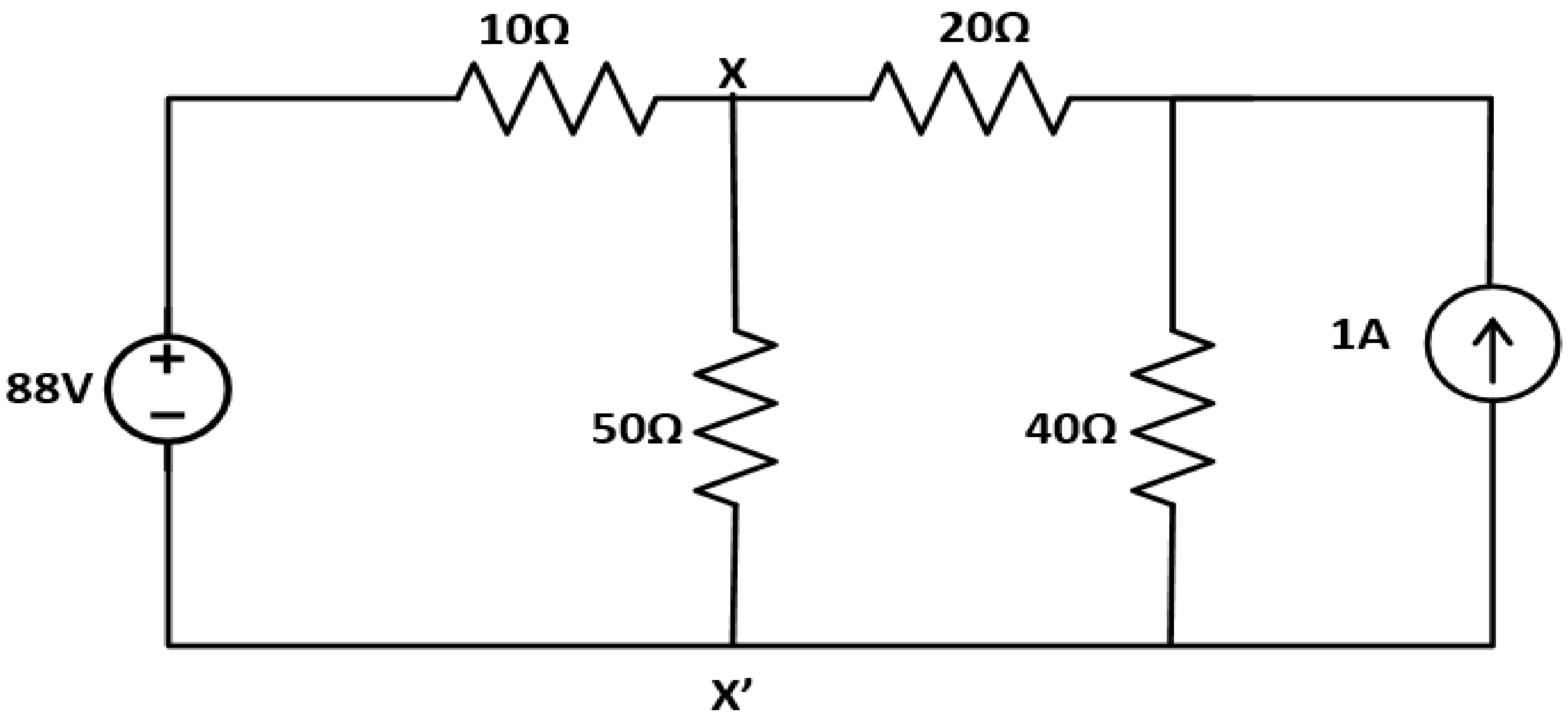
EE 101ME – Electric Circuits

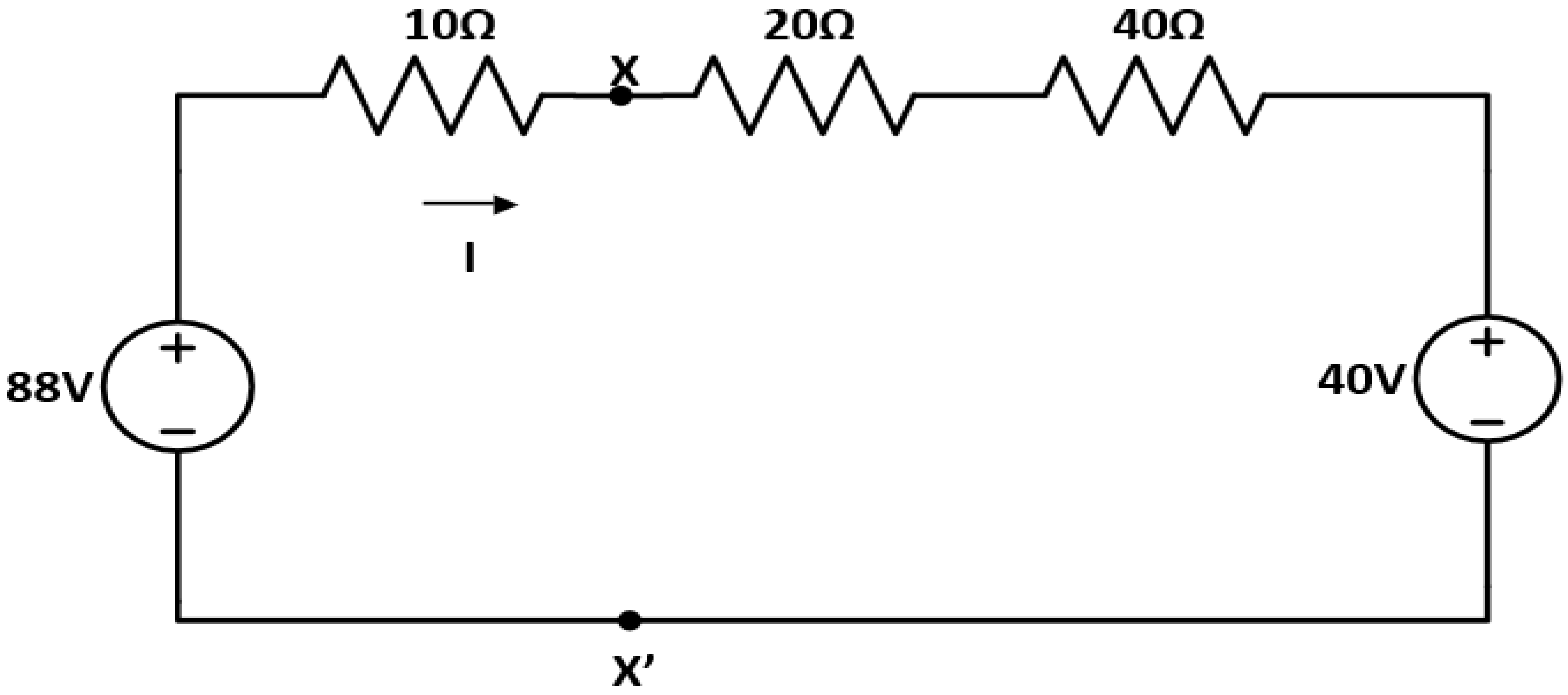
Practice Problems

Q1. Find voltage across the terminal pair x-x' for the network shown below using

