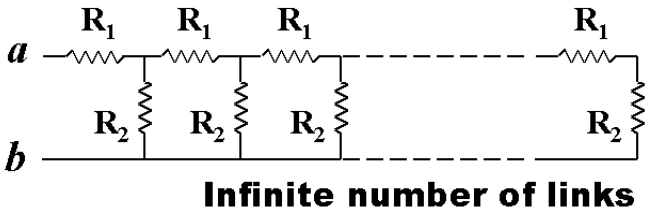
EECS 215 Midterm exam 1

Problem 1

Consider the infinitely long chain of resistors shown on the diagram.



Part 1 (5 points).

Derive the algebraic expression for the equivalent resistance R_{ab} of the infinitely long chain.

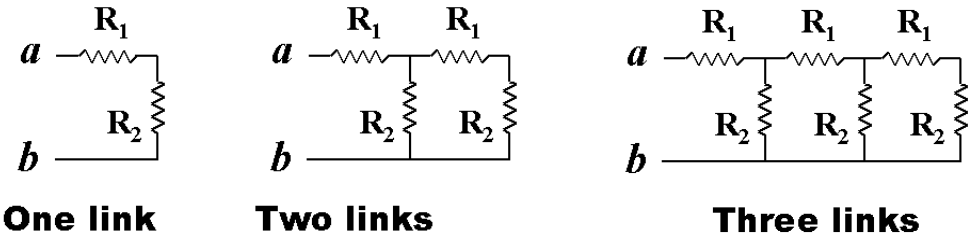
Part 2 (5 points).

Consider $R_1 = 10\ \Omega$ and $R_2 = 100\ \Omega$. Calculate the equivalent resistance R_{ab} of the infinitely long chain shown above.

Part 3 (10 points).

Consider $R_1 = 10\ \Omega$ and $R_2 = 100\ \Omega$. Calculate the equivalent resistance R_{ab} of the short chains shown below.

Notice that you can do this part even if you skipped parts (1) and (2).



Keep 4 significant digits in your calculations and answers.
Write your answers in the box below:

The algebraic expression
for the equivalent resistance R_{ab}
of the infinitely long chain is: _____

The equivalent resistance R_{ab}
of the infinitely long chain is: _____ Ω

The equivalent resistance R_{ab}
of the one-link chain is: _____ Ω

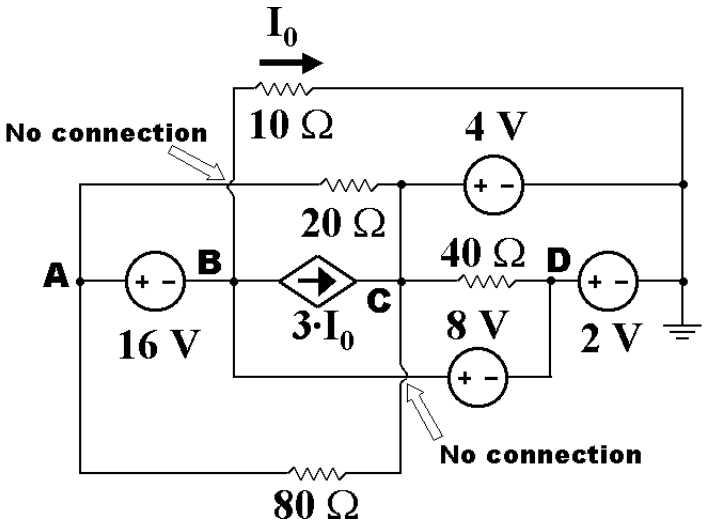
The equivalent resistance R_{ab}
of the two-link chain is: _____ Ω

The equivalent resistance R_{ab}
of the three-link chain is: _____ Ω

Show your work. Your solution should justify your answers.
If you need more space, get additional pages from your instructor.

Problem 2

Consider the circuit shown on the diagram.



Part 1 (5 points).
Obtain the node voltages V_A, V_B, V_C, and V_D.

Part 2 (5 points).
Obtain the power absorbed by the dependent current source.

Part 3.
Obtain the power absorbed by each independent voltage source. **(2.5 points for each source thus 10 points for Part 3.)**

Comments.

1. Use the passive sign convention: absorbed power is positive, supplied power is negative.
2. **Do <u>not</u> spend too much time on Part 3** at the expense of solving other problems.

