ENGR-2300

Electronic Instrumentation

Quiz 1

Fall 2021

Print Name _____ RIN _____

Section ___

I have read, understood, and abided by the Collaboration and Academic Dishonesty statement in the course syllabus. The work presented here was solely performed by me.

Signature: _____

Date: _____

On all questions: SHOW ALL WORK. BEGIN WITH FORMULAS, THEN SUBSTITUTE VALUES AND UNITS. No credit will be given for numbers that appear without justification. Unless otherwise stated in a problem, provide 3 significant digits in answers. Read the entire quiz before answering any questions. Also it may be easier to answer parts of questions out of order.

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

Table 1: Standard resistor values for 5% tolerance resistors.

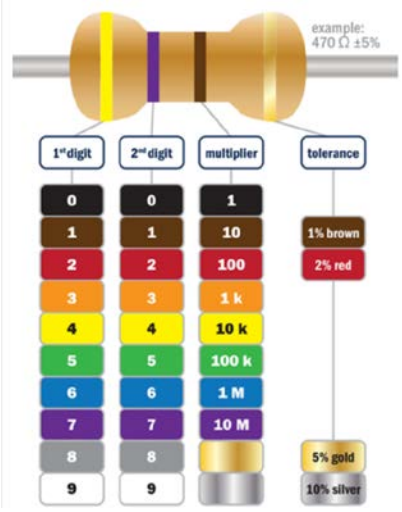
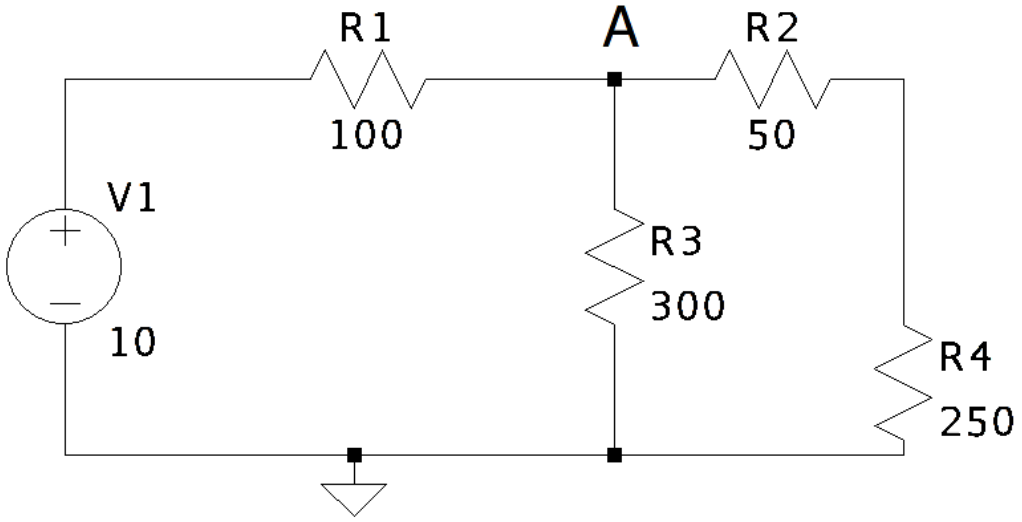


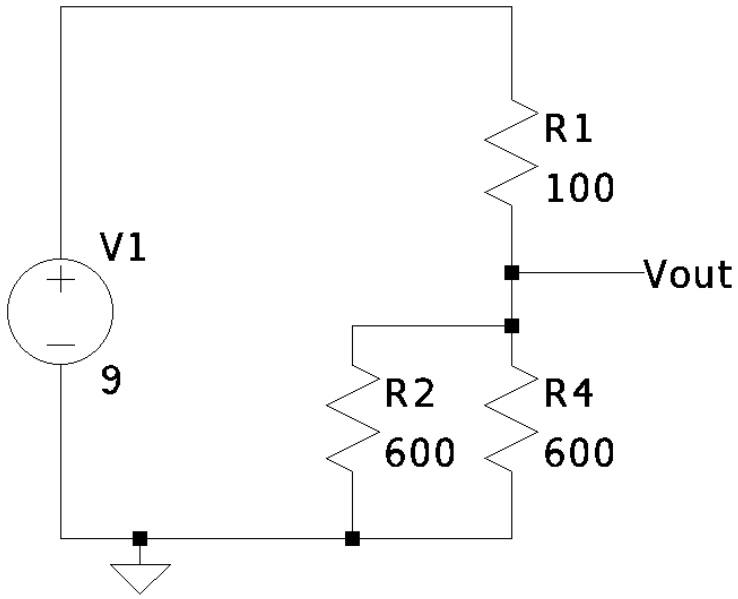
Figure 1: Resistor color and Tolerance bands