(a) Thevenin's equivalent circuit and (b) Norton's equivalent circuit



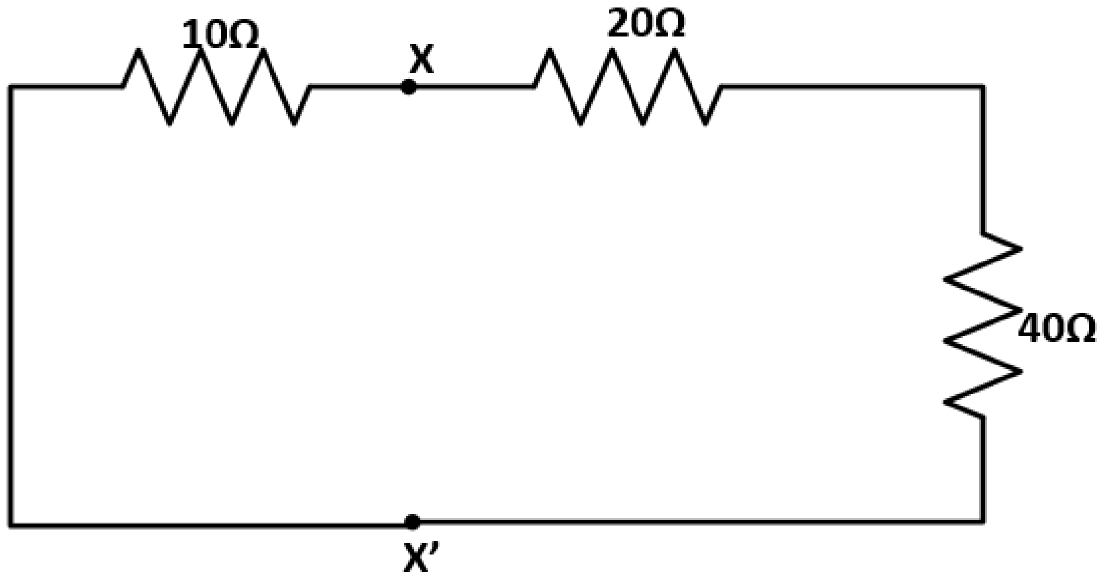
By Source transformation of 1A source,



Voltage across X X' = $V_{XX'}$ = 88 – 10 I

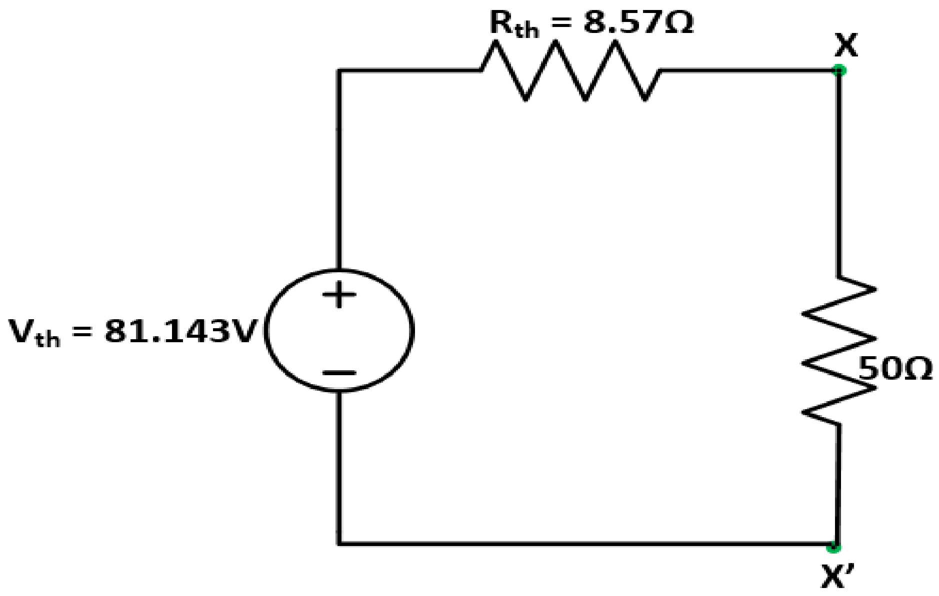
