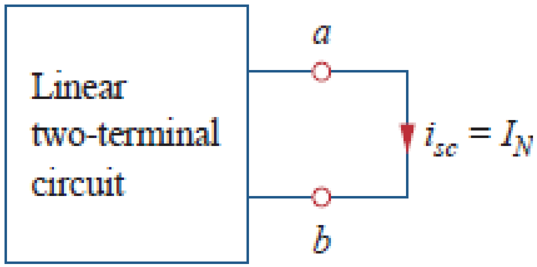
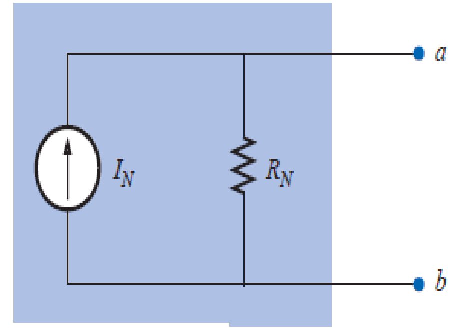
Chapter 5

Circuit Analysis Techniques

Norton Theorem

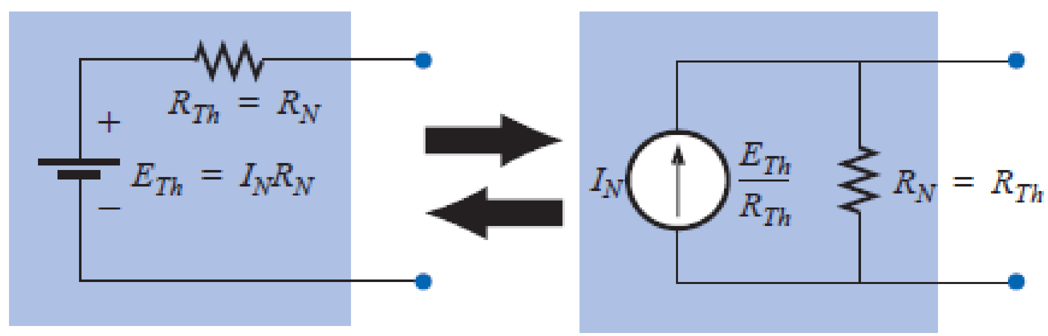
NORTON'S THEOREM





R_N

Source transformation



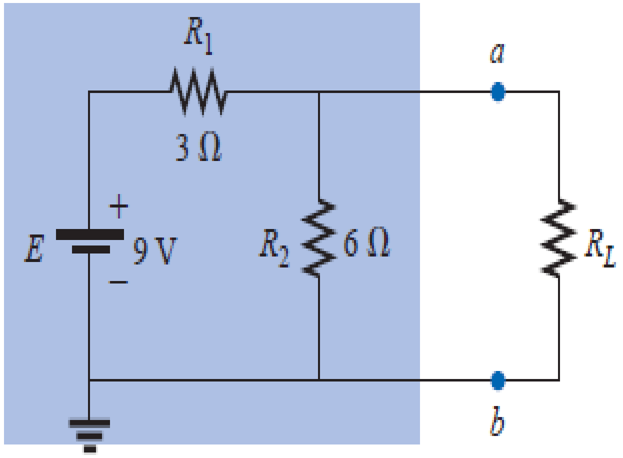
If we have dependent source

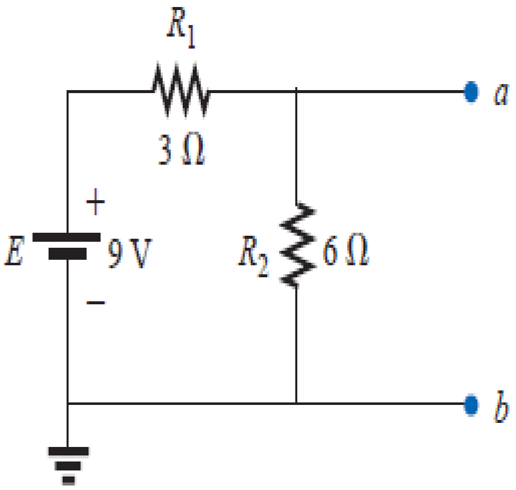
$$V_{Th} = v_{oc}$$

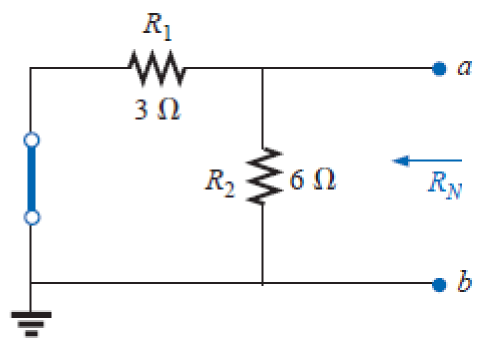
