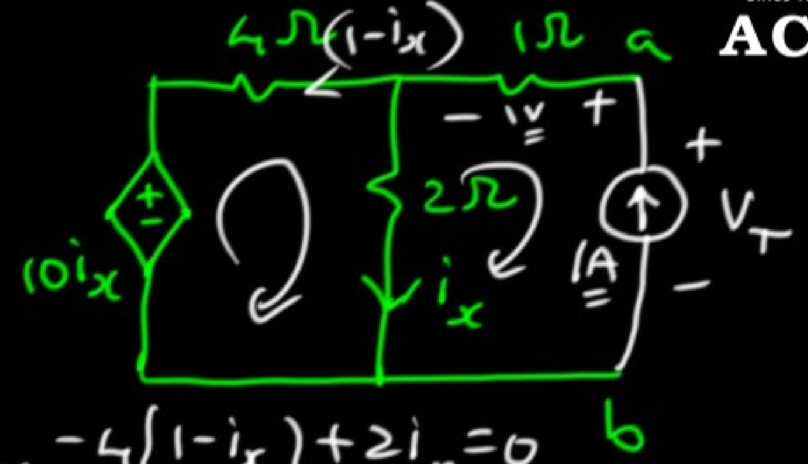
$$R_{TH} = R_N = \frac{V_T}{1} = \underline{\underline{3\,\Omega}}$$

T·E (or) N·E



ISRO Thevenin's equivalent across a-b





a) ~~1 V, 1 Ω~~

b) ~~1 V, −1 Ω~~

c) 0 V, 1 Ω

d) 0 V, −1 Ω

KVL-1 $-10i_x - 4[1-i_x] + 2i_x = 0$

$i_x = -1$ (1)

KVL-2 $-2i_x - 1 + V_T = 0 \rightarrow V_T = 1 + 2i_x$ (2)

$$V_T = 1 + 2[-1]$$

$$V_T = -1$$

$$R_{TH} = \frac{V_T}{1} = -1\,\Omega$$

H.W
GATE/2M.

Find Norton's equivalent across X–Y