Quiz I ECSE 1010 **Fall 2017**

Name ________________________________

Part B (80 Points)

1. (10 Pts) _________
2. (8 Pts) _________
3. (16 Pts) _________
4. (7 Pts) _________
5. (12 Pts) _________
6. (16 Pts) _________
7. (11 Pts) _________

Total __________________

Be sure to simplify circuits into standard forms.

For partial credit in some question, you may want to re-draw circuit diagrams as you simplify the circuits.

For partial credit, you may want to annotate plots, even when the problem does not ask you to do this.

Show all of your work. Use the backs of pages if there is not enough room on the front.

Almost all problems can be solved using more than one method. Check your answers by using a second method.

At least skim through the entire quiz before you begin and then start with the problems you know best.

The proctor will only answer clarification questions where wording is unclear or where there may be errors/typos. No other questions will be responded to.

Inductance Specs – From Digilent Parts Kit Website

Electrical Specifications (@ 25 °C)

Part Number	Inductance (μH)	Tol.	Q (Min.)	Test Frequency L	Test Frequency Q	SRF (MHz) Typ.	DCR (Ω) Max.	I dc (A)
RL622-1R0K-RC	1.0	±10 %	20	7.96 MHz	7.96 MHz	150	0.013	10
RL622-1R5K-RC	1.5	±10 %	20	7.96 MHz	7.96 MHz	130	0.016	8.5
RL622-2R2K-RC	2.2	±10 %	20	7.96 MHz	7.96 MHz	100	0.021	6.5
RL622-3R3K-RC	3.3	±10 %	20	7.96 MHz	7.96 MHz	79	0.025	5.5
RL622-4R7K-RC	4.7	±10 %	20	7.96 MHz	7.96 MHz	51	0.030	4.3
RL622-6R8K-RC	6.8	±10 %	20	7.96 MHz	7.96 MHz	29	0.035	3.7
RL622-100K-RC	10	±10 %	50	2.52 MHz	2.52 MHz	14	0.045	3.0
RL622-120K-RC	12	±10 %	50	2.52 MHz	2.52 MHz	13	0.050	2.7
RL622-150K-RC	15	±10 %	40	2.52 MHz	2.52 MHz	12	0.056	2.3
RL622-180K-RC	18	±10 %	40	2.52 MHz	2.52 MHz	11	0.061	2.2
RL622-220K-RC	22	±10 %	40	2.52 MHz	2.52 MHz	9.2	0.070	2.0
RL622-270K-RC	27	±10 %	30	2.52 MHz	2.52 MHz	8.5	0.080	1.7
RL622-330K-RC	33	±10 %	30	2.52 MHz	2.52 MHz	7.8	0.090	1.6
RL622-390K-RC	39	±10 %	30	2.52 MHz	2.52 MHz	6.9	0.10	1.5
RL622-470K-RC	47	±10 %	30	2.52 MHz	2.52 MHz	6.5	0.16	1.4
RL622-560K-RC	56	±10 %	30	2.52 MHz	2.52 MHz	5.4	0.18	1.3
RL622-680K-RC	68	±10 %	30	2.52 MHz	2.52 MHz	4.9	0.21	1.2
RL622-820K-RC	82	±10 %	30	2.52 MHz	2.52 MHz	4.1	0.23	1.1
RL622-101K-RC	100	±10 %	20	796 KHz	796 KHz	3.7	0.28	0.91
RL622-121K-RC	120	±10 %	20	796 KHz	796 KHz	3.4	0.32	0.84
RL622-151K-RC	150	±10 %	20	796 KHz	796 KHz	3.2	0.37	0.75
RL622-181K-RC	180	±10 %	20	796 KHz	796 KHz	2.8	0.58	0.69
RL622-221K-RC	220	±10 %	20	796 KHz	796 KHz	2.7	0.65	0.64
RL622-271K-RC	270	±10 %	20	796 KHz	796 KHz	2.4	0.75	0.57
RL622-331K-RC	330	±10 %	20	796 KHz	796 KHz	2.3	0.85	0.54
RL622-391K-RC	390	±10 %	20	796 KHz	796 KHz	2.1	1.0	0.48
RL622-471K-RC	470	±10 %	20	796 KHz	796 KHz	1.9	1.1	0.46
RL622-561K-RC	560	±10 %	20	796 KHz	796 KHz	1.8	1.4	0.41
RL622-681K-RC	680	±10 %	20	796 KHz	796 KHz	1.6	1.6	0.38
RL622-821K-RC	820	±10 %	20	796 KHz	796 KHz	1.5	1.8	0.38
RL622-102K-RC	1000	±10 %	50	252 KHz	252 KHz	1.3	2.9	0.29
RL622-122K-RC	1200	±10 %	50	252 KHz	252 KHz	1.1	4.0	0.13
RL622-152K-RC	1500	±10 %	20	252 KHz	252 KHz	1.0	6.1	0.08
RL622-182K-RC	1800	±10 %	20	252 KHz	252 KHz	1.0	6.4	0.08
RL622-222K-RC	2200	±10 %	20	252 KHz	252 KHz	0.9	6.8	0.08
RL622-272K-RC	2700	±10 %	20	252 KHz	252 KHz	0.9	7.7	0.08
RL622-332K-RC	3300	±10 %	20	252 KHz	252 KHz	0.7	9.0	0.08
RL622-392K-RC	3900	±10 %	20	252 KHz	252 KHz	0.6	14	0.08
RL622-472K-RC	4700	±10 %	20	252 KHz	252 KHz	0.5	16	0.05
RL622-562K-RC	5600	±10 %	20	252 KHz	252 KHz	0.4	18	0.05
RL622-682K-RC	6800	±10 %	20	252 KHz	252 KHz	0.4	19	0.05
RL622-822K-RC	8200	±10 %	20	252 KHz	252 KHz	0.3	21	0.05
RL622-103K-RC	10,000	±10 %	40	79.6 KHz	79.6 KHz	0.3	25	0.05