$$I_N = i_{sc}$$

$$R_{Th} = \frac{v_{oc}}{i_{sc}} = R_N$$

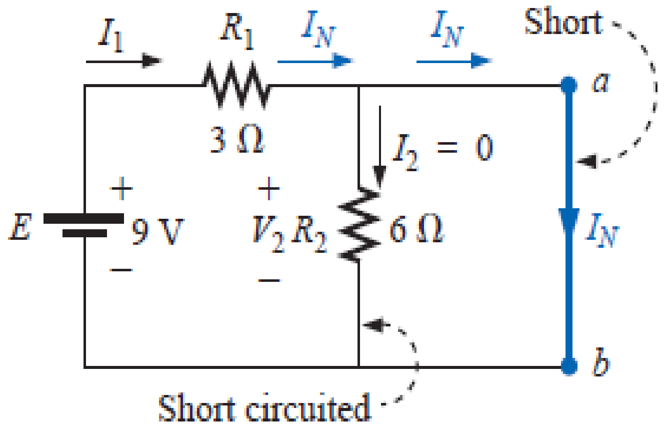
Find Norton equivalent seen by RL



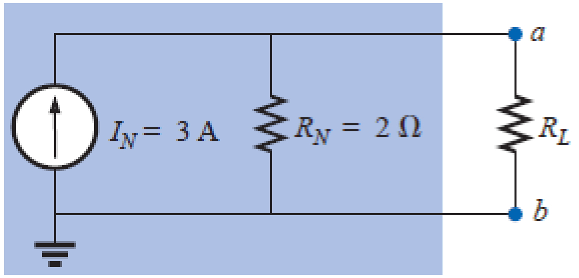




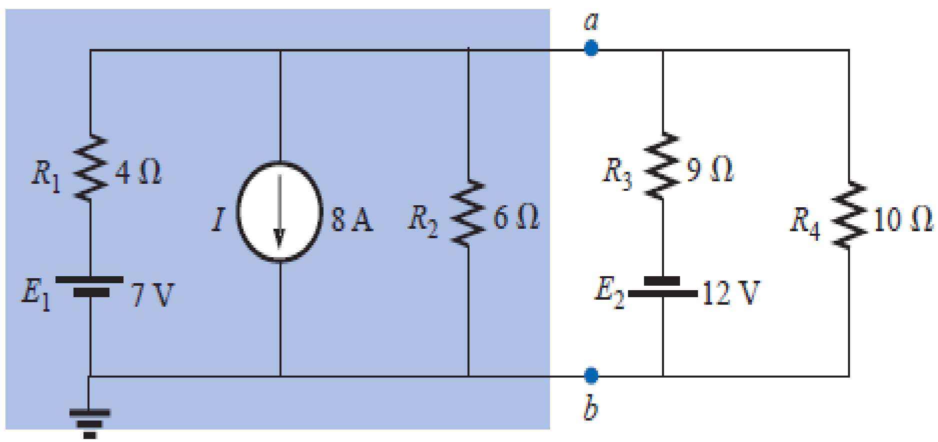
$$R_N = R_1 \parallel R_2 = 3\,\Omega \parallel 6\,\Omega = \frac{(3\,\Omega)(6\,\Omega)}{3\,\Omega + 6\,\Omega} = \frac{18\,\Omega}{9} = \mathbf{2\,\Omega}$$

