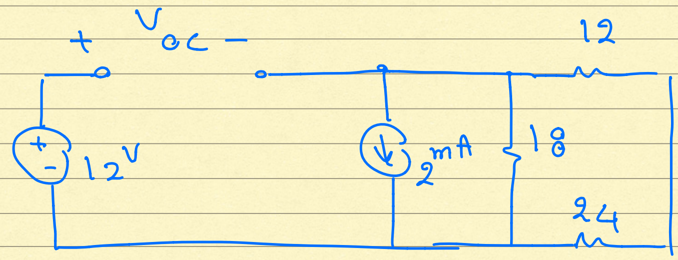
Solution of Assignment 4 by Emad Gad

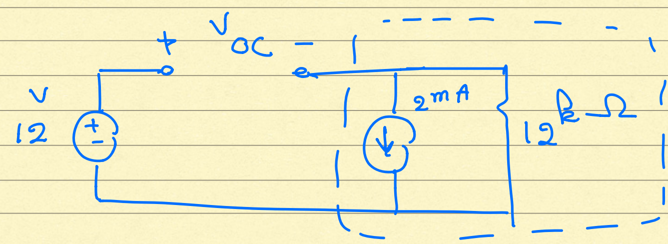
Part i) Thevenin Equivalent circuit

V_{oc}, R_t

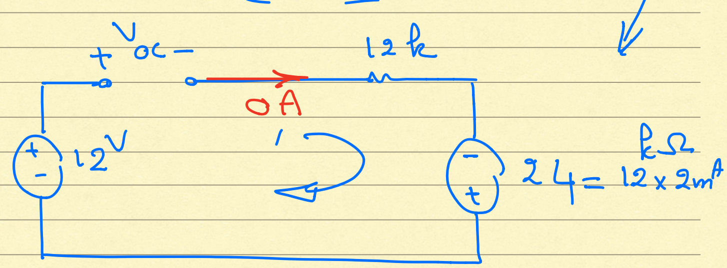
To find V_{oc}, we remove R_L and leave an open circuit



we can simplify the circuit



Source transformation

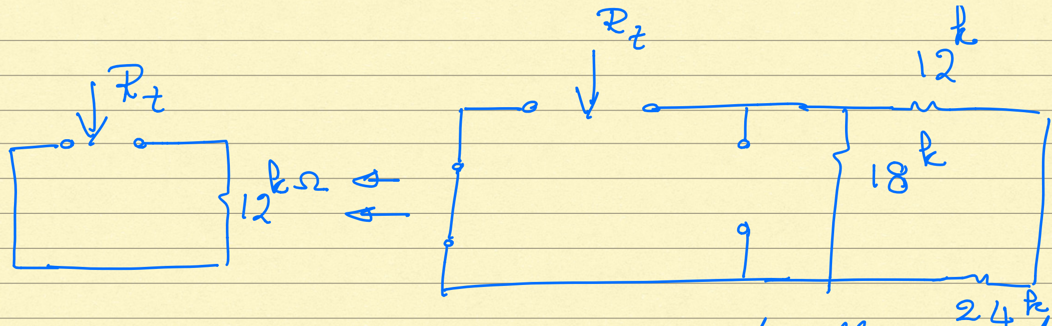


KVL @ the only loop gives

$$-12 + V_{oc} + 12 \times 0 - 24 = 0$$

$$V_{oc} = 36^V$$

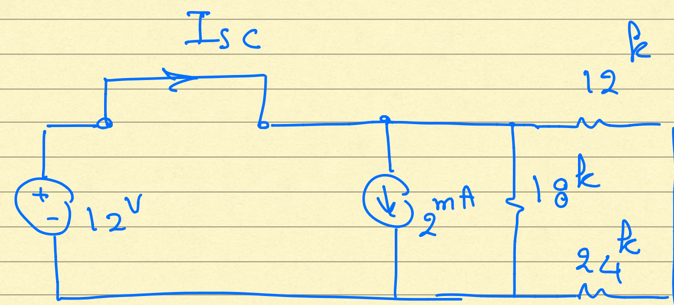
To find R_t, we deactivate independent sources



