Question 3.

For the circuit shown in *Figure 3* determine the Thevenin's equivalent circuit.

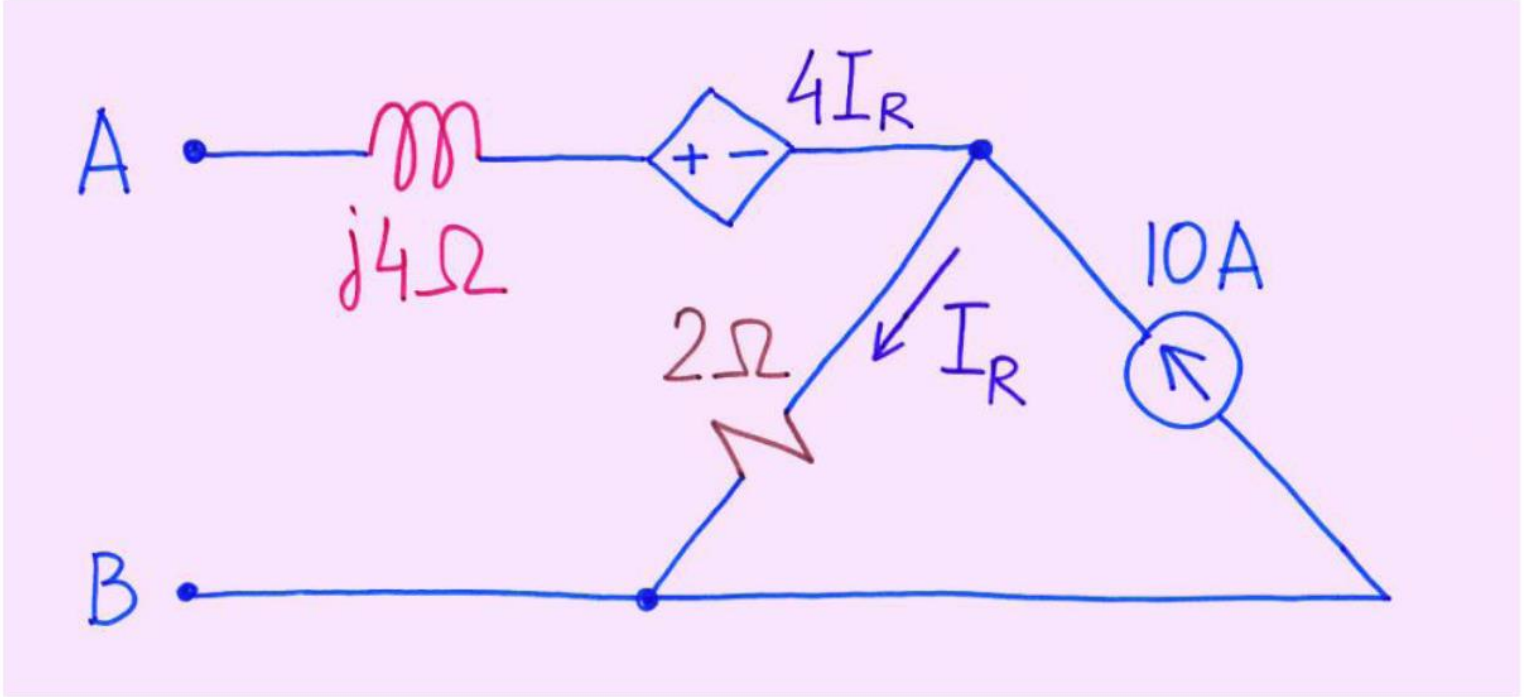
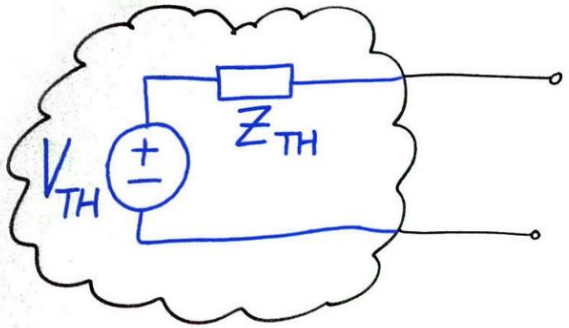