= 88 – 10 x 0.6857 = 81.143 V⇒$\mathbf{V_{TH} = V_{THEVENIN} = V_{XX'} = 81.143}$

Deactivating the independent sources,



$R_{TH} = 10 \parallel 60 = 8.57\ \Omega$

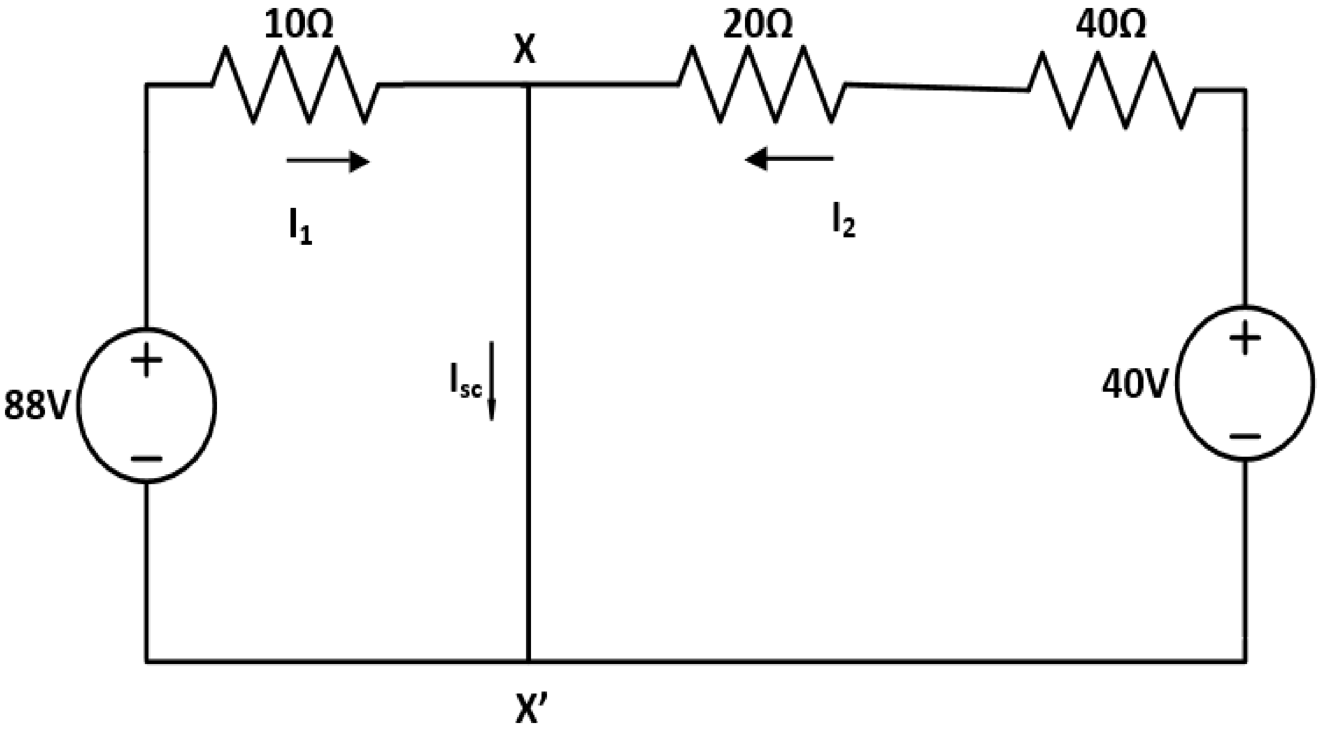
Thevenin Equivalent Circuit:



