Name ________________________________

Part A (20 Points)

1. (3 Pts) _________
2. (3 Pts) _________
3. (4 Pts) _________
4. (13 Pts) _________
5. (4 Pts) _________
6. (3 Pts) _________

Part B (80 Points)

1. (10 Pts) _________
2. (10 Pts) _________
3. (15 Pts) _________
4. (10 Pts) _________
5. (5 Pts) _________
6. (10 Pts) _________
7. (15 Pts) _________
8. (5 Pts) _________

Total __________________

Draw circuit diagrams for all problems, especially as you simplify the circuits.

Be sure to fully annotate plots, even when the problem does not ask you to do this.

Show all of your work

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.

The **American Institute of Electrical Engineers** (**AIEE**) was a United States based organization of electrical engineers that existed from 1884 through 1962. On January 1, 1963 it merged with the Institute of Radio Engineers (IRE) to form the Institute of Electrical and Electronics Engineers (IEEE). The 1884 founders of the American Institute of Electrical Engineers (AIEE) included some of the most prominent inventors and innovators in the then new field of electrical engineering, among them Nikola Tesla, Thomas Alva Edison, Elihu Thomson, Edwin J. Houston, and Edward Weston. The purpose of the AIEE was stated "to promote the Arts and Sciences connected with the production and utilization of electricity and the welfare of those employed in these Industries: by means of social intercourse, the reading and discussion of professional papers and the circulation by means of publication among members and associates of information thus obtained." The first president of AIEE was Norvin Green, president of the Western Union Telegraph Company. Other notable AIEE presidents were Alexander Graham Bell (1891–1892), Charles Proteus Steinmetz (1901–1902), Schuyler S. Wheeler (1905–1906), Dugald C. Jackson (1910–1911), Ralph D. Mershon (1912–1913), Michael I. Pupin (1925–1926), and Titus G. LeClair (1950–1951).

The first technical meeting of the AIEE was held during the International Electrical Exhibition of 1884, in Philadelphia, Pennsylvania (**October 7–8**, at the Franklin Institute). After several years of operating primarily in New York, the AIEE authorized local sections in 1902. These were formed first in the United States (Chicago and Ithaca, 1902) and then in other countries (the first section outside the US being Toronto, Canada, established in 1903). The AIEE's regional structure was soon complemented by a technical structure –the first technical committee of AIEE (the High Voltage Transmission Committee) being formed in 1903.

The formation of the AIEE Subcommittee on Large-Scale Computing in 1946 was considered a key milestone in the history of computer engineering. It was the first time that a professional association recognized the significance of computers and computing in electro-technology.

The early technical areas of interest of AIEE were electric power, lighting, and wired communications. Radio and wireless communications became the major focus of a rival organization, the Institute of Radio Engineers (the IRE, established 1912). The dynamic growth of radio technology and the emergence of the new discipline of electronics in the 1940s led to stiff competition between AIEE and IRE, with IRE showing faster growth in the 1950s and early 1960s, and attracting more students. In 1957, the IRE, with approximately 55,500 members, surpassed the AIEE in membership size; by 1962 the IRE had 96,500 members to the AIEE’s 57,000.

Source: Wikipedia

Contact: rpi.student.ieee@gmail.com

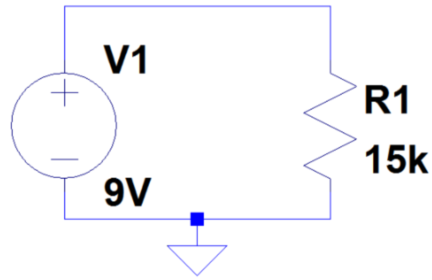
Inductance Specs – From Digilent Parts Kit Website

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

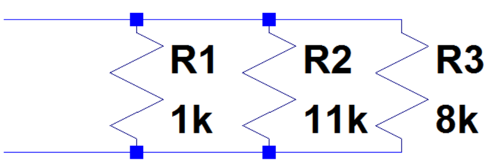
Part A: Multiple Choice (20 Points)

