ECE 209 — Exam # 2

Estimated time for completion: <75 minutes
27 October 2016

Rules of the Exam

Rule 1: The examination period begins at 11:00am on Thursday 27 October 2016 and ends at 12:15pm on Thursday 27 October 2016.

Rule 2: There are four problems.

Rule 3: Show all work and state all assumptions. Make sure to include the units along with the numerical answer.

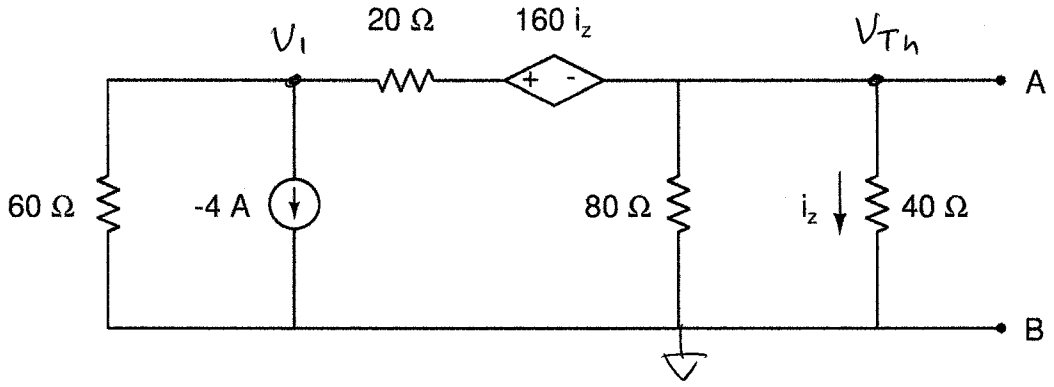
Rule 4: The exam is closed book and closed notes. You may have an 8.5" x 11" sheet of paper with notes. You may use a calculator.

Answer Key

Name

Problem 1 (20 points)

Consider the circuit below:



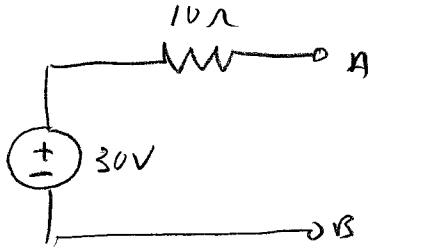
Draw the Thévenin Equivalent Circuit with respect to terminals A and B.

KCL @ V_1: $\frac{V_1}{60} - 4 + \frac{V_1 - V_{Th} - 160 i_z}{20} = 0$

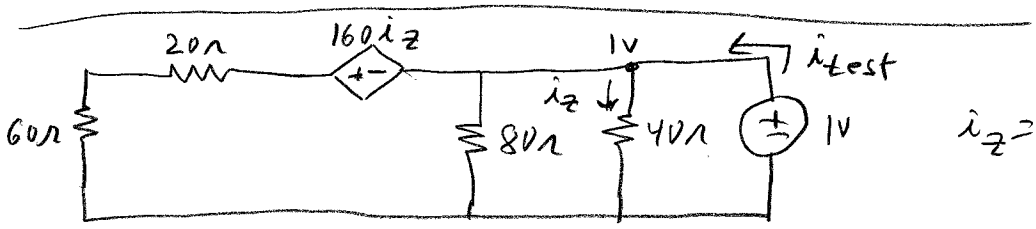
KCL @ V_2: $\frac{V_{Th}}{40} + \frac{V_{Th}}{80} + \frac{V_{Th} + 160 i_z - V_1}{20} = 0$