Figure 3

Thevenin Theorem – Equivalent

Thevenin Equivalent



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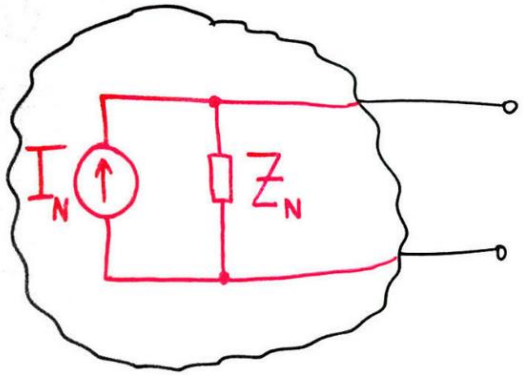
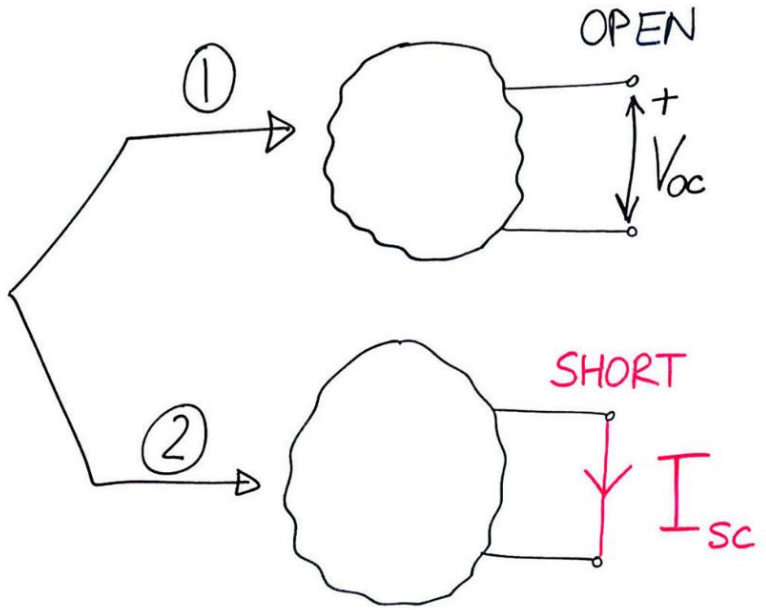


Norton Equivalent

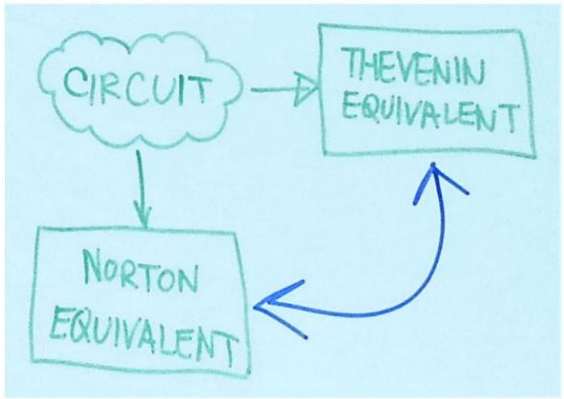


1) $V_{TH} = V_{OC}$

2) ALWAYS $Z_{TH} = \frac{V_{OC}}{I_{SC}}$

$$I_N = \frac{V_{TH}}{Z_{TH}}$$

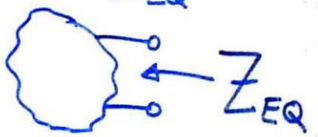
$$Z_N = Z_{TH}$$



ONLY CIRCUITS WITH INDEPENDENT SOURCES

"SHORTCUT"