$$\text{Voltage across xx'} = V_{TH}\,\frac{50}{50+8.57}$$

$$= 81.143\,\frac{50}{50+8.57} \quad = \mathbf{69.27\ V.}$$

Using Source transformation of 1A source,



Now, Loop I ⇒ $88 - 10\,I_1 = 0$

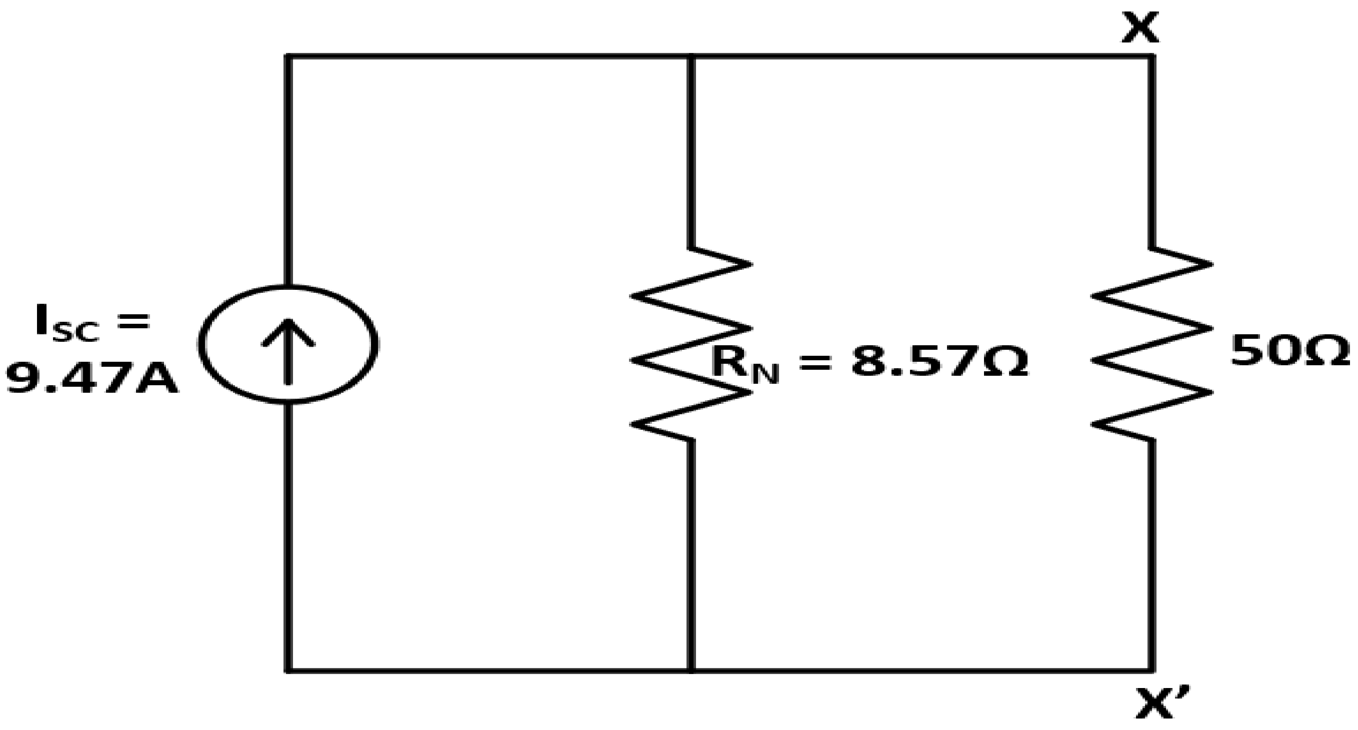
or, $\mathbf{I_1 = 8.8\ A.}$

Loop II ⇒ $40 - I_2 \times 60 = 0$

or, $\mathbf{I_2 = 0.67\ A}$

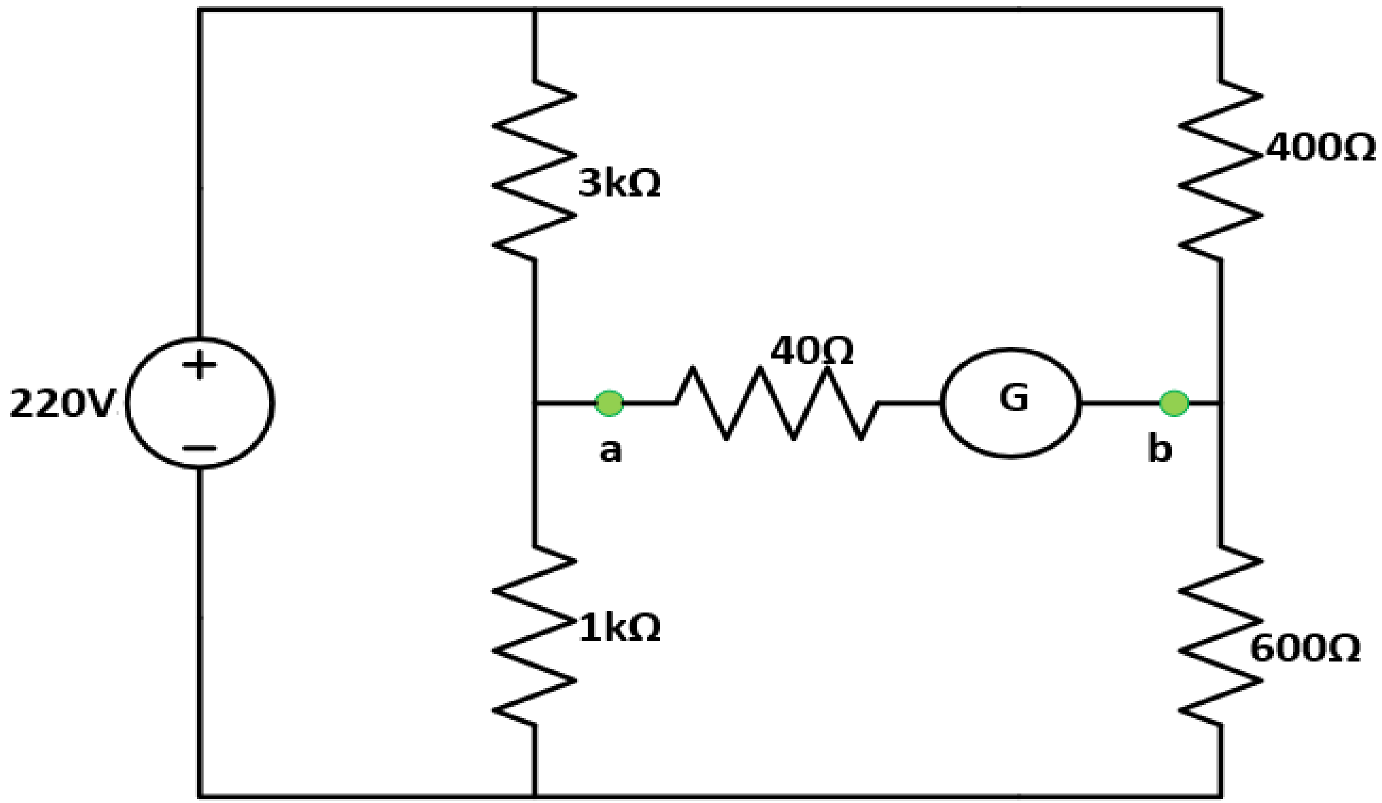
Now $I_{SC} = I_1 + I_2 = \mathbf{9.47\ A}$