1. (3 Pts) Ohm's Law: What is the current I passing through the resistor R1 due to the voltage source V1? *Circle the correct answer and show your work*
   a. 10mA
   b. 60mA
   c. 1mA
   d. 0.6mA
   e. 6mA
   f. 100mA

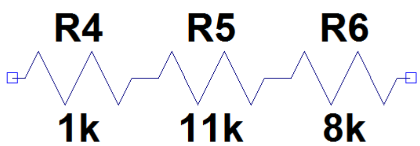


2. (3 Pts) Power to Resistor: What is the power delivered to the resistor in the circuit of question 1? *Circle the correct answer and show your work.*
   a. 90mW
   b. 540mW
   c. 9mW
   d. 5.4mW
   e. 54mW
   f. 900mW

3. (4 Pts) Resistors in Series and Parallel: Circle the total resistance in each of the parallel circuits and write 'parallel' next to the total for the parallel circuit and 'series' next to the total for the series circuit.



Parallel Circuit

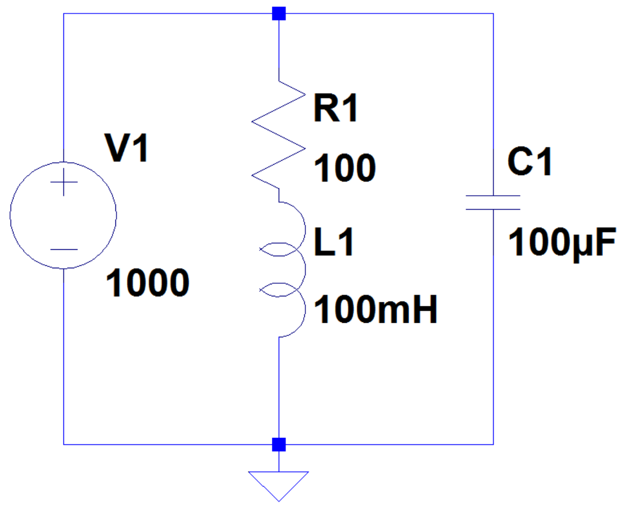


Series Circuit

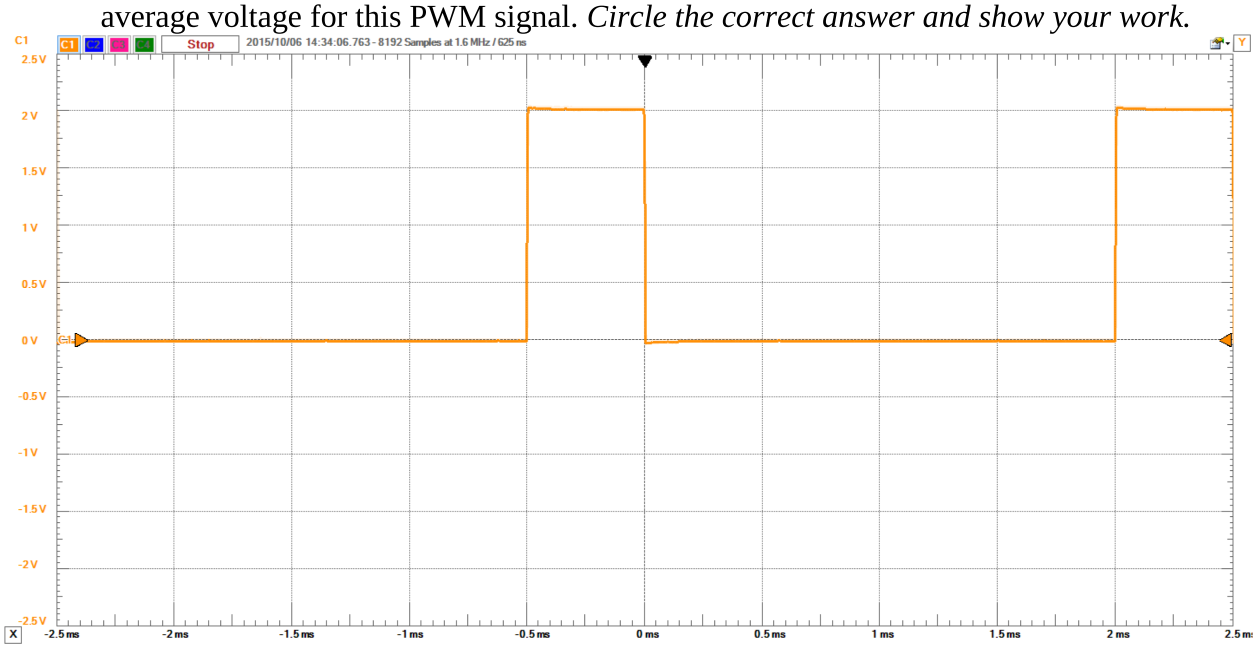
   a. 10kΩ
   b. 82kΩ
   c. 0.82kΩ
   d. 1kΩ
   e. 20kΩ
   f. 8.2kΩ

