Engr228 **Mid-term Test #1** **Spring, 2013**

NAME KEY SCORE _____/30

This is a closed book test except for your calculator and cheat sheet. Each page is worth 10 points. Partial credit may be given but only if you show your work.

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1 The ideal input resistance of a multi-meter placed in the current-measuring mode is 0 Ω

1 When writing node equations, all terms are in units of Amperes

.5 How many ***total*** nodes are in the circuit below? 3

.5 How many ***total*** branches are in the circuit below? 6

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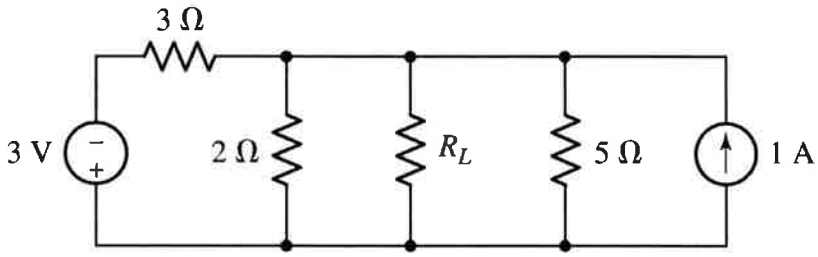
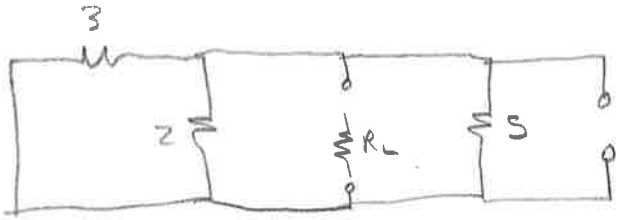
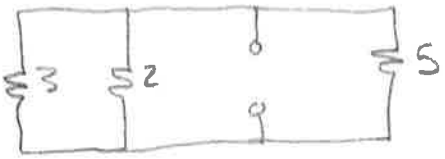
7 What value of R_L will ensure it absorbs the maximum possible amount of power?



The value of R_L that absorbs the most power will be R_{th} as seen by R_L.

To find R_{th}, set all sources = 0



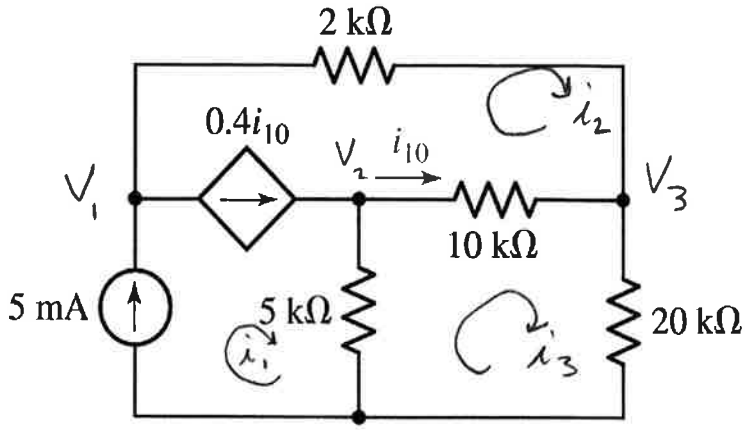


$R_{th} = 3 \| 2 \| 5$

$= 0.968\,\Omega$

R_L for max power = 0.968Ω

Solve for the current labeled i_{10} in the circuit below. Use either mesh or loop analysis.



NODE ANALYSIS

NODE V_1: $5\text{mA} = .4i_{10} + \frac{V_1 - V_3}{2K}$

NODE V_2: $.4i_{10} = \frac{V_2}{5K} + \frac{V_2 - V_3}{10K}$

NODE V_3: $\frac{V_1 - V_3}{2K} + \frac{V_2 - V_3}{10K} = \frac{V_3}{20K}$

Dependent eq: $i_{10} = \frac{V_2 - V_3}{10K}$

Solving:

$V_1 = 6.52\text{V}$
$V_2 = 12\text{V}$
$V_3 = 52\text{V}$

$i_{10} = -4.0\text{mA}$ ✓

MESH ANALYSIS

mesh i_1: $i_1 = 5\text{mA}$

mesh i_2: $.4i_{10} = i_1 - i_2$

mesh i_3: $5K(i_3 - i_1) + 10K(i_3 - i_2) + 20K(i_3) = 0$

$i_{10} = i_3 - i_2$

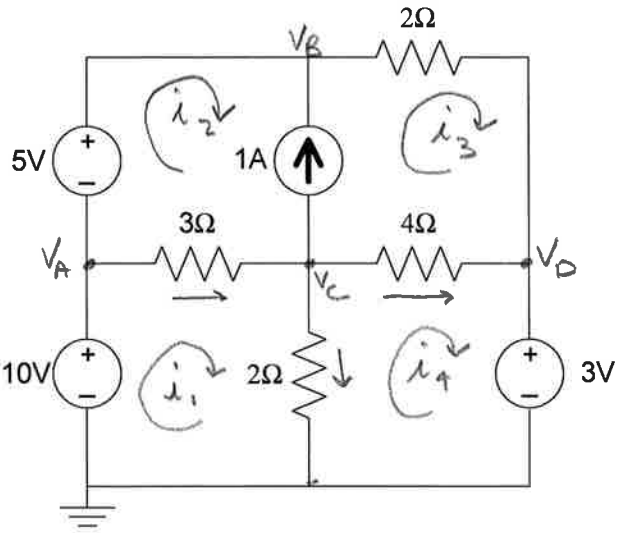
Solving:

$i_1 = 5\text{mA}$
$i_2 = 6.6\text{mA}$
$i_3 = 2.6\text{mA}$

$i_{10} = -4.0\text{mA}$

Solve this problem two ways:

Write the necessary **node** equations and solve for the power dissipated in the 4Ω resistor.
Write the necessary **mesh** equations and solve for the power dissipated in the 4Ω resistor.



Node

$V_A = 10V$

$V_B = 15V$

$V_D = 3V$

Node V_C: $\frac{V_A - V_C}{3} = 1 + \frac{V_C}{2} + \frac{V_C - V_D}{4}$

$V_C = 2.8462V$

$P_{4\Omega} = \frac{V^2}{R} = \frac{(V_C - V_D)^2}{4} = \boxed{5.917\,mW}$

Mesh

This is a super mesh problem.

mesh i_1 : $-10 + 3(i_1 - i_2) + 2(i_1 - i_4) = 0$

i_2, i_3 : $-5 + 2i_3 + 4(i_3 - i_4) + 3(i_2 - i_1) = 0$

$1 = i_3 - i_2$

i_4 : $2(i_4 - i_1) + 4(i_4 - i_3) + 3 = 0$

$$\begin{aligned} 5i_1 - 3i_2 - 2i_4 &= 10 \\ -3i_1 + 3i_2 + 6i_3 - 4i_4 &= 5 \\ -i_2 + i_3 &= 1 \\ -2i_1 - 4i_3 + 6i_4 &= -3 \end{aligned}$$

Solving :

$i_1 = 7.385A$

$i_2 = 5.00\ A$

$i_3 = 6.00\ A$

$i_4 = 5.962\ A$

$P_{4\Omega} = i^2 R = (i_4 - i_2)^2 4 = \boxed{5.917\,mW}$

Engr228 **Mid-term Test #1** **Autumn, 2016**

NAME_____ SCORE KEY /30

This test is 60 minutes in length and is closed book except for your calculator and one side of a cheat sheet.

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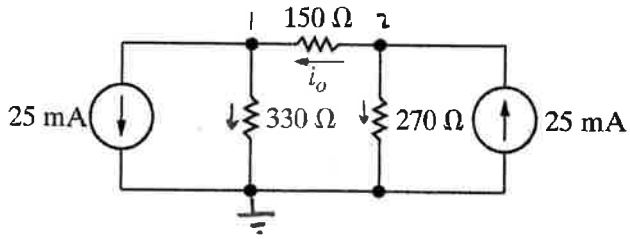
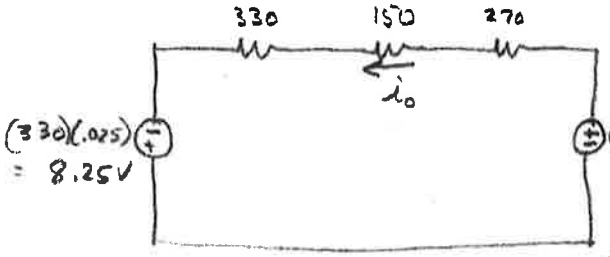
6 pts Find i_O using your method of choice.