I. Voltage Dividers (20 points) As stated on the cover page: Round answers to 3 significant digits. Show formulas first and show your work. No credit will be given for numbers that appear without justification.



a. (6 pts) What is the voltage at point A in the circuit above?

b. (4 pts) What is the current through R4?



c. (2 pts) In the circuit above, the voltage source represents some 9-volt battery with battery resistance $R_{batt,}$ which is not shown. Draw R_{batt} in the correct location in the circuit above. (This may require you to draw a resistor overtop of a wire.)

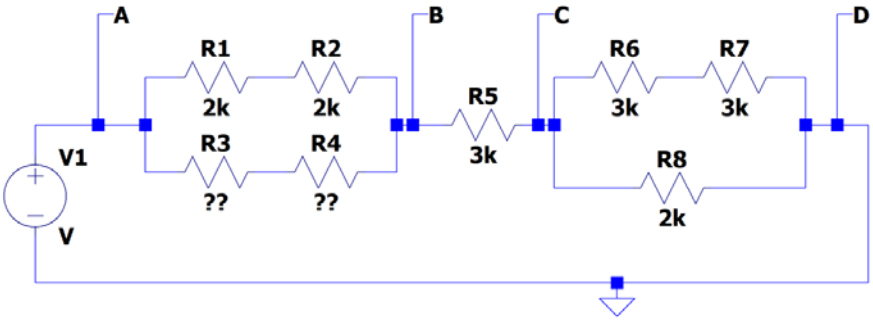
d. (4 pts) You use a voltage probe with a very high input resistance to measure V_{out} and you find it to be 5.4V. What is the value of R_{batt}?

e. (2 pts) How does this value of R_{batt} compare to what is typical for a new 9-volt battery? (Answering "more", "less" or "about the same" is sufficient).

f. (2 pts) Suppose that you instead measured V_{out} using a voltage probe with much lower input resistance. How would this affect the voltage measured at V_{out}?

II. Resistor Combinations, concepts and miscellaneous (20 points) *Note: Page 2 of this quiz has background information. The crib sheet may also be useful.*

The following circuit consists of 8 resistors and there are 4 voltage markers at points A, B, C, and D. V1 is a dc voltage source which can be created using W1 of the instrumentation board. **Note:** several of the following questions are independent of each other, but not all.



a. (4 pt) It is desired to have the effective **resistance of R3 combined with R4 to be 8kΩ**. Using the table on page 2 of this quiz, standard 5% resistor values, **pick resistors for R3 and R4**. State the resistance of each. These have 5% tolerance, what is the 4-band color code for each resistor? You should note that 8k isn't a standard value.

R3 value: _____ Color bands: _____

R4 value: _____ Color bands: _____

b. (3 pts) If the voltage is measured to be 1V at point C, what is the current through R7, R8, and R5? Be sure to include units on all answers.

I(R7) _____

I(R8) _____

I(R5) _____

c. (2 pts) What is the equivalent resistance between points A and B, Call this R_{AB}. Use part a. for the values of R3 and R4,

R_{AB} _____

d. (2 pts) What is the equivalent resistance between points C and D, Call this R_{CD}.