4. (3 Pts) Astable Multivibrator (555 Timer) Circuit – If a load is connected between pin 3 of the 555 timer chip and ground in the astable multivibrator configuration, what is the range of possible duty cycles? *Circle the correct answer and show your work.*
   a. $0 \leq$ Duty Cycle $\leq 100\%$
   b. $0 \leq$ Duty Cycle $\leq 50\%$
   c. $20\% \leq$ Duty Cycle $\leq 80\%$
   d. $50\% \leq$ Duty Cycle $\leq 100\%$

5. (4 Pts) Energy Stored in L and C: In the circuit at the right, we have a configuration like the LC oscillator we have studied in class except that the inductance, capacitance and voltage levels are much higher. Circle the energy stored in the inductor and the energy stored in the capacitor and write W_L next to the former and W_C next to the latter.
   a. 500mJ
   b. 1J
   c. 5J
   d. 10J
   e. 50J
   f. 100J



6. (3 Pts) Duty Cycle of PWM: Using the information in the plot below, determine the average voltage for this PWM signal. *Circle the correct answer and show your work.*

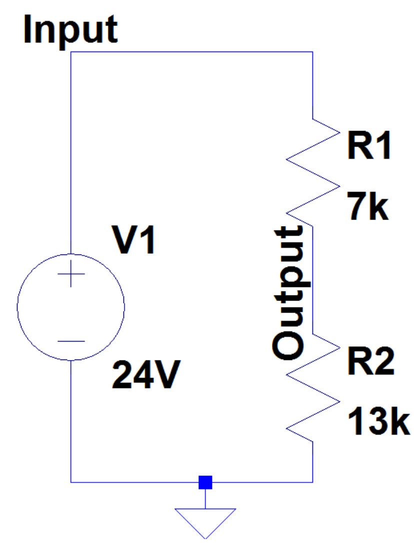


   a. 2V
   b. 1V
   c. 1.6V
   d. 0.4V
   e. 0V

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

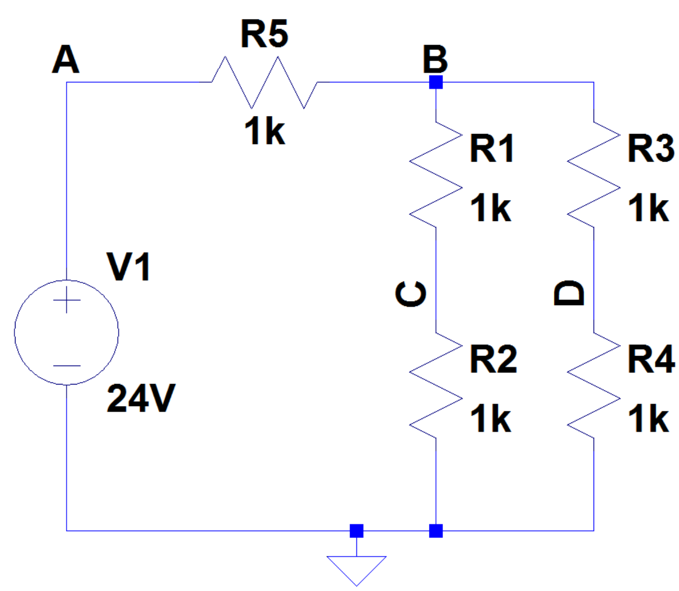


b. Determine the power delivered by the input voltage source.

Problem 2 (10 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.