1) Source transformations

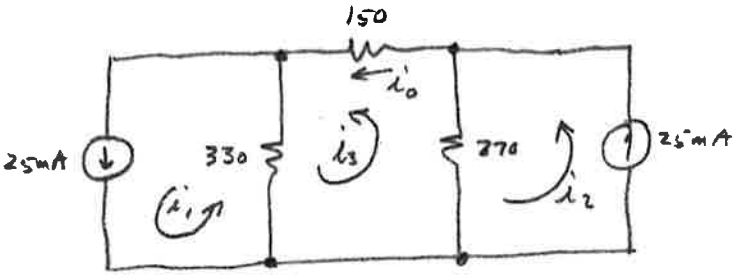


$$i_o = \frac{V}{R} = \frac{8.25 + 6.75}{330 + 150 + 270} = \boxed{20\,mA = i_o}$$

2) mesh equations

$i_1 = 25mA$

$i_2 = 25mA$



mesh i_3: $150i_3 + 330(i_3 - i_1) + 270(i_3 - i_2) = 0$

$$\boxed{i_3 = i_o = 20\ mA}$$

3) NODE equations

node 1: $\frac{V_2 - V_1}{150} = 25mA + \frac{V_1}{330}$

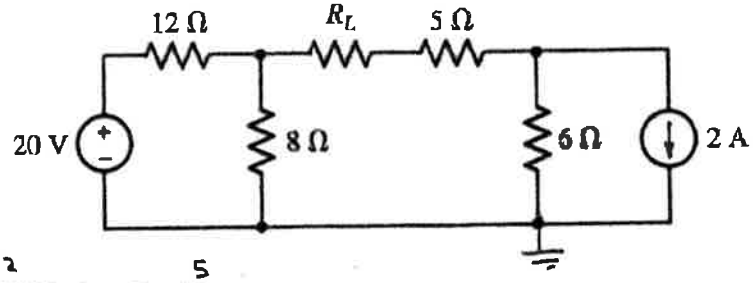
node 2: $25mA = \frac{V_2 - V_1}{150} + \frac{V_2}{270}$

$V_1 = -1.65V$

$V_2 = +1.35V$

$$i_o = \frac{V_2 - V_1}{150} = \underline{\underline{20\,mA}}$$

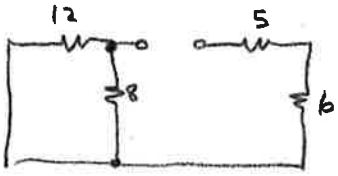
5 pts Find the Thévenin equivalent as seen by R_L



FIND R_{Th}

$R_{Th} = (12 \| 8) + 6 + 5$

$\boxed{R_{Th} = 15.8\,\Omega}$

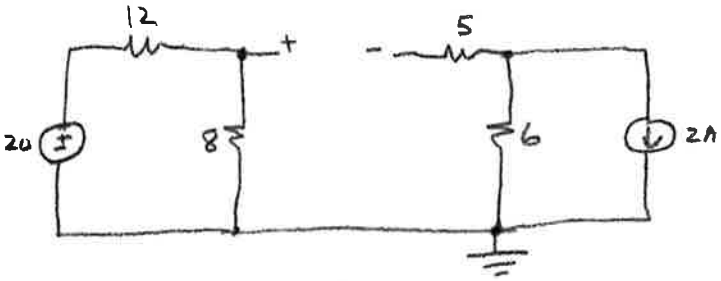


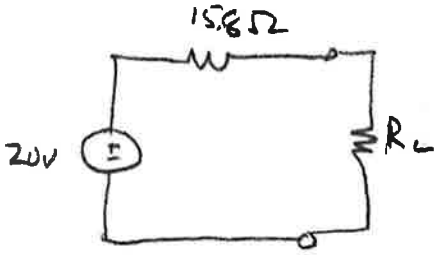
FIND V_{Th}

$V_+ = \frac{20(8)}{12+8} = 8\,V$

$V_- = -(2)(6) = -12\,V$

$V_{Th} = V_+ - (V_-) = \boxed{20\,V}$





1 pt What value of R_L will dissipate the most power?

$R_L = R_{Th} = 15.8\,\Omega$

2 pts Find the maximum power dissipated by R_L

$P = \frac{V_{Th}^2}{4R_L} = \frac{(20)^2}{4(15.8)} = \boxed{6.329\,W}$