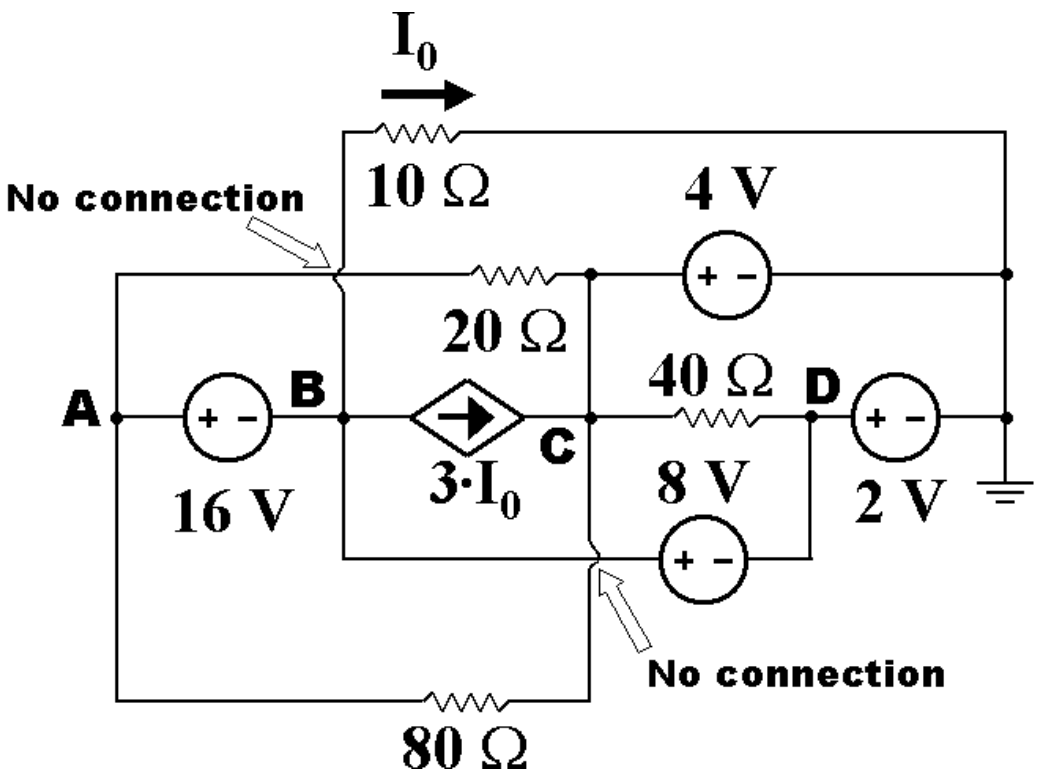
Write your answers in the box below. Your solution should justify your answers.

Node voltages: $V_A =$ _____ *(remember the units!)*
$V_B =$ _____
$V_C =$ _____
$V_D =$ _____

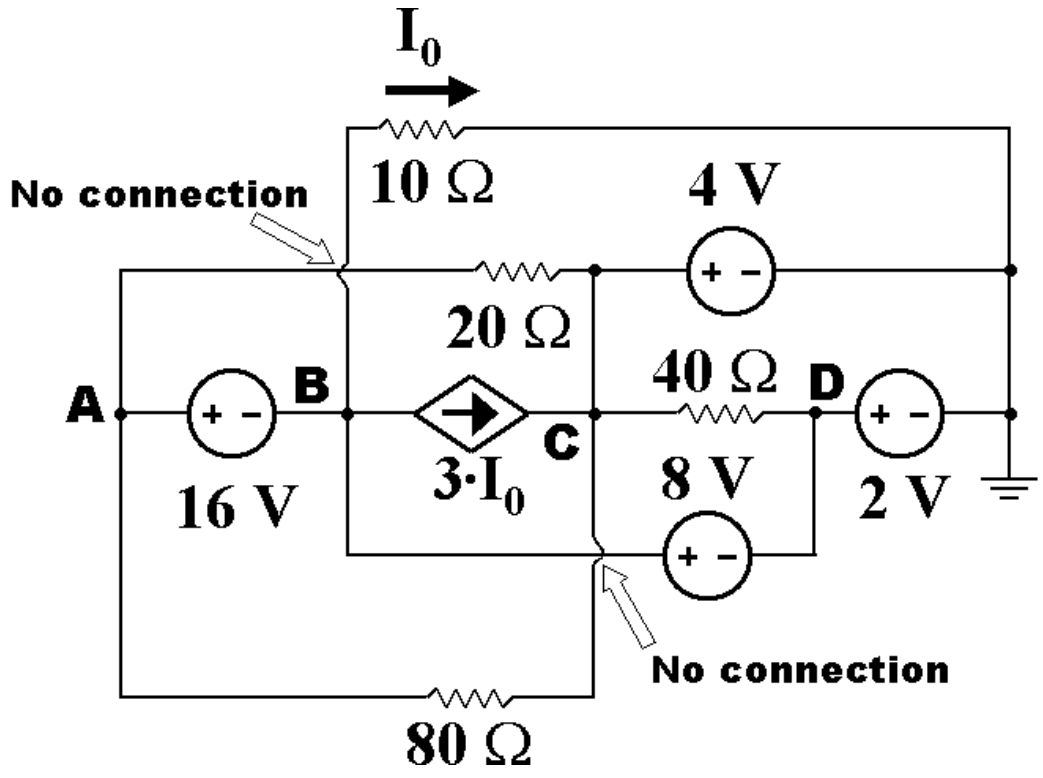
Power absorbed by the dependent current source:
$P_{3I} =$_____ *(remember the units and the sign!)*