Standard Resistor Values (±5%)						
1.0	10	100	1.0K	10K	100K	1.0M
1.1	11	110	1.1K	11K	110K	1.1M
1.2	12	120	1.2K	12K	120K	1.2M
1.3	13	130	1.3K	13K	130K	1.3M
1.5	15	150	1.5K	15K	150K	1.5M
1.6	16	160	1.6K	16K	160K	1.6M
1.8	18	180	1.8K	18K	180K	1.8M
2.0	20	200	2.0K	20K	200K	2.0M
2.2	22	220	2.2K	22K	220K	2.2M
2.4	24	240	2.4K	24K	240K	2.4M
2.7	27	270	2.7K	27K	270K	2.7M
3.0	30	300	3.0K	30K	300K	3.0M
3.3	33	330	3.3K	33K	330K	3.3M
3.6	36	360	3.6K	36K	360K	3.6M
3.9	39	390	3.9K	39K	390K	3.9M
4.3	43	430	4.3K	43K	430K	4.3M
4.7	47	470	4.7K	47K	470K	4.7M
5.1	51	510	5.1K	51K	510K	5.1M
5.6	56	560	5.6K	56K	560K	5.6M
6.2	62	620	6.2K	62K	620K	6.2M
6.8	68	680	6.8K	68K	680K	6.8M
7.5	75	750	7.5K	75K	750K	7.5M
8.2	82	820	8.2K	82K	820K	8.2M
9.1	91	910	9.1K	91K	910K	9.1M

Type	R_{int} (Ω)	V_{oc} (V)	Capacity[a] continuous, to 1V/cell (mAh)	@ (mA)	(mAh)	@ (mA)	Size (in)	Weight (gm)	Connec[b]	Comments
9V "1604"										
Le Clanche	35	9	300	1	160	10	0.65x1x1.9	35	S	
Heavy Duty	35	9	400	1	180	10	"	40	S	
Alkaline	2	9	500	1	470	10	"	55	S	280mAh@100mA
Lithium	18	9	1000	25	950	80	"	38	S	Kodak Li-MnO_2