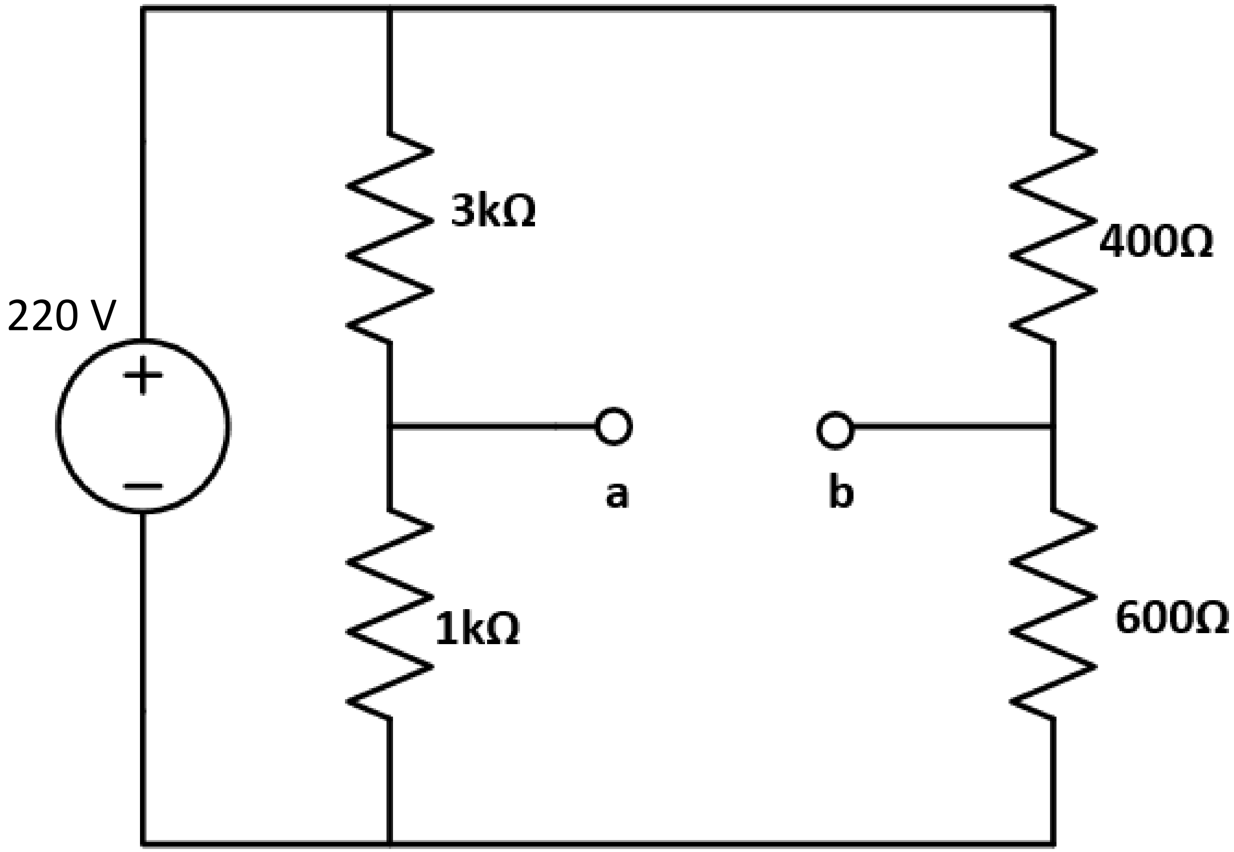
∴ Norton equivalent circuit is



$$\text{Voltage across xx'} = I_{SC}\,\frac{8.57}{(8.57+50)} \times 50 = \mathbf{69.27\ V.}$$

Q2. Find current through the Galvanometer (G, from terminal a to terminal b) which has an internal resistance of 40 Ω.





Thevenin equivalent across a-b are to be estimated.