Constraint: $i_z = \frac{V_{Th}}{40}$

Solve: $\boxed{V_{Th} = 30V}$



Thévenin Equivalent Circuit



$i_z = \frac{1V}{40}$

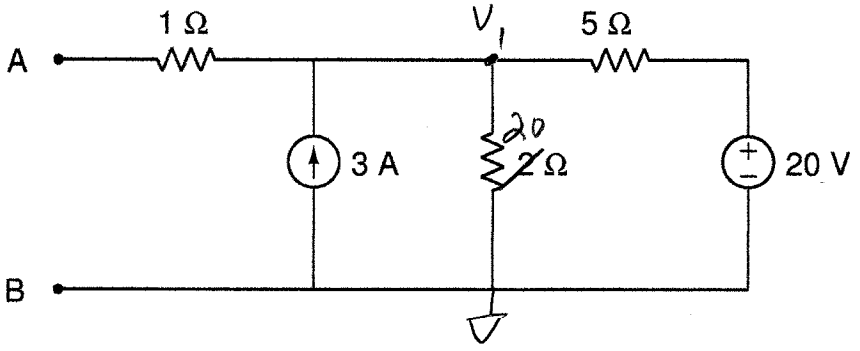
KCL @ 1V node: $\frac{1}{80} + \frac{1}{40} + \frac{1 + 160 i_z}{80} = i_{test}$

$i_{test} = \frac{1}{80} + \frac{1}{40} + \frac{5}{80} = \frac{8}{80} = \frac{1}{10}$

$\boxed{R_{Th} = \frac{1V}{i_{test}} = 10\Omega}$

Problem 2 (30 points)

Consider the circuit below:

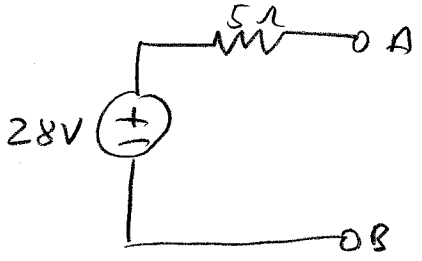


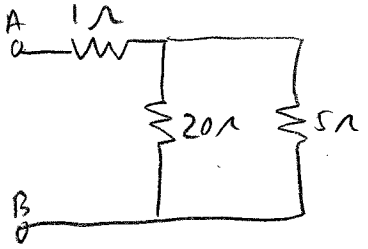
Part A: Draw the Thévenin Equivalent Circuit with respect to terminals A and B.

$V_{AB} = V_1$

KCL @ V_1: $-3 + \frac{V_1}{20} + \frac{V_1 - 20}{5} = 0$

$V_1 = 28\,V$





$R_{TL} = 20 \| 5 + 1 = 5\,\Omega$

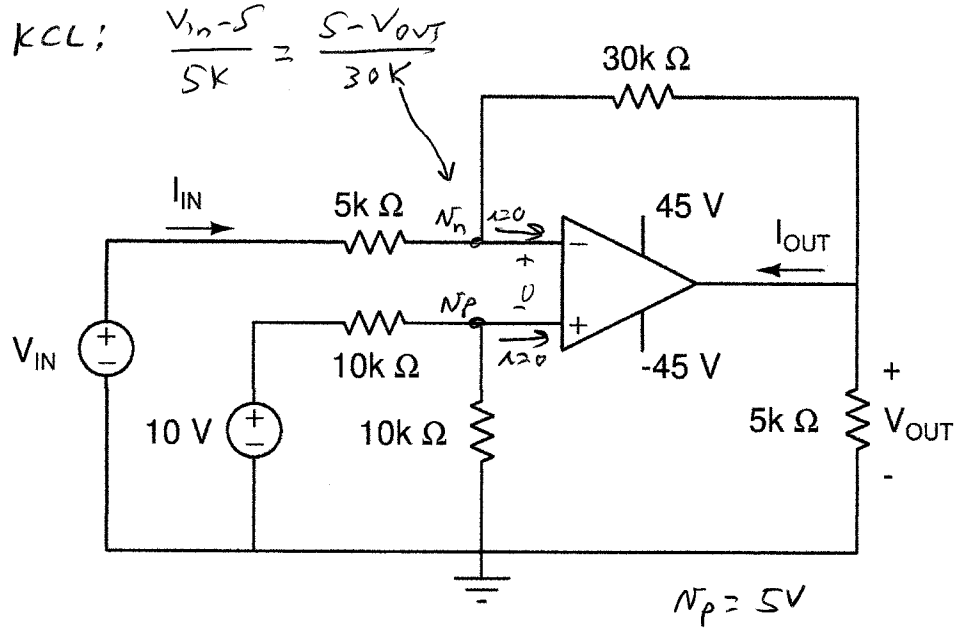
Part B: If a load resistor R_L is placed between terminals A and B:

What value of R_L produces maximum power transfer to the load? $R_L = R_{TL} = 5\,\Omega$

What is the maximum power dissipated by R_L? $P = (28)^2/4R_L = 39.2\,W$

Problem 3 (20 points)

Consider the ideal Op Amp circuit below:



Derive an expression relating V_{OUT} as a function of V_{In}: $V_{out} = 35 - 6V_{in}$

When $V_{IN} = 5$ V, what is the current I_{IN}? $\frac{V_{in}-5}{5K} = \frac{5-5}{5K} = 0A$

$V_{out} = 5V$

When $V_{IN} = 5$ V, what is the current I_{OUT}? $I_{out} = -1mA$

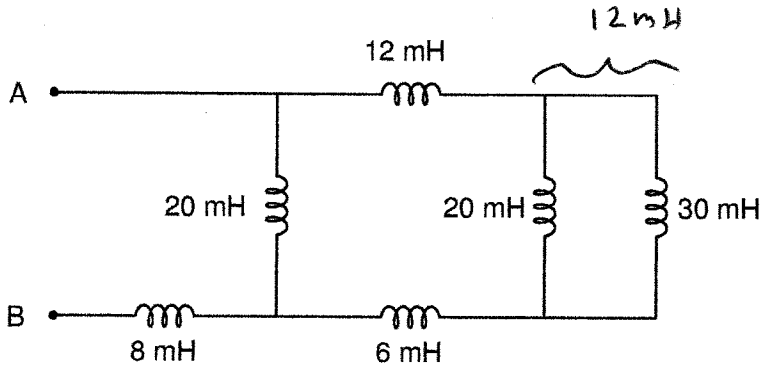
$\frac{5}{5000} + 0 + I_{out} = 0$

Complete the table below:

V_{In}	V_{Out}	
-4 V	45	} Saturation
-2 V	45	
0 V	35	
2 V	23	
4 V	11	

Problem 4 (30 points)

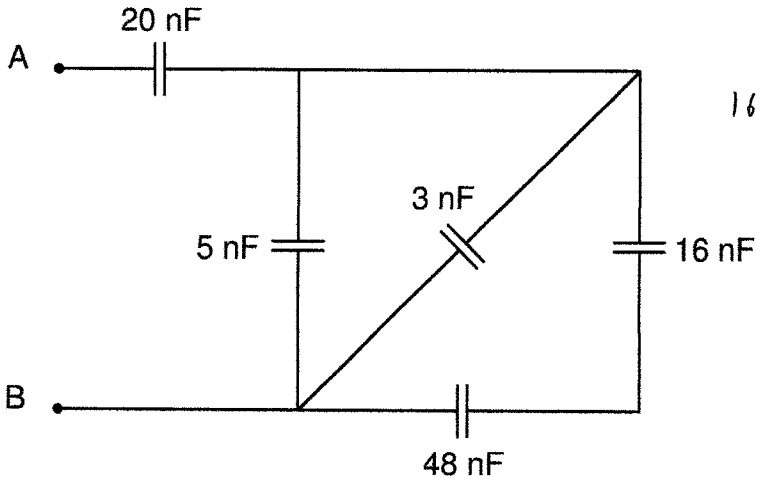
Consider the circuits below:



$20\,mH \,||\, 30\,mH = 12\,mH$

$12\,mH + 8\,mH = 20\,mH$

What is the equivalent capacitance between terminals A and B? 20 mH



$16\,nF + 48\,nF = 12\,nF$

$12\,nF \,||\, 5\,nF \,||\, 3\,nF$

$= 20\,nF$

$20\,nF + 20\,nF = 10\,nF$

What is the equivalent inductance between terminals A and B? 10 nF