Power absorbed by the independent voltage sources:
$P_{2V} =$ _____ *(remember the units and the signs!)*
$P_{4V} =$ _____
$P_{8V} =$ _____
$P_{16V} =$ _____

Additional Workspace for Problem 2



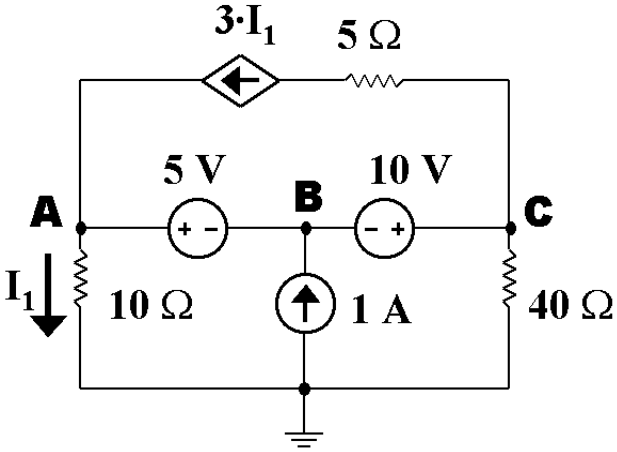
Additional Workspace for Problem 2



Problem 3

This problem has 4 parts.
Part 4, which requires mesh current equations, is on the following page.
You can do Part 4 even if you skip Part 1.

Consider the circuit shown on the diagram.



Part 1 (5 points).
Obtain the node voltages V_A, V_B and V_C by solving **node voltage equations.**

Part 2 (5 points).
Calculate the power absorbed by each independent source. Use the passive sign convention: supplied power is negative.

Part 3 (5 points).
Calculate the power absorbed by the dependent source. Check the power balance.

Part 3 is on the following page!

Keep 4 significant digits in your calculations and answers.
Write your answers in the box below:

The node voltage V_A equals: _____ Volts
The node voltage V_B equals: _____ Volts
The node voltage V_C equals: _____ Volts

The power absorbed by the 5-V source equals: _____ W

The power absorbed by the 10-V source equals: _____ W

The power absorbed by the 1-A source equals: _____ W

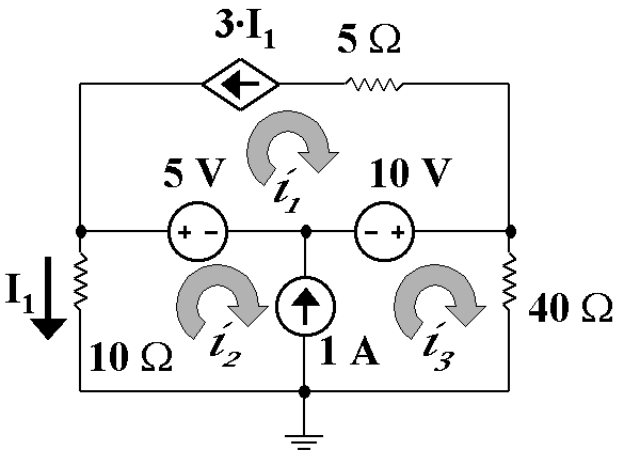
The power absorbed by the dependent source equals: _____ W

Show your work. Your solution should justify your answers.
If you need more space, get additional pages from your instructor.

Problem 3, continued

This problem has 4 parts.
Here is Part 4.
You can do Part 4 even if you skipped Part 1.
If you skipped Part 1, use the results of Part 4 to complete Parts 2 and 3.