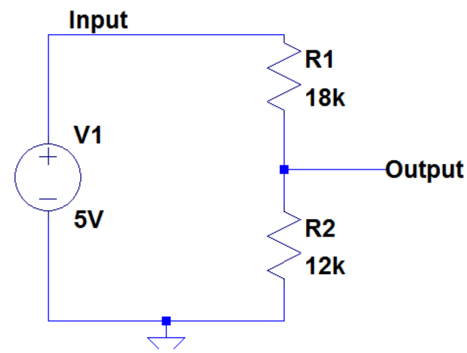
Capacitance Standard Values

These fixed capacitor values are the most commonly found										
pF	pF	pF	pF	μF	μF	μF	μF	μF	μF	μF
1.0	10	100	1000	0.01	0.1	1.0	10	100	1000	10,000
1.1	11	110	1100							
1.2	12	120	1200							
1.3	13	130	1300							
1.5	15	150	1500	0.015	0.15	1.5	15	150	1500	
1.6	16	160	1600							
1.8	18	180	1800							
2.0	20	200	2000							
2.2	22	220	2200	0.022	0.22	2.2	22	220	2200	
2.4	24	240	2400							
2.7	27	270	2700							
3.0	30	300	3000							
3.3	33	330	3300	0.033	0.33	3.3	33	330	3300	
3.6	36	360	3600							
3.9	39	390	3900							
4.3	43	430	4300							
4.7	47	470	4700	0.047	0.47	4.7	47	470	4700	
5.1	51	510	5100							
5.6	56	560	5600							
6.2	62	620	6200							
6.8	68	680	6800	0.068	0.68	6.8	68	680	6800	
7.5	75	750	7500							
8.2	82	820	8200							
9.1	91	910	9100							

Problem 1 (10 Points) – Basic Voltage Divider

A voltage divider consisting of two resistors and a DC voltage source is configured as shown.

a. Determine the output voltage across **R2** (in Volts)



b. Determine the power delivered to the resistor **R1** (in milli-Watts)

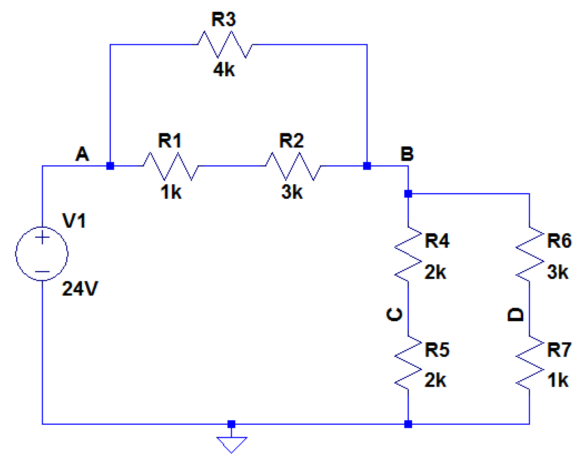
Problem 2 (8 Points) – Measurements

The Discovery Board is used to measure the input (Channel 1) and output (Channel 2) voltages in the previous problem. Additionally, the Discovery Board is used to produce the 5V source. In the following table, indicate what wire connections are used on the Discovery Board and the associated color. There are more rows in the table than you need. On the circuit diagram, indicate where those connections go using the shorthand labels on the Discovery Board, eg. 1+, 1- , etc.. *There is more than one correct answer.*

Wire Connection	Color

Problem 3 (16 Points) – A Bit More Complicated Voltage Divider

A somewhat more complicated voltage divider, consisting of more than the usual two resistors and DC source, is configured as shown.

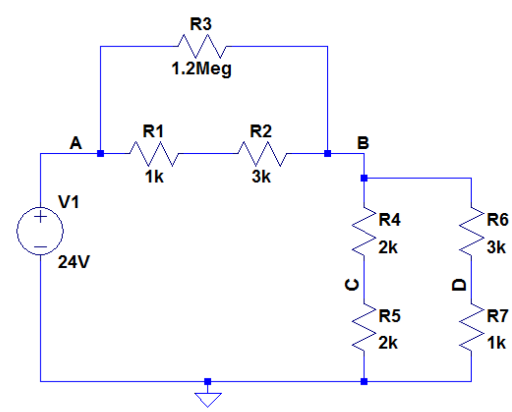


a. (6 pts) Determine the voltages at **B** and **D** (in Volts)

b. (4 pts) Determine the current through **R5** (in milli-Amps)

The circuit is modified by replacing the 4kΩ resistor R3 with a 1.2MegΩ resistor.

