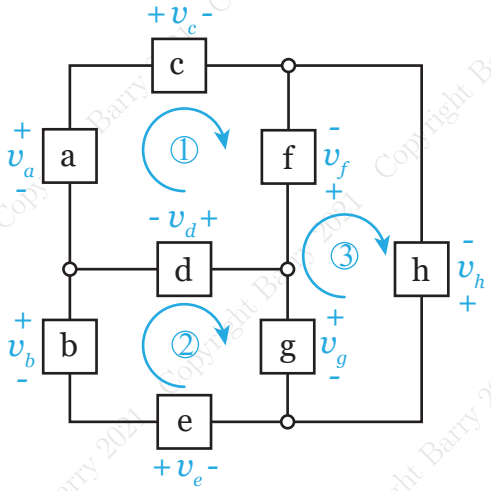
MEMS 0031 - Electrical Circuits
Quiz #1
Assigned: February 8th, 2021
Due: February 12th, 2021, 9:00 pm

Name: _____

Intermediate Problem #1

(1 pt) Using Kirchhoff's Voltage Law, construct equations for Loops (1) through (3):



Loop 1:

$$-V_a + V_c - V_f + V_d = 0$$

Loop 2:

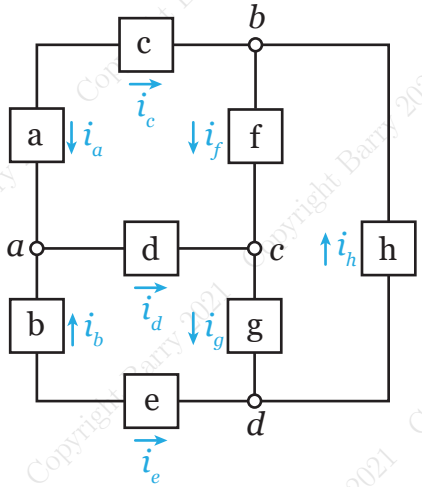
$$-V_b - V_d + V_g - V_e = 0$$

Loop 3:

$$-V_g + V_f - V_h = 0$$

Intermediate Problem #2

(1 pt) Using Kirchhoff's Current Law, construct equations for nodes a through d:



Node a:

$$i_a + i_b = i_d$$

Node b:

$$i_c + i_h = i_f$$

Node c:

$$i_d + i_f = i_g$$

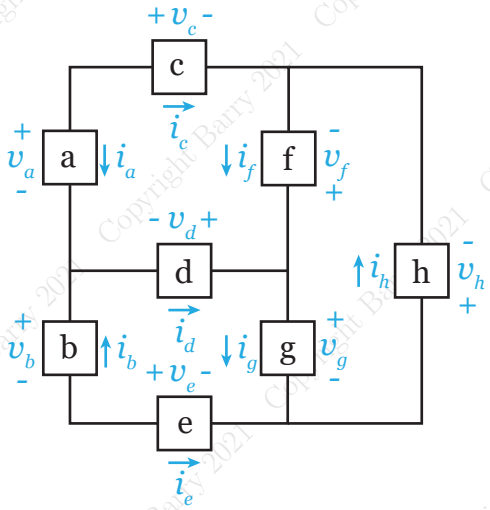
Node d:

$$i_e + i_g = i_h$$

Intermediate Problem #3

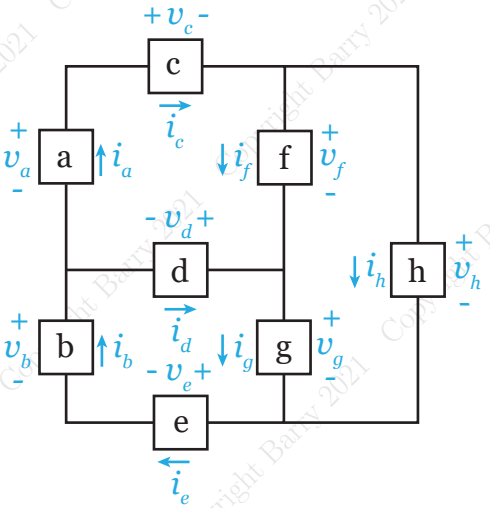
(1 pt) Consider the following circuit, with listed voltage potential and current values. Using the principle of conservation of electrical energy, determine which value, either current or voltage, that is incorrect for the circuit shown below.