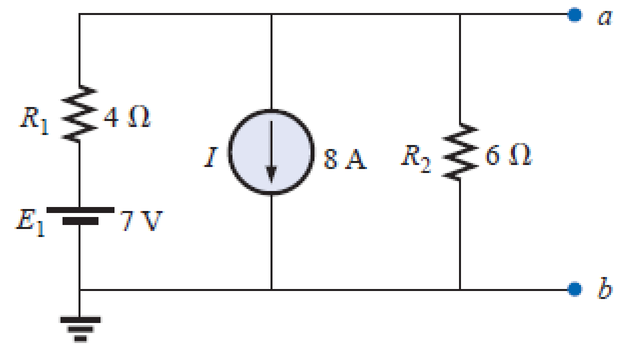


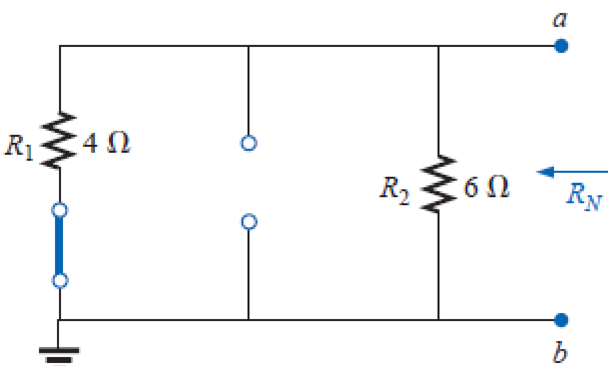
$$I_N = \frac{E}{R_1} = \frac{9\,\text{V}}{3\,\Omega} = \mathbf{3\,A}$$



Find Norton equivalent seen by a and b to the left

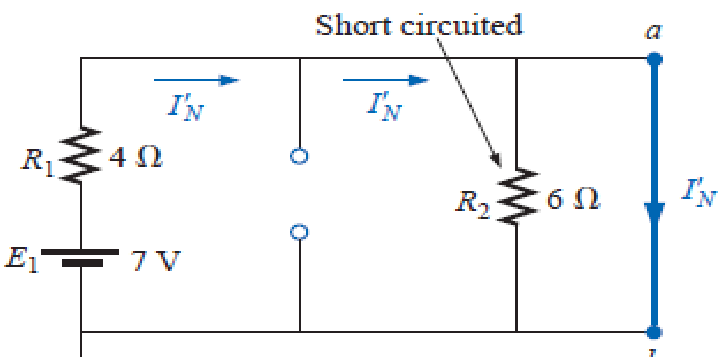






$$R_N = R_1 \parallel R_2 = 4\ \Omega \parallel 6\ \Omega = \frac{(4\ \Omega)(6\ \Omega)}{4\ \Omega + 6\ \Omega} = \frac{24\ \Omega}{10} = \mathbf{2.4\ \Omega}$$

