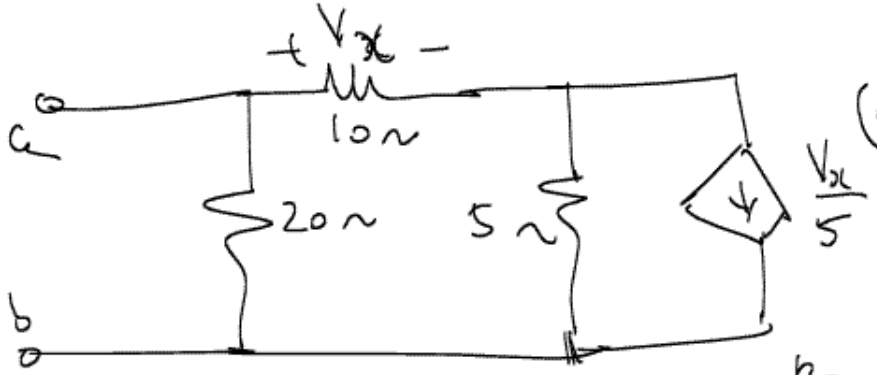
EE 100 Discussion 2

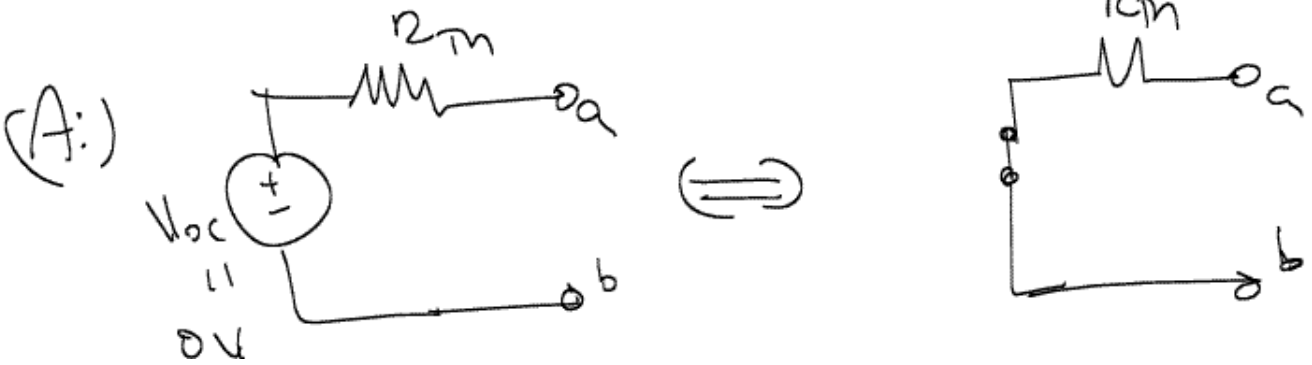
(Q. 1) Example of Thevenin/Norton with dependent sources

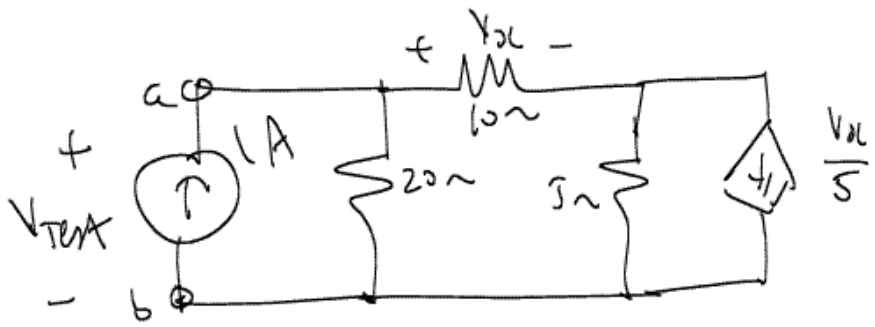
Ex:



(Q:) Find Thevenin equivalent at ab

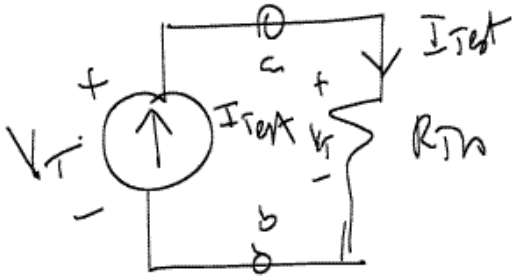
(A:)