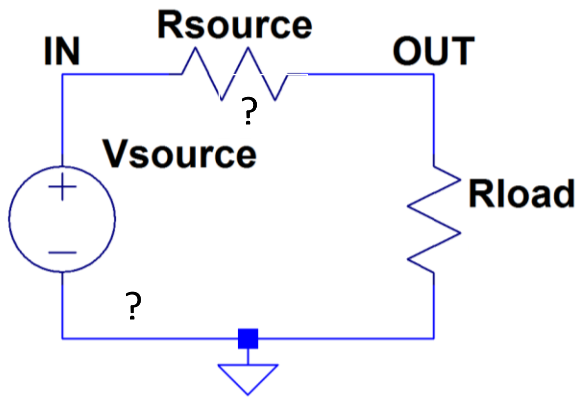
c. (3 pts) Determine the voltage at **B** (in Volts)



d. (3 pts) Determine the current through **R2** (in milli-Amps)

Problem 4 (7 Points) – Source Characterization Using a Voltage Divider

Batteries and other voltage sources can generally be modeled by combining an ideal voltage source and a resistor. The circuit at the right is set up to study some kind of a black box DC voltage source. Thirteen different load resistors are connected and the voltage V(OUT) is measured. The results of the thirteen trials are listed in the table below. *Note that there is more information than you need to find the source voltage and resistance.*



Trial	Rload	V(OUT)
1	1Ω	0.16V
2	5Ω	0.86V
3	10Ω	1.74V
4	50Ω	6.0V
5	100Ω	8.61V
6	500Ω	13.20V
7	1kΩ	13.98V
8	5kΩ	14.82V
9	10kΩ	14.92V
10	50kΩ	14.99V
11	100kΩ	14.99V
12	500kΩ	15.0V
13	1MΩ	15.0V

a. Determine the source voltage **Vsource** (in Volts)

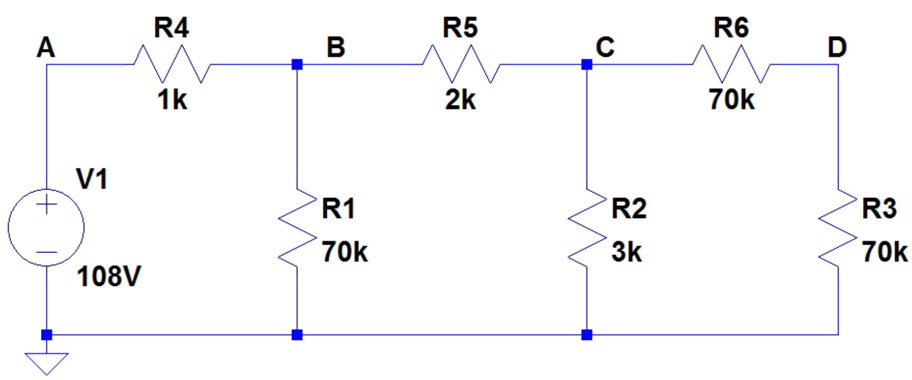
b. Determine the source resistance **Rsource** (in Ohms)

Problem 5 (12 Points) – Resistor Ladder Circuit

A more complex circuit is formed by essentially connecting two voltage dividers. The voltage source is 108V DC, so that is the input voltage. The remainder of the circuit is built with resistor values: 1kΩ, 2kΩ, 3kΩ and 70kΩ.

a. (2 pts) Before beginning the analysis of this circuit, answer the following two general questions for arbitrary resistors R_A and R_B:
   i. What is the approximate value for the series combination of two resistors, R_A and R_B, when $R_A >> R_B$?

   ii. What is the approximate value for the parallel combination of two resistors, R_A and R_A, when $R_A >> R_B$?



b. (2 pts) Assume that you built the circuit and were able to measure the actual voltages only at nodes B and C and (94.1V and 69.1V, respectively). Determine the voltage at node D.

c. (2 pts) The circuit above was designed without checking to be sure the resistor values chosen were standard values. Check the values selected and change any non-standard values to the closest standard value and indicate the changes on the circuit diagram.

d. (3 pts) Using your modified circuit and the approximations of part a, find approximate values for the voltages at nodes B, C, D). This will give you reasonable estimates of the actual voltages.