$$V_a = \frac{1000}{1000 + 3000} \times 220 = 55\,V$$

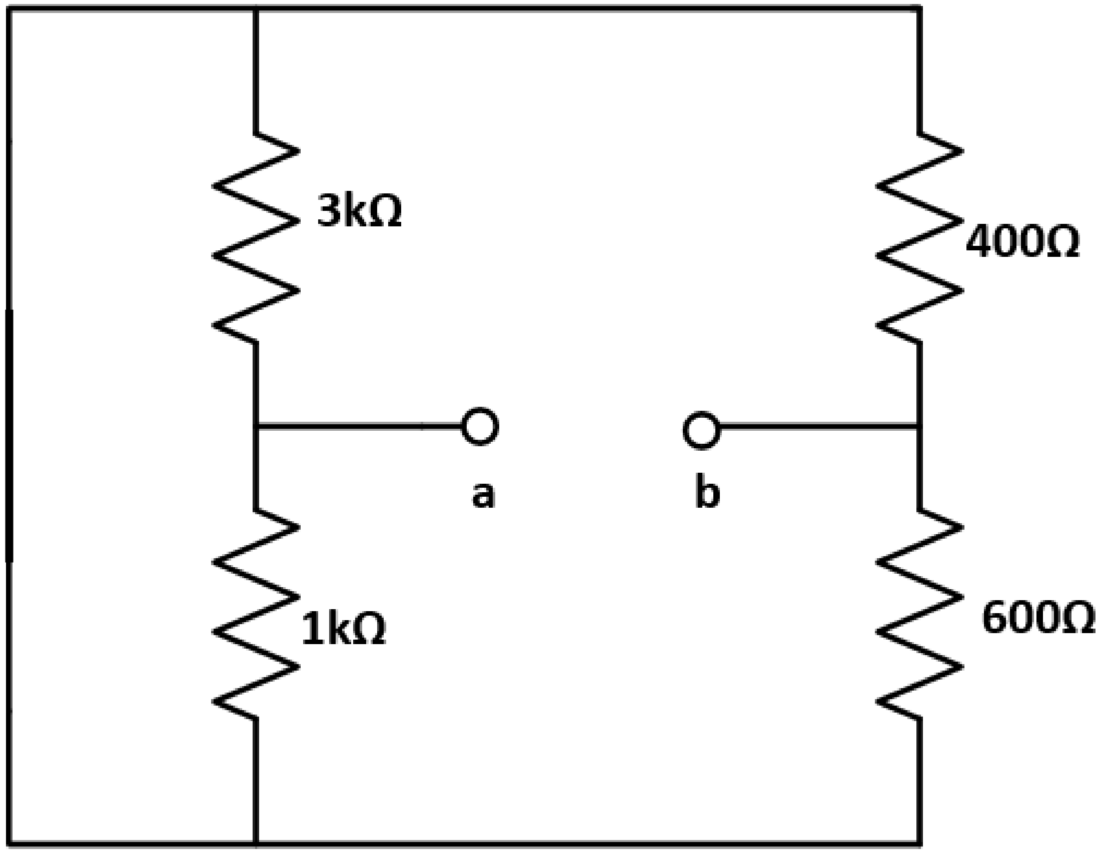
$$V_b = \frac{600}{600 + 400} \times 220 = 132\,V$$

Applying KVL around loop **ab** gives

$$-V_a + V_{th} + V_b = 0$$

$$\Rightarrow V_{th} = V_a - V_b = 55 - 132$$

$$= -77V$$

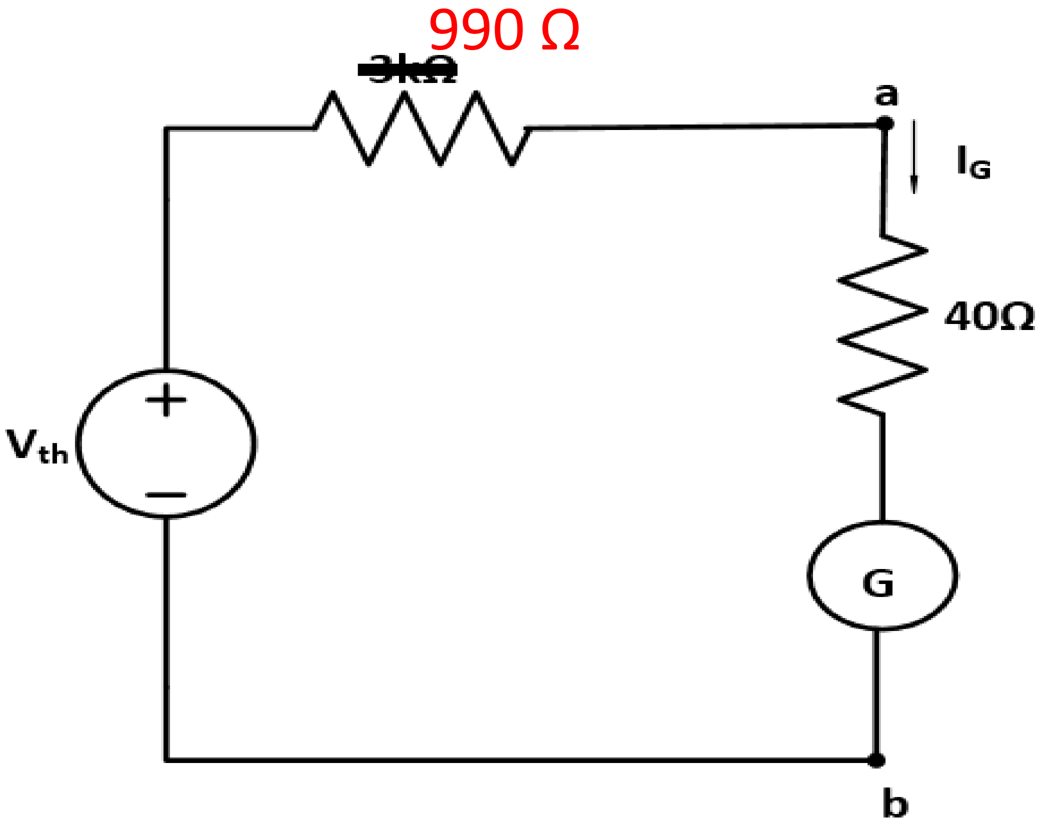


Notice that 3 kΩ and 1 kΩ resistors are in parallel and so are the 400 Ω and 600 Ω resistors. The two parallel combinations form a series combination with respect to terminals **a** and **b**.