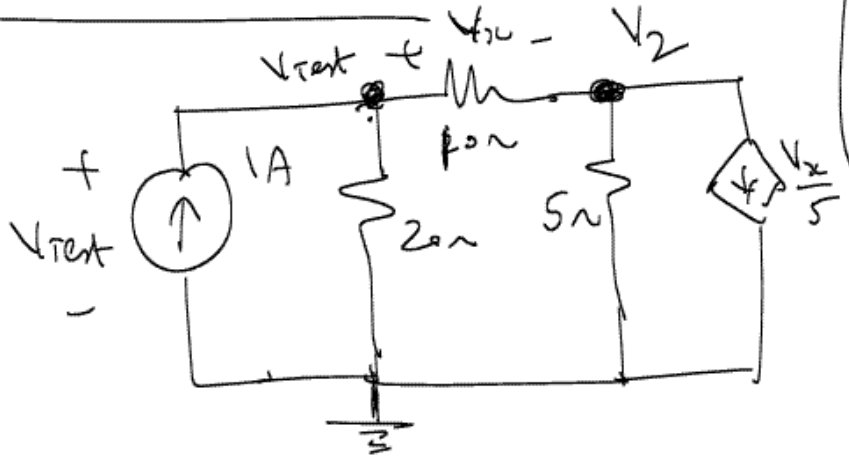


Note:

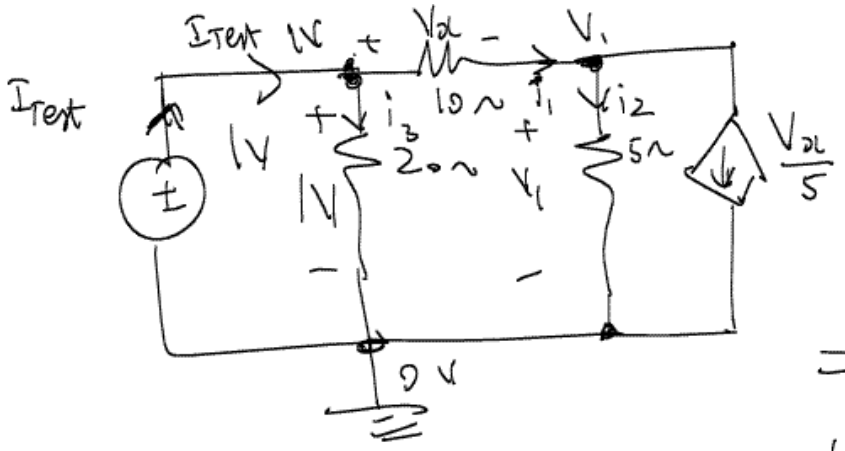
To pick direction of test source.



Nodal analysis:



Notice we have two unknown node voltages, but lets backtrace. Let pick a test voltage source.



KCL @ V_1:

$$i_1 = i_2 + \frac{V_x}{5}$$

$$\Rightarrow \frac{V_x}{10} = \frac{V_1}{5} + \frac{V_x}{5}$$

$$1 - V_1 = V_x$$

$$\Rightarrow V_1 = 1 - V_x$$

$$\therefore \frac{V_x}{10} = \frac{1 - V_x}{5} + \frac{V_x}{5}$$

$$\Rightarrow \frac{V_x}{10} = \frac{1}{5}$$

$$\Rightarrow \boxed{V_x = 2\,V}$$

Goal: $I_{Test} = ?$

$$I_{Test} = i_3 + i_1$$

$$I_{Test} = \frac{1}{20} + i_1$$

$$\therefore I_{Test} = \frac{1}{20} + \frac{V_x}{10}$$

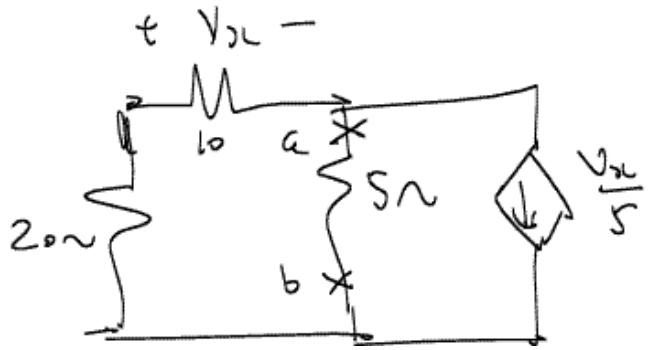
$$= \frac{1}{20} + \frac{2}{10}$$

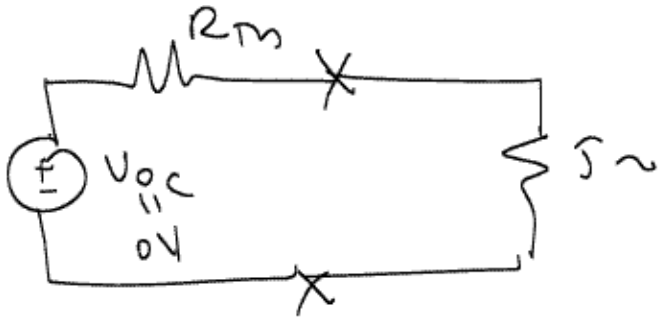
$$\Rightarrow \quad I_{Test} = \frac{1}{20} + \frac{9}{20}$$