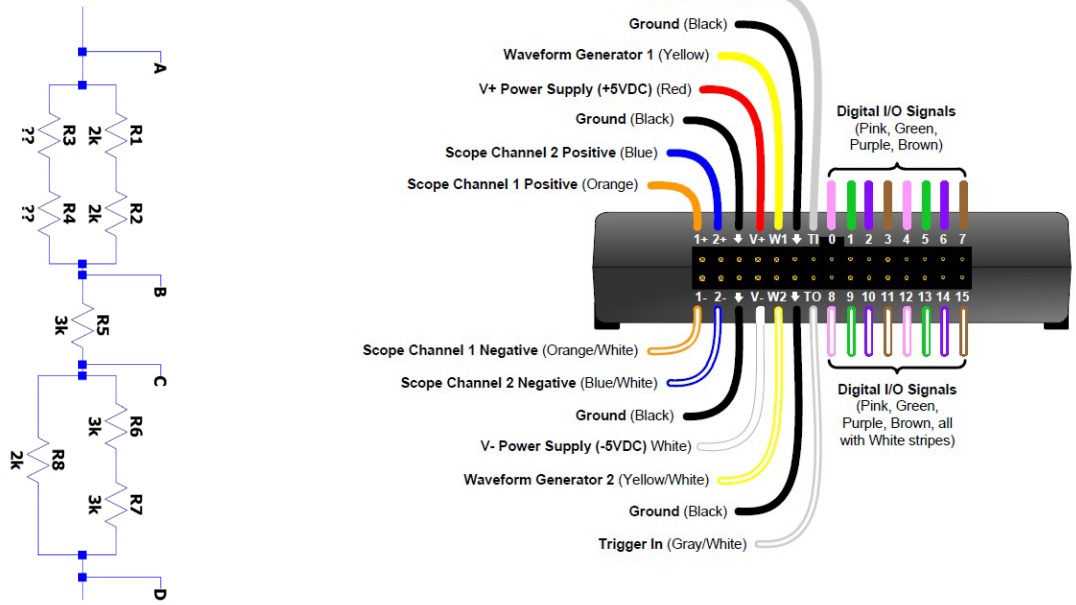
R_{CD} _____

e. (2 pts) Redraw the circuit with 3 resistors, R_{AB}, R5, R_{CD}. Label the resistor values and mark points A, B, C, and D.

f. (2 pts) Using the figure you drew for part e., if V1=5V what is the voltage at point B?

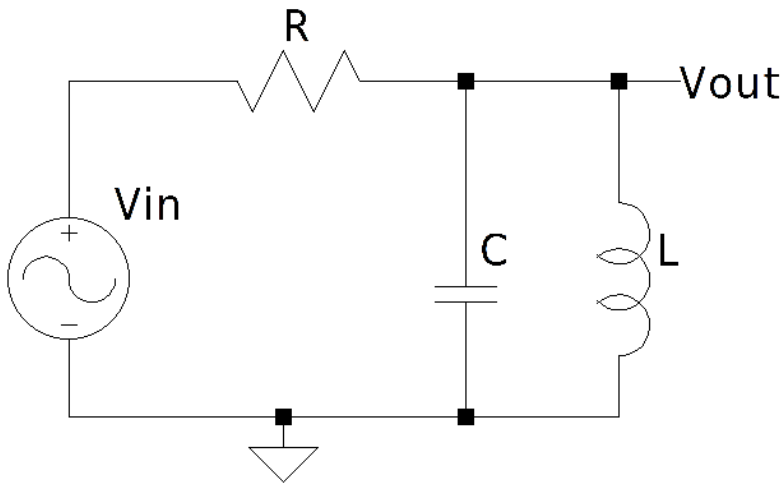
V_B = _____

g. (5 pts) Wire this circuit shown for part a. by drawing lines on the figure below. Use the wave gen/signal gen to provide a signal for V1, which is point A. Use channel 1 to measure the signal at point B and use channel 2 to measure the signal at point C.



Draw lines between the 2 figures to indicate wires. Both the M2K and the AD2 have the same wiring and colors. W1 is called Signal Generator on the M2K and Waveform Generator on the AD2.

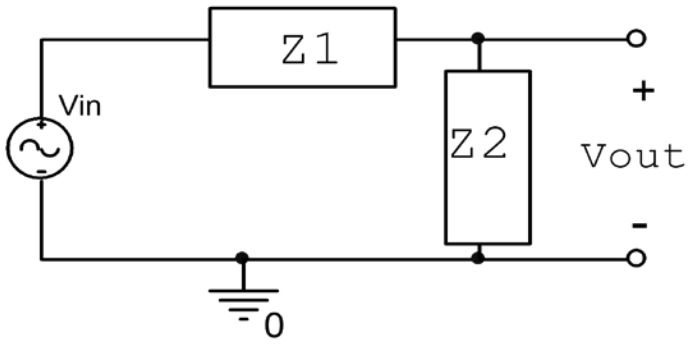
III. Filters & Transfer Functions (20 points) For this problem, assume AC steady state.



a. (6 pts) Find the transfer function of the circuit shown. Simplify such that there are no fractions in the numerator or denominator of the transfer function. $H(j\omega) = Vout(j\omega)/Vin(j\omega)$

b. (3 pts) What is the magnitude and phase of the transfer function when the frequency is very small (approaches zero)? How about when the frequency is very large (approaches infinity)?

c. (2 pts) What type of filter does this circuit represent? Justify your answer.