	[V]	[A]
a	120	-10
b	120	9
c	10	10
d	10	1
e	-10	-9
f	-100	5
g	120	4
h	-220	-5



We will construct a table looking at each element and determine if it is dissipating or supplying power, once we apply the negative signs associated with the voltage potentials and currents.

	[V]	[A]	P_{supp} [W]	P_{diss} [W]
a	120	10	1,200	-
b	120	9	1,080	-
c	10	10	-	100
d	10	1	10	-
e	10	9	-	90
f	100	5	-	500
g	120	4	-	480
h	220	5	-	1,100

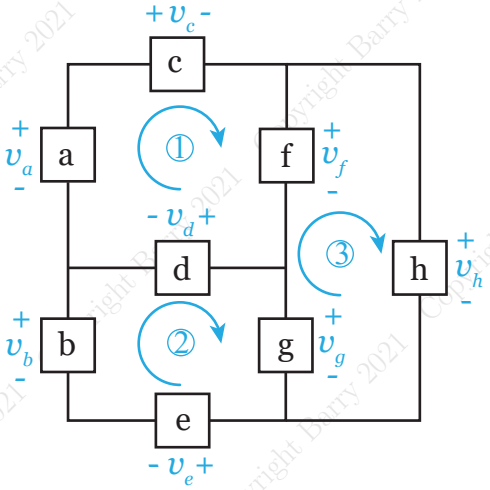


We see the power supplied is 2,290 [W] and the power dissipated is 2,270 [W]. Thus, the reasonable conclusion is element d is behaving incorrectly - element d should be dissipating power. Doing such, we would supply 2,280 [W] and dissipate 2,280 [W]. We need to check our KVL and KCL equations to determine if we need to change the voltage potential or direction of current.

Challenge Problem #1

(2 pt) Based upon the results obtained from Intermediate Problem #3, and the equations cast in Intermediate Problems #1 and #2, ensure all KVL, KCL and conservation equations are satisfied.

Using the modified schematic from Intermediate Problem #3 and the associated table:



Loop 1:

$$-V_a + V_c + V_f + V_d = 0$$

$$\implies (-120 + 10 + 100 + 10)\,[\text{V}] = 0$$

This tells us V_d is correct. Loop 2:

$$-V_b - V_d + V_g + V_e = 0$$

$$\implies (-120 - 10 + 120 + 10)\,[\text{V}] = 0$$

Loop 3:

$$-V_g - V_f + V_h = 0$$

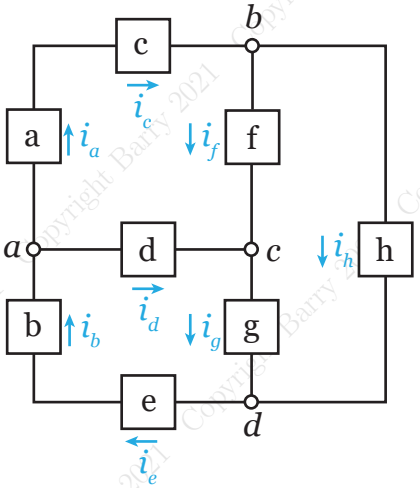
$$\implies (-120 - 100 + 220)\,[\text{V}] = 0$$

Node a:

$$i_b = i_a + i_d$$

$$\implies 9\,[\text{A}] = (10 + 1)\,[\text{A}]$$

This equality is incorrect. Thus, i_d must go the other direction. As seen with the KVL Loop ①, V_d was found to be correct. Thus, changing the direction of i_d will satisfy KCL and the Conservation of Electrical Power equation.



Node b:

$$i_c = i_f + i_h$$

$$\implies 10\,[\text{A}] = (5 + 5)\,[\text{A}]$$

Node c:

$$i_d + i_f = i_g$$

$$\implies (1 + 5)\,[\text{A}] = 4\,[\text{A}]$$

Once again, we have cofirmation i_d is existing in the wrong direction.

Node d:

$$i_g + i_h = i_e$$

$$\implies (4 + 5)\,[\text{A}] = 9\,[\text{A}]$$