$$I_{Test} = \frac{1}{4}\ A \qquad \therefore \boxed{R_{Th} = \frac{V_{Test}}{I_{Test}} = \frac{1}{1/4} = 4\Omega}$$

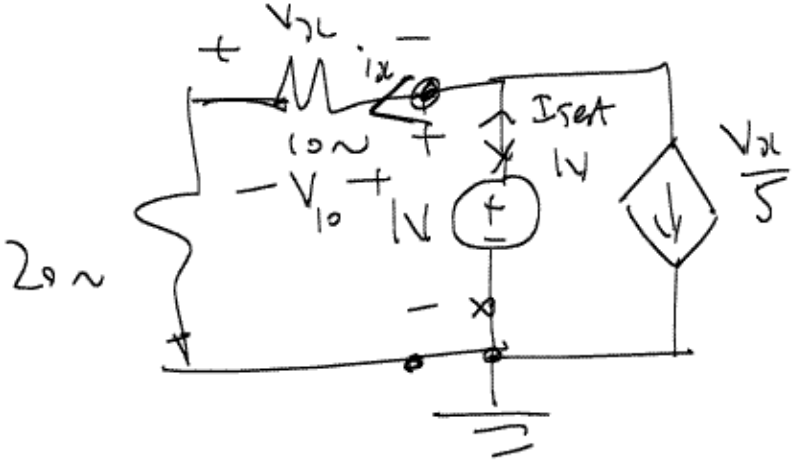
(Q.) Thevenin / Norton at different terminals in a circuit

Ans:-





$R_{TH} = ?$



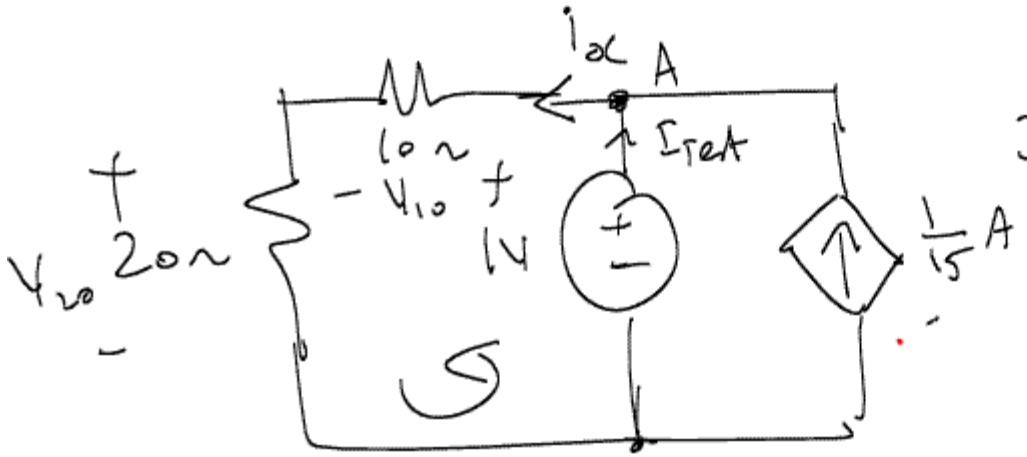
$$V_x = -\frac{10}{30}\ V$$

(Qi.) $I_{SCA} = ?$

$$V_{10} = 1V \cdot \frac{10}{10+20}$$

(Voltage divider)

$$V_{10} = \frac{10}{30}\ V$$



$$I_{Dependent} = \frac{V_{2L}}{5} = \frac{-10}{30} \cdot \frac{1}{5}$$

$$= \frac{-1}{15} A$$

$$I_{Test} + \frac{1}{15} = i_x \quad \text{(KCL at node A)}$$

$$I_{Test} = \frac{V_{10}}{10} - \frac{1}{15}$$

$$= \frac{1}{30} - \frac{1}{15} = \frac{-1}{30} = -33.33 \text{ mA}$$

Oops, $R_m < 0 \Rightarrow R_m = \frac{V_{Th}}{I_{Th}} = \frac{1}{-\frac{1}{30}} = -30\,\Omega$

Verified in PSPICE: (ask me in office hours to explain this)