- SWITCH OFF ALL THE SOURCES
- FIND Z_{EQ}

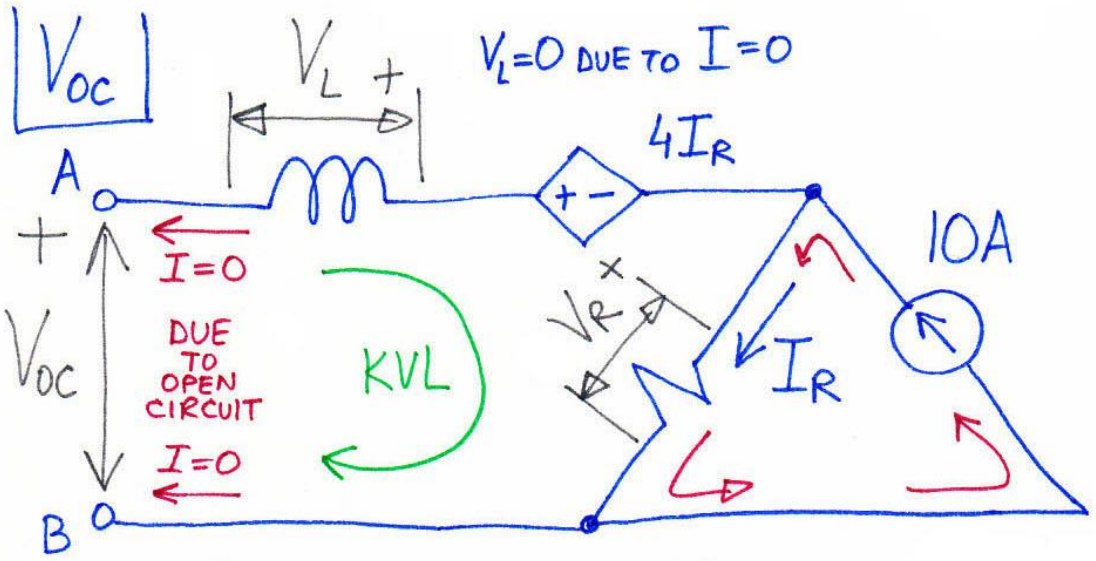


$Z_{TH} = Z_{EQ}$

Thevenin Equivalent – Solution (page 1)

Q3

CIRCUIT CONTAINS DEPENDENT SOURCE
⇒ MUST FIND BOTH V_{OC} & I_{SC}



$I_R = 10A$
CIRCULATING CURRENT

$V_R = I_R \cdot R$
$= 10A \cdot 2\Omega$
$= 20V$

KVL: $-V_{OC} - V_L + 4I_R + V_R = 0$

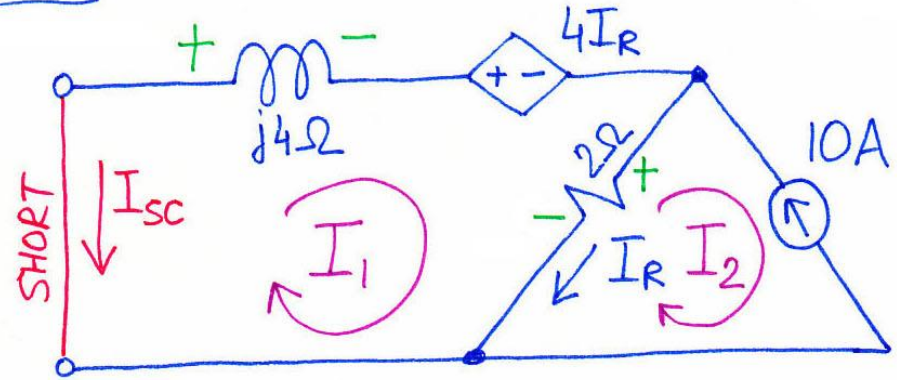
$V_{OC} = -0 + 4 \cdot 10 + 20 \Rightarrow \boxed{V_{OC} = 60V}$

$V_{TH} = V_{OC} = 60V$

Thevenin Equivalent – Solution (page 2)

I_{SC}

REDRAW CIRCUIT:



$I_2 = -10A$ ✓

$I_R = I_1 - I_2$

$= I_1 - (-10A)$

$= I_1 + 10A$

CANNOT USE CURRENT DIVIDER DUE TO (DEPENDENT) SOURCE.

USE MESH CURRENTS:

KVL LOOP 1 : $+Z_L I_1 + 4I_R + RI_R = 0$ KVL EQUATION

$j4I_1 + 4(I_1 + 10) + 2(I_1 + 10) = 0$

$j4I_1 + 6I_1 + 60 = 0$

$(6 + j4)I_1 = -60$

THUS $I_1 = \frac{-60}{6+j4} \cdot \frac{6-j4}{6-j4} = \frac{-360+j240}{36+16} = -\frac{90}{13} + j\frac{60}{13} A$

$I_{SC} = -I_1 = \frac{90}{13} - j\frac{60}{13} A$

Thevenin Equivalent – Solution (page 3)

$$\boxed{Z_{TH}} \qquad Z_{TH} = \frac{V_{oc}}{I_{sc}} = \frac{60}{\frac{90}{13} - j\frac{60}{13}} = \frac{6 \cdot 13}{9 - j6} \cdot \frac{9 + j6}{9 + j6} = \frac{702 + j468}{9^2 + 6^2} = 6 + j4\,\Omega$$

$$Z_{TH} = 6 + j4\,\Omega$$