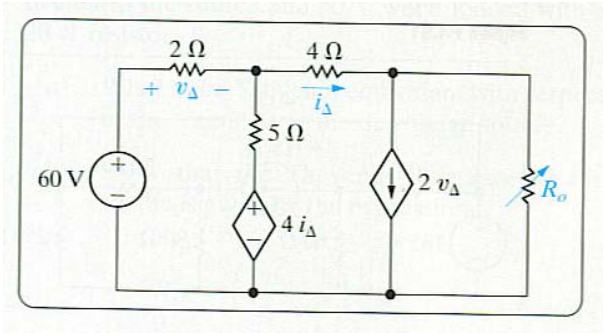
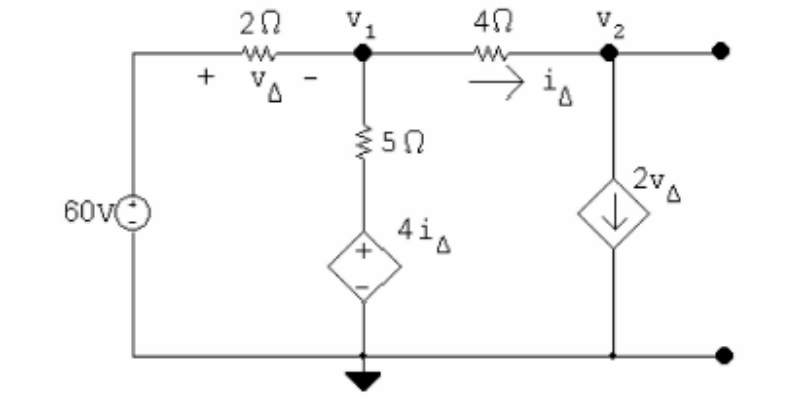
KING FAHD UNIVERSITY OF PETROLEUM & MINERALS
ELECTRICAL ENGINEERING DEPARTMENT
EE-201 ELECTRIC CIRCUITS
Dr. Ibrahim O. Habiballah

Sec: 9 Quiz # 3 Ser. # Name: I.D.#

For the circuit shown below, find the maximum power transfer to R_o.



Solution



Node voltage equations:

$$\frac{v_1 - 60}{2} + \frac{v_1 - 4i_\Delta}{5} + \frac{v_1 - v_2}{4} = 0$$

$$\frac{v_2 - v_1}{4} + 2v_\Delta = 0$$

Constraint equations:

$$v_\Delta = 60 - v_1$$

$$i_\Delta = \frac{v_1 - v_2}{4}$$

Place the equations in standard form:

$$v_1\left(\frac{1}{2}+\frac{1}{5}+\frac{1}{4}\right)+v_2\left(-\frac{1}{4}\right)+i_\Delta\left(-\frac{4}{5}\right)+v_\Delta(0) = 30$$

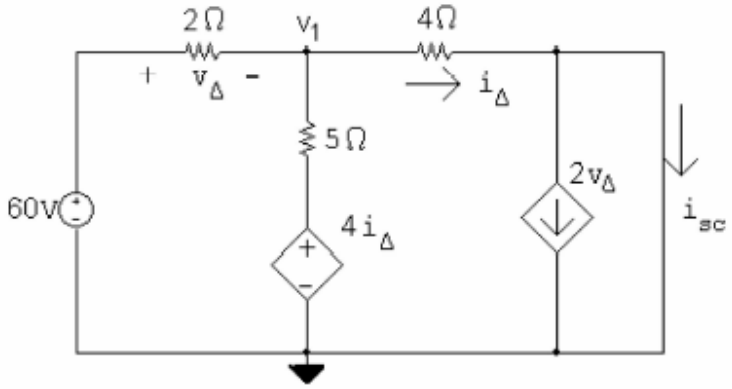
$$v_1\left(-\frac{1}{4}\right)+v_2\left(\frac{1}{4}\right)+i_\Delta(0)+v_\Delta(2) = 0$$

$$v_1(1)+v_2(0)+i_\Delta(0)+v_\Delta(1) = 60$$

$$v_1(1)+v_2(-1)+i_\Delta(-4)+v_\Delta(0) = 0$$

Solving, $v_1 = 20$ V; $v_2 = -300$ V; $i_\Delta = 80$ A; $v_\Delta = 40$ V

Short circuit current:



The node voltage equation:

$$\frac{v_1-60}{2}+\frac{v_1-4i_\Delta}{5}+\frac{v_1}{4}=0$$

The constraint equation:

$$i_\Delta = v_1/4$$

Place these equations in standard form:

$$v_1\left(\frac{1}{2}+\frac{1}{5}+\frac{1}{4}\right)+i_\Delta\left(-\frac{4}{5}\right) = 30$$

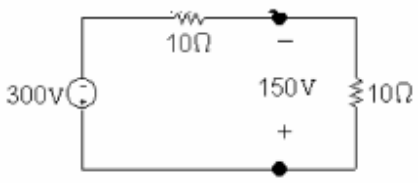
$$v_1\left(\frac{1}{4}\right)+i_\Delta(-1) = 0$$

Solving, $v_1 = 40$ V; $i_\Delta = 10$ A

Then, $v_\Delta = 60-40 = 20$ V

and $i_{sc} = i_\Delta - 2v_\Delta = 10-40 = -30$ A

Thus, $R_{Th} = -300/-30 = 10\,\Omega$



$$p_{\max} = \frac{(150)^2}{10} = 2250 \text{ W}$$