Problem 6 (16 Points) – Conceptual Questions

This problem contains some conceptual questions. The following addresses how to approach such questions, provided in the unlikely event that you have not seen such questions before.

A **conceptual question** is designed to help determine whether a student has an accurate working knowledge of a specific set of concepts. For example, from the background quiz you completed on the first day of class:
A 9V battery is connected across a 2kΩ resistor. If the resistor is replaced with a 10kΩ resistor, will the current from the battery

a. Increase
b. Decrease
c. Stay about the same

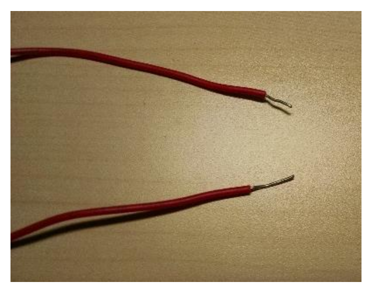
This question tests conceptual knowledge of Ohm's Law. It can most rigorously be answered by recalling the relationship between voltage, current and resistance (the three parameters mentioned directly or indirectly in the question). $I = \frac{V}{R}$. From this expression a larger R will produce a smaller I for the same voltage (9V in this case). The answer does not depend on the exact values of the two resistances, only that a resistor is replaced with one that is larger. Then the current will be smaller, so the answer is b. Decrease.

Conceptual Questions: The answers for all questions are worth (2 pts) each, except where noted.

Remember to briefly explain your answers.

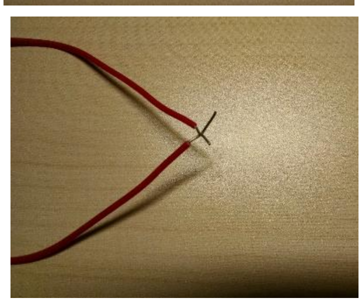
a) Is the image shown at the right

1. A short circuit?
2. An open circuit?

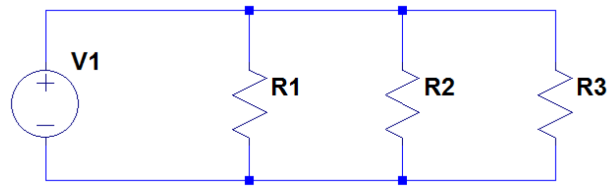


b) Is the image shown at the right

1. A short circuit?
2. An open circuit?



c) For the circuit shown to the right, which of the following are true (circle any correct answers)



1. $V_{R1} = V_{R2}$
2. $V_{R2} = V_{R3}$
3. $V_{R1} = V_{R3}$
4. None of the above

d) For the same circuit shown above, which of the following are true (circle any correct answers)

1. $I_{R1} = I_{R2}$
2. $I_{R2} = I_{R3}$
3. $I_{R1} = I_{R3}$
4. None of the above

A: Increasing R1	B: Decreasing R1
C: Increasing R2	D: Decreasing R2
E: Increasing C	F: Decreasing C

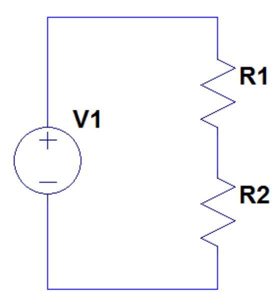
e) When considering the 555 Timer circuit and the above list of possibilities, holding all other values constant, the **time high** can be **increased** by (indicated all correct possibilities)

(list of letters): ________________________________

f) When considering the 555 Timer circuit and the above list of possibilities, holding all other values constant, the **duty cycle** can be **decreased** by (indicated all correct possibilities)