$$R_{th} = 3000||1000 + 400||600$$

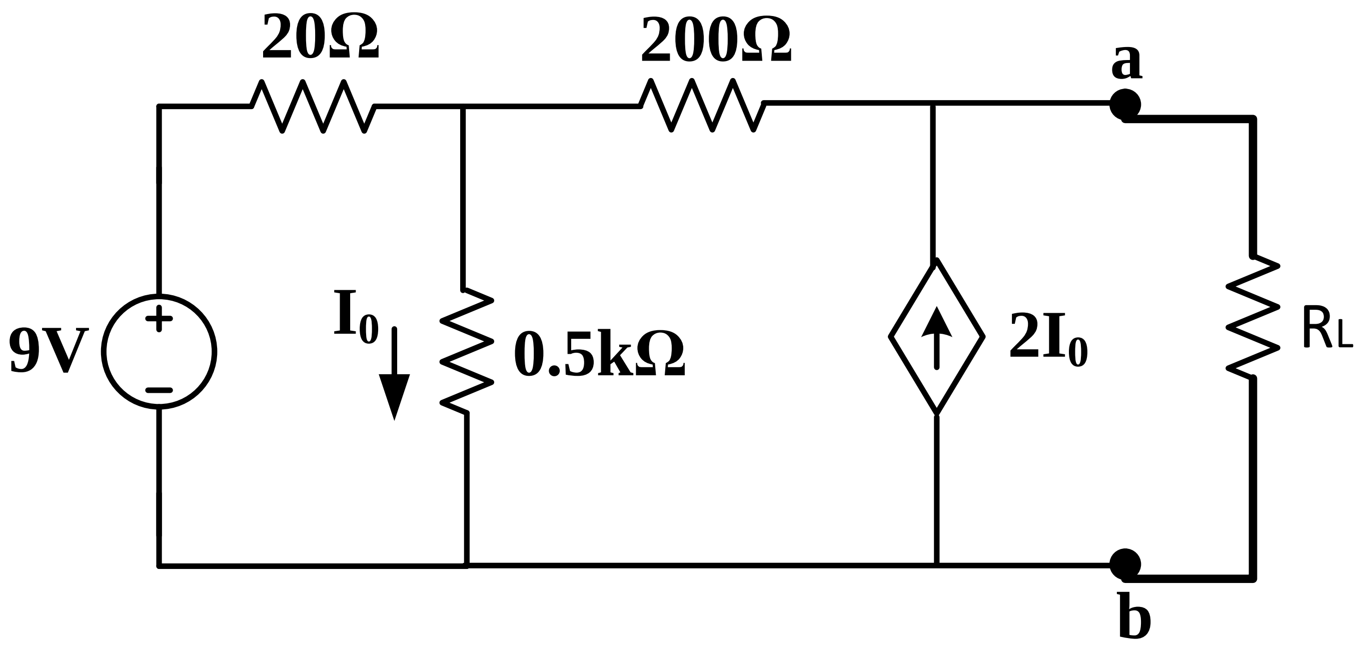
$$= 990\ \Omega$$

The equivalent circuit is:



$$I_G = \frac{V_{Th}}{R_{Th} + R_m} = \frac{-77}{990 + 40} = -74.76mA$$

Q3. Find maximum power delivered to the load resistor R_L of the following circuit.



After disconnecting R_L, let the voltage across 0.5 kΩ be Vx and the open circuit voltage across **a-b** be the Thevenin's voltage Vth.

Current through 20 Ω is I_0. Then, $9 + 20 I_0 = 500 I_0 \Rightarrow I_0 = 9/480$ giving $Vth = 9 + 20 I_0 + 400 I_0 = 16.875$ V.

Next, when a-b is short-circuited, let the current flowing from terminal a to terminal b be Isc. Let the node voltage between the resistors 20 Ω and 200 Ω be Vx.

Then, $(Vx – 9)/20 + Vx/500 + Vx/200 = 0 \Rightarrow Vx = 7.895$ V

$Isc = 2I_0 + Vx/200 = 2Vx/500 + Vx/200 = 0.071$ A

Now, Rth = Equivalent resistance across a-b

= Vth/Isc = 237.676 Ω

Maximum power delivered to the load $R_L = 0.25\ Vth^2 / Rth = 0.3$ W (approx.)

END