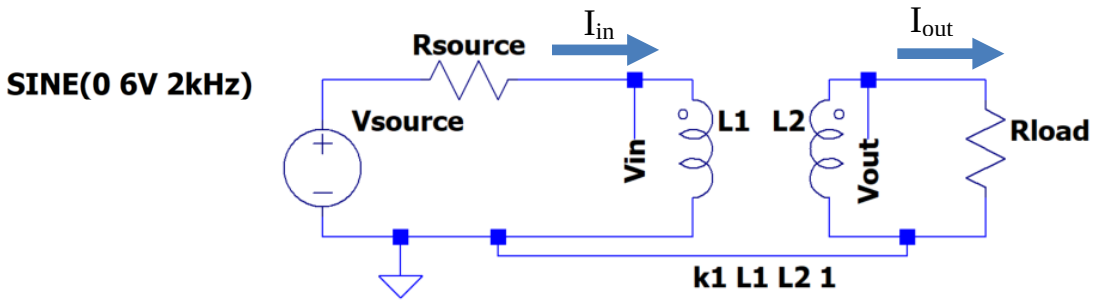


d. (5 pts) In the circuit shown, Z1 and Z2 represent a single component, either a resistor, capacitor or inductor. Complete the table below by entering a Y for yes or an N no to represent whether or not the circuit would be a high or low-pass filter with each combination of elements.

Z1	**Z2**	**Low Pass (Y or N)**	**High Pass (Y or N)**
R	C		
C	R		
R	R		
R	L		
L	R		

e. (3 pts) Draw a low-pass filter using just a 2kΩ resistor and a 1uF capacitor. Label the input and output. Then calculate the corner frequency for this circuit in hertz.

IV – Phasors and Transformers (20 points)



1) Assume L1 and L2 form an ideal transformer with full coupling. The transformer has these specifications: **a=1/3, L1= 300mH**

a. (2pts) Determine the value of L2 that will match the allow the result in the transformer matching these specs:

L2=_____

b. (4 pts) Determine the ratios Vout/Vin, and Iout/Iin

Vout/Vin=_____

Iout/Iin=_____

c. (3 pts) Find the value of Rload that results in Rin = 3kΩ (Rin is Vin/Iin)

Rload=_____

d. (2 pts) Given Rsource = 500Ω and $Vsource = 6\text{Sin}(2\pi * 2000t)$ What is the time domain value of Vin? Give the answer in the form of: **$v(t)=V_1\text{Sin}(\omega t+\theta_1)$**

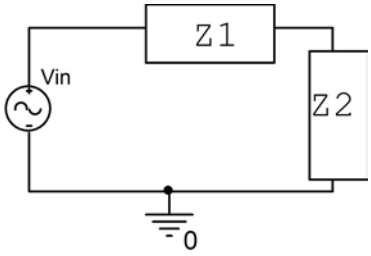
Vin = _____

e. (3pts) The ideal transformer model assumes that self-inductance L1 and L2 are infinite, |jωL1| and |jωL2| approach infinity. On the practical side the transformer is close to ideal if |jωL1| >10*Rsource and |jωL2| >10*Rload. Just looking at L1, will this transformer be close to the ideal? If not, how could the transformer be changed to approach ideal but yet have the same value for a?

Is it near ideal? Yes or No

If No, say in words how the transformer could be changed to approach ideal but without changing the desired ratio of Vout/Vin.

2. Phasors: This circuit shown has 2 complex impedances, Z1 and Z2, connected as shown.
Given: $Vin = 6V\angle 0^o$ and the voltage across Z2 is measured to be $Vz2 = 4V\angle -45^o$ (This format is a magnitude and a phase angle.)



a. (2pts) Write Vin and Vz2 in Cartesian form.

b. (3pts) Determine Vz1, the voltage across Z1 in Cartesian and polar form

3. (1pt) Give the names of 2 of the people teaching this course. This can be first names or last names and can be the professors, teaching assistants, or undergraduate student assistants. Spelling doesn't count. Using their Discord name is also valid.