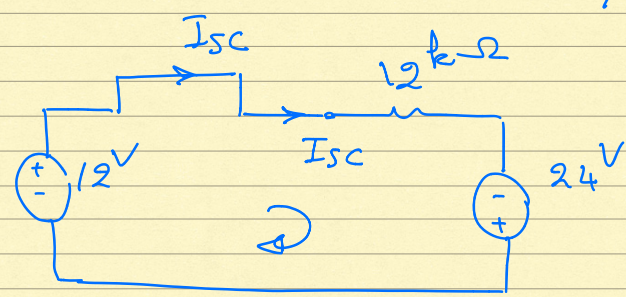
The circuit after deactivating independent sources

$R_t = 12^{k\Omega}$

Part 2) To find the Norton Equivalent circuit we need to find I_{sc} and R_t



We can simplify the circuit as we did in part 1)



Writing a KVL @ loop

$$-12^V + 12^k \times I_{sc} - 24 = 0$$

$$I_{sc} = \frac{36^V}{12^k} = \frac{36}{12000} = 3\ mA$$

R_t has already been computed and found to be

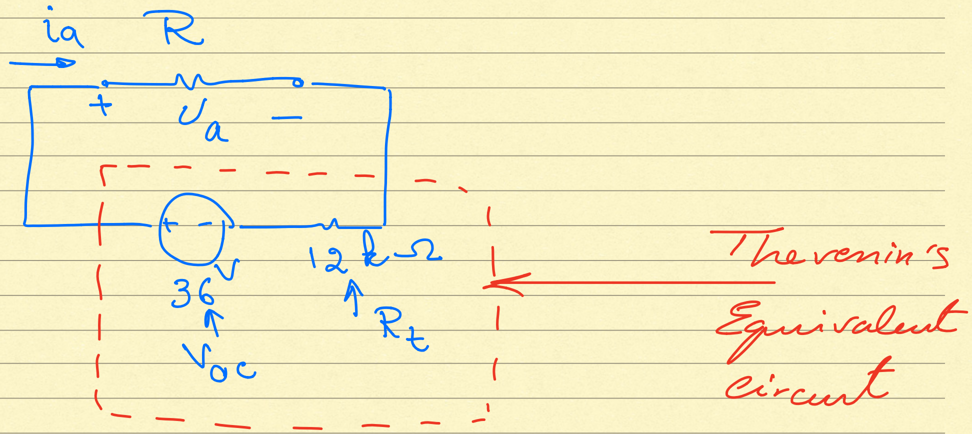
$$R_t = 12^k\ \Omega$$

Notice also that R_t can be obtained alternatively from V_{oc} and I_{sc}, using

$$R_t = \frac{V_{oc}}{I_{sc}} = \frac{36}{3^{mA}} = \frac{36}{0.003} = 12000\ \Omega = 12k\Omega$$

Part 3)

Using the Thevenin equivalent, we can replace the circuit between the terminals with its Thevenin. as shown here



$$i_a = \frac{V_{oc}}{R_t + R} \qquad 0 \leq R \leq 100\ k\Omega$$

a) maximum current i_a is at min R.

$$i_{a_{max}} = \frac{V_{oc}}{0 + R_t} = \frac{36}{12000} = 3\ mA$$

b) maximum voltage for v_a

$$v_a = i_a \times R = \frac{V_{OC}}{R + R_t} \times R = \frac{V_{OC}}{1 + \frac{R_t}{R}}$$

maximum value for v_a is at the value, where R is maximum, i.e at $R = 100000\ \Omega$

$$v_{a_{max}} = \frac{36}{1 + \frac{12000}{100000}} = 32.14\,V$$

c) maximum power delivered to R is

$$P_{max} = \frac{V_{oc}^2}{4 R_t} = \frac{36^2}{4 \times 12000} = 0.027\,W$$
$$= 27\,mW$$

This power is delivered to R when
$R = R_t = 12000\ \Omega$