Consider the circuit shown on the diagram. This is the same circuit as in the first parts of Problem 3.



Part 4 (5 points).

Obtain the mesh currents i_1 , i_2, and i_3 , and the current I_1 by solving mesh current equations.

Write your results in the box below:

The mesh current i_1 equals _____ A

The mesh current i_2 equals _____ A

The mesh current i_3 equals _____ A

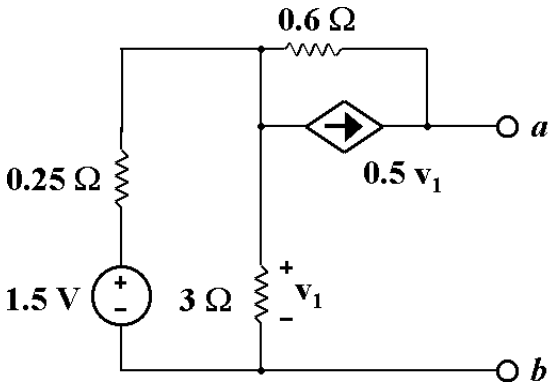
The current I_1 equals _____ A

Show your work. Your solution should justify your answers.

Workspace for Problem 3

Problem 4

Consider the circuit shown on the diagram.



Part 1 (10 points).

Obtain the open-circuit voltage, the short-circuit current, and the Thevenin equivalent resistance at the terminals a and b.

Part 2 (5 points).

Draw the **both** Thevenin and Norton equivalent circuits in the boxes below.
On each circuit diagram clearly write the numerical values of resistance, voltage and/or current; label the terminals a and b.

Part 3 (5 points).

Calculate what load resistor (in Ω) dissipates the maximal power, and the maximal power (in W) that can be dissipated in the load connected to the terminals a and b.

Write your answers in the box below:

The open-circuit voltage at a and b equals: _____ Volts

The short-circuit current at a and b equals: _____ Amps

Thevenin equivalent resistance at a and b equals: _____ Ω

Thevenin equivalent circuit (draw it in this box)	Norton equivalent circuit (draw it in this box)

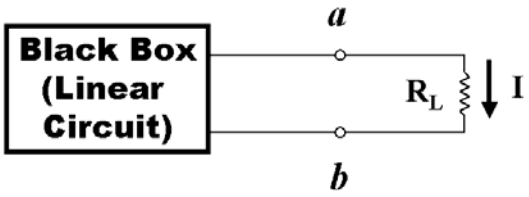
Load resistance, which ensures the maximal power transfer, equals _____ Ω

The maximal power dissipated in the load resistor equals _____ W

Show your work.
Your solution should justify your answers.
If you need more space, get additional pages from your instructor.

Problem 5

The linear circuit (black box) is connected to the load resistor R_L at the terminals a and b as shown on the diagram.



If the $R_L = 2\ k\Omega$, then the current through the load equals $I = 8\ mA$.
If the $R_L = 5\ k\Omega$, then the current through the load equals $I = 4\ mA$.

Part 1 (5 points) .

On the grid provided in the workspace, plot the current-voltage characteristic of the circuit.
Clearly label the axes (Voltage, Current), indicate the units of measure and the numerical values.
Clearly label the numerical values of both intersect points with the axes and of the slope of the line.

Part 2 (5 points).

From your plot, obtain the open-circuit voltage, the short-circuit current, and the Thevenin equivalent resistance.
To make clear how exactly you obtained them, add formulas and/or labels to the plot.

Part 3 (5 points).

Obtain the open-circuit voltage, the short-circuit current, and the Thevenin equivalent resistance at the terminals a and b **algebraically** from the values given in the assignment.

Part 4 (5 points).

Draw the **both** Thevenin and Norton equivalent circuits in the boxes below. On each circuit diagram clearly write the numerical values of resistance, voltage, and current, label the terminals a and b.