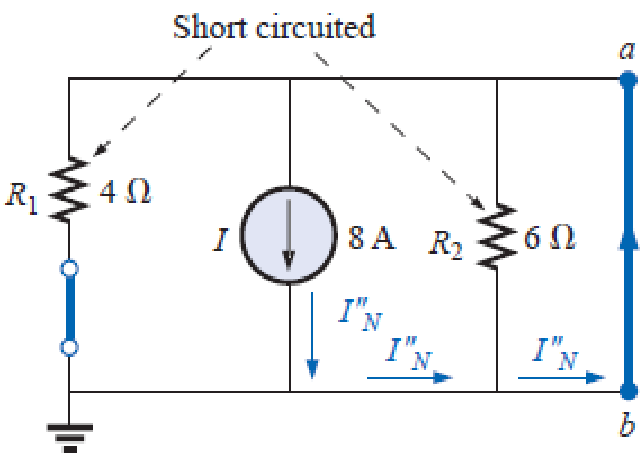
Using superposition

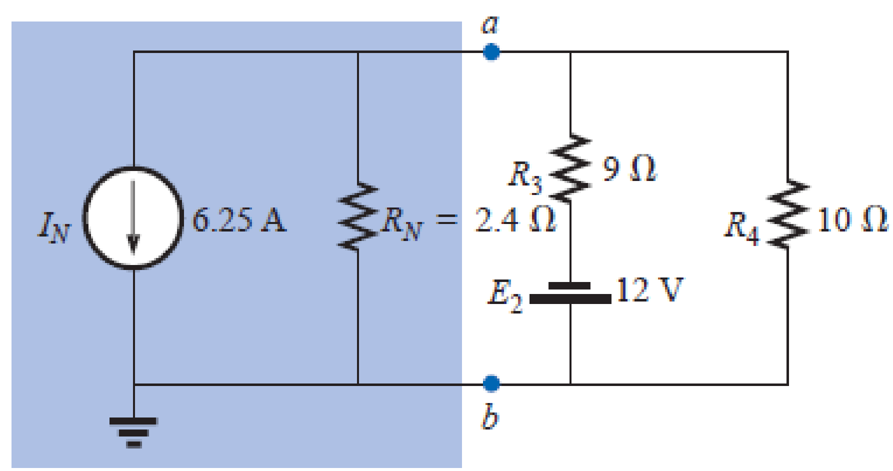


$$I'_N = \frac{E_1}{R_1} = \frac{7\text{ V}}{4\ \Omega} = 1.75\text{ A}$$

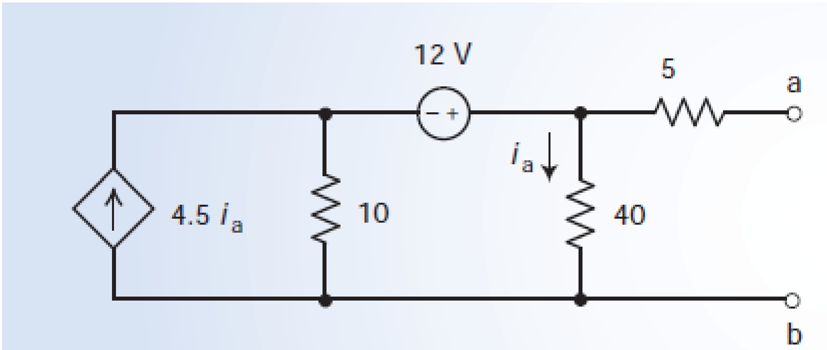
$$I''_N = I = 8\text{ A}$$

$$I_N = I''_N - I'_N = 8\text{ A} - 1.75\text{ A} = 6.25\text{ A}$$



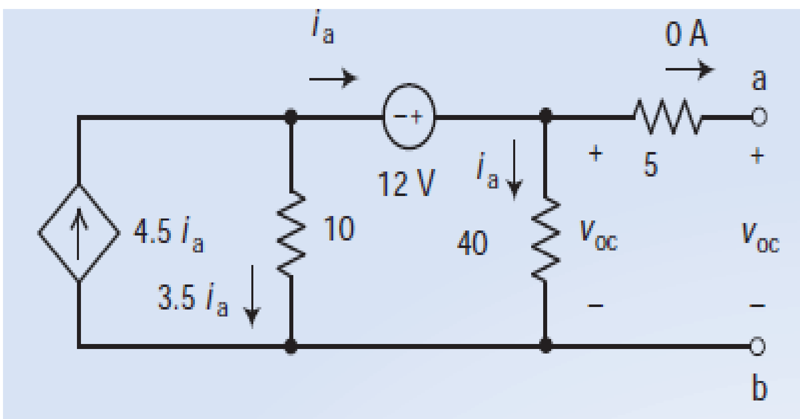


Find thevenin equivalent seen by terminals a and b



Soultion :   Since we have dependent source

$$R_{th} = \frac{V_{o.c}}{I_{s.c}}$$

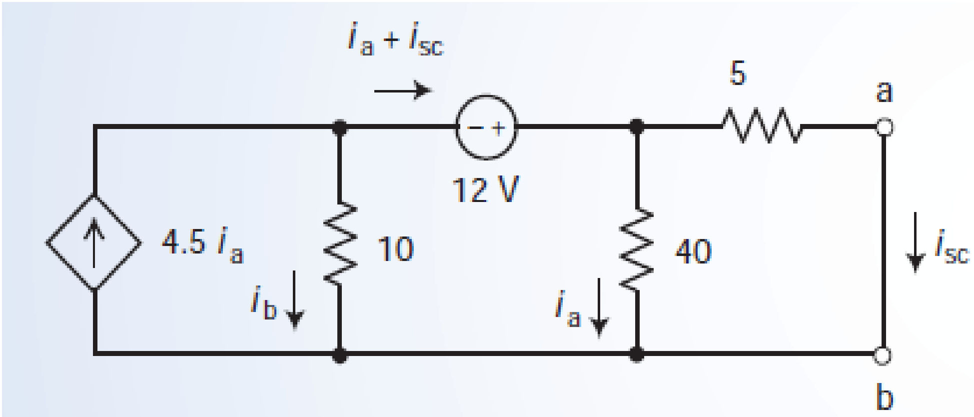


$$i_a = \frac{v_{oc}}{40}$$

KVL

$$0 = -12 + v_{oc} - 10(3.5 i_a)$$

$$v_{oc} = 96\text{ V}$$



KVL at loop 1

$$5 i_{sc} - 40 i_a = 0 \quad \Rightarrow \quad i_a = \frac{i_{sc}}{8}$$

KCL at Node 1

$$4.5 i_a = i_b + (i_a + i_{sc}) \quad \Rightarrow \quad i_b = 3.5 i_a - i_{sc} = -\frac{9}{16} i_{sc}$$

KVL at loop2

$$-12 + 5 i_{sc} - 10\left(-\frac{9}{16} i_{sc}\right) = 0$$

$$i_{sc} = \frac{12}{5 + \frac{90}{16}} = 1.1294\text{ A}$$

$$R_{th} = \frac{V_{o.c}}{I_{s.c}} = \frac{96}{1.1294} = 85\Omega$$