(list of letters): ________________________________

For the voltage divider circuit shown to the right

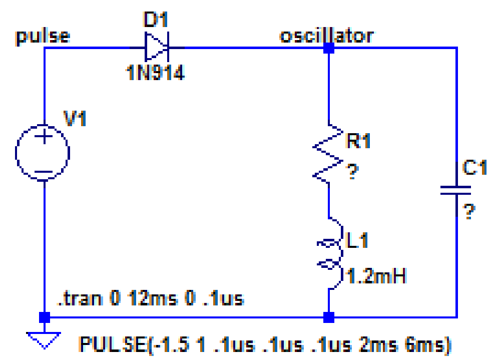


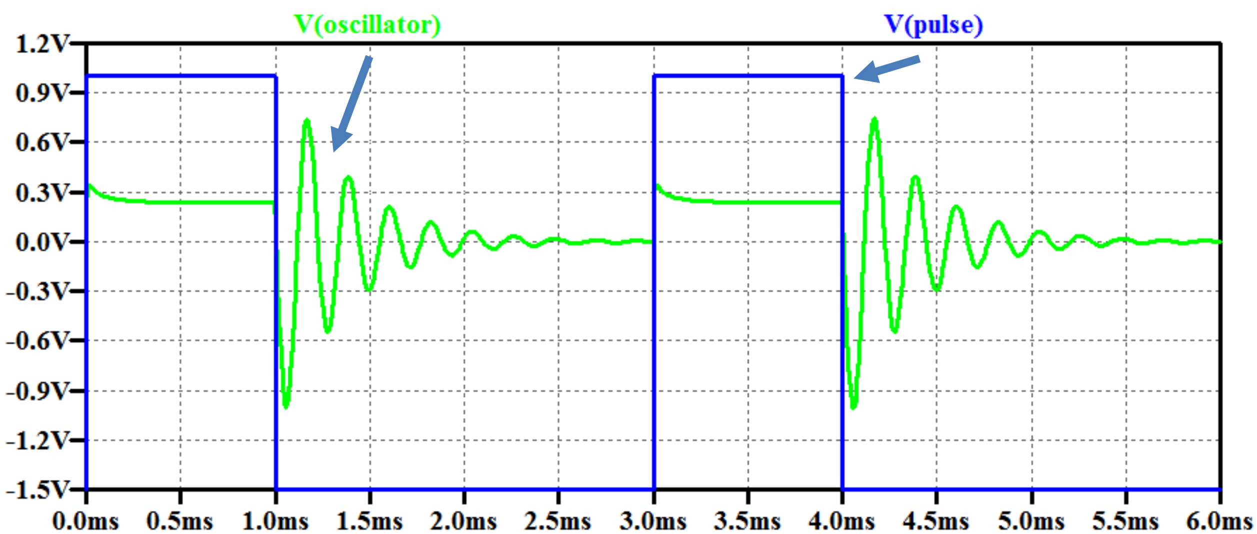
g) When $\mathbf{R_2}$ is a open circuit, the voltage across $\mathbf{R_2}$ will be (circle the correct answer): 0 or V_{in}

h) When $\mathbf{R_2}$ is an open circuit, the current through $\mathbf{R_2}$ will be (circle the correct answer): 0 or V_{in}/R_1

Problem 7 (11 Points) – LC Resonant Circuit Experiment

The circuit at the right is similar to the one we studied in classes 5 and 7. A different inductor (L is given) and a different capacitor (C is unknown) are used. The resistance is also the DC Resistance of the inductor (also not given in the figure). The pulsed source is a square wave that is -1.5V when low and +1V when high. Two complete cycles of the Source and Oscillator voltages are shown below. The time scale is 1ms/Div and the voltage scale is 0.3V/Div. Express answers below to within 5%.





a. (3 pts) What is the frequency and duty cycle of the Source square wave voltage V(pulse)?

b. (3 pts) What is the frequency of the damped oscillation voltage V(oscillator)? *Hint: Can be found 2 ways, but one approach will be much easier.*

c. (3 pts) What is the value of the capacitance? *Hint: The capacitor value is standard.*

d. (2 pts) What is the value of the resistance? *Hint: The inductor is a standard component.*