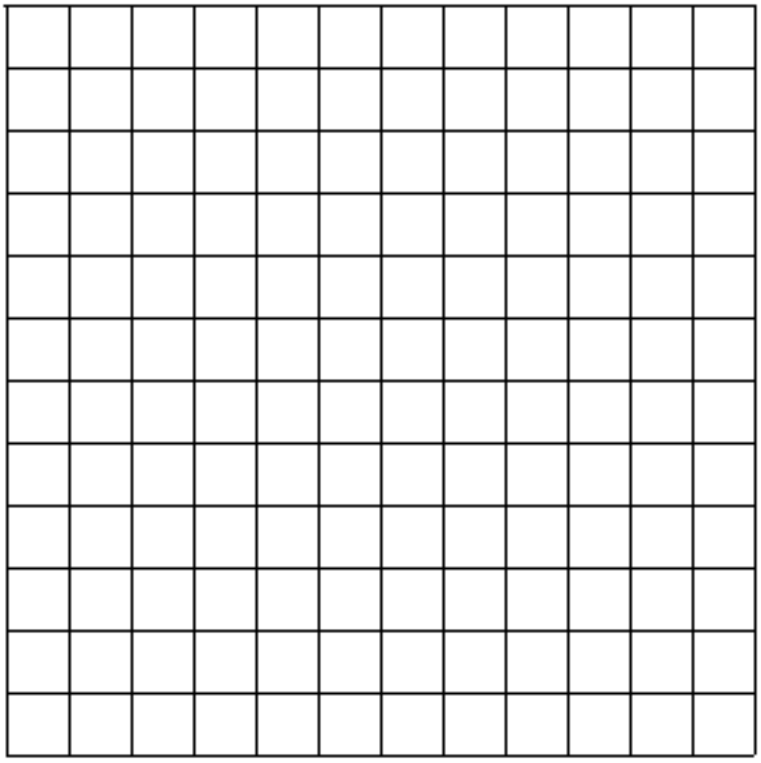
Write your answers in the boxes below and on the following page.

Values obtained from your plot:
Thevenin equivalent resistance at a and b equals: _____ kΩ
The open-circuit voltage at a and b equals: _____ Volts
The short-circuit current at a and b equals: _____ Amps

Values obtained from algebraic calculations:
Thevenin equivalent resistance at a and b equals: _____ kΩ
The open-circuit voltage at a and b equals: _____ Volts
The short-circuit current at a and b equals: _____ Amps

Thevenin equivalent circuit (draw it in this box)	Norton equivalent circuit (draw it in this box)

Show your work. Your solution should justify your answers.



If you need more workspace or a new grid, get additional pages from your instructor.

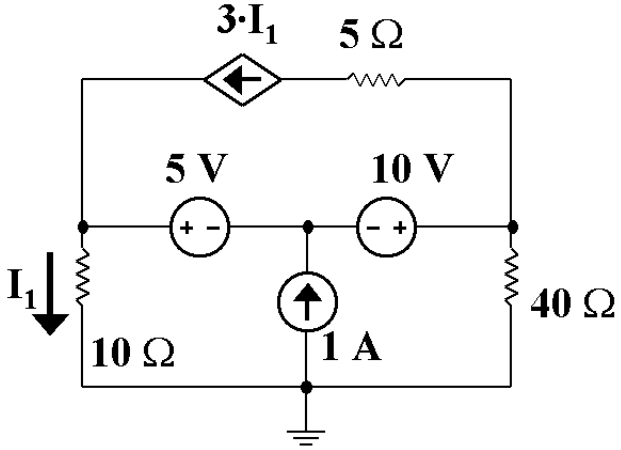
Advice on Exam Time Management

You are given a 2-hour (120 minutes) exam that costs 100 points. The exam has 5 problems, 20 points each.

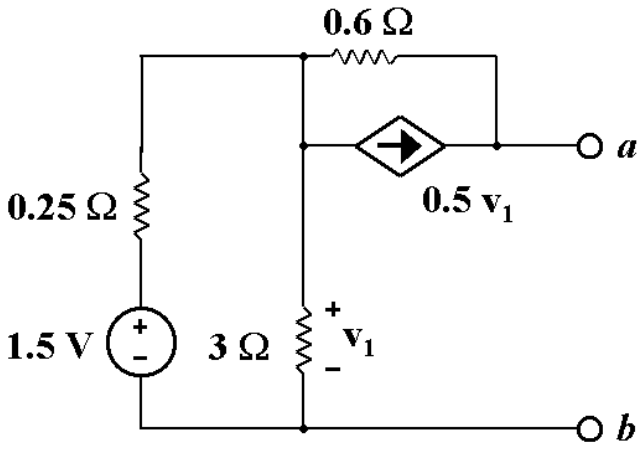
Allot time to work on every problem. **Work on each problem for no more than 20 minutes – then move to the next one.**

Then at the end of the exam you will have at least 20 minutes left, which you can use to double check your results and/or complete the problems you left undone.

Additional Workspace for Problem 3



Additional Workspace for Problem 4



Additional Workspace for Problem 5