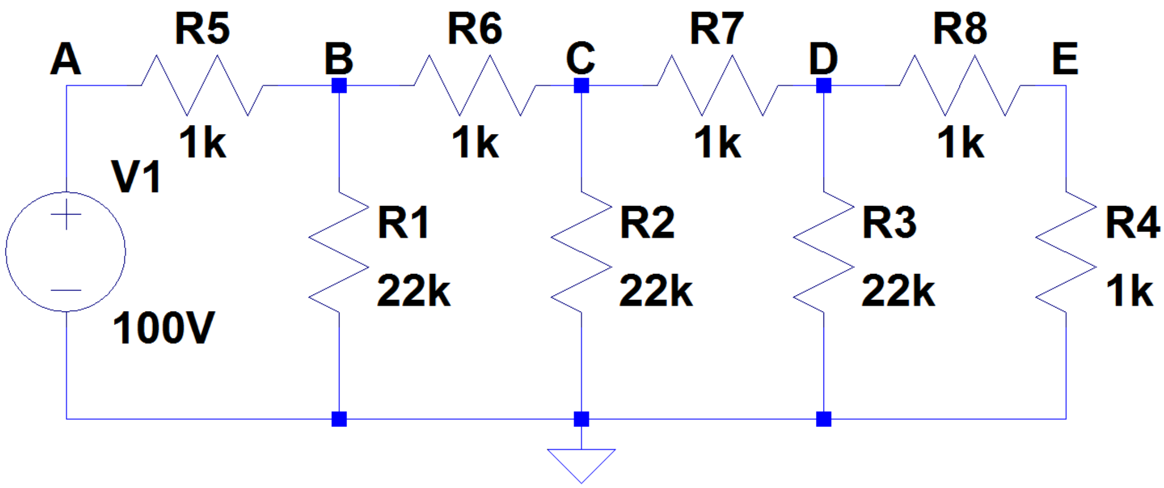
a. Determine the voltages at B and C.



b. Determine the current through R4.

Problem 3 (15 Points) – Resistor Ladder Circuit

A more complex circuit is formed by essentially connecting a bunch of voltage dividers, one after another. The voltage source is 100V DC, so that is the voltage at A.

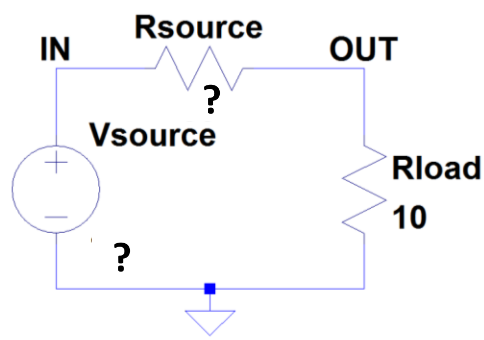


a. Find the voltages at nodes B, C, D and E. *Hint: You can use the large and small resistor combination approach to approximate and check your solution, but it will not be accurate enough to give the answer to even 10% accuracy at all nodes.*

b. What is the total current from the source?

Problem 4 (10 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. Six different load resistors are connected and the voltage V(OUT) is measured. The results of the six trials are listed in the table below. *Note that there is more information than you need to find the source voltage and resistance.*



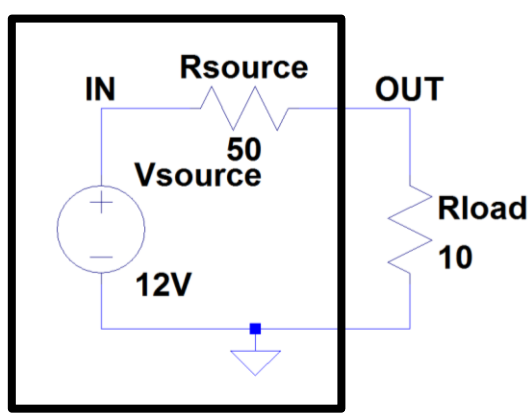
Trial	Rload	V(OUT)
1	1MΩ	12V
2	100kΩ	11.99V
3	10kΩ	11.94V
4	1kΩ	11.43V
5	100Ω	8V
6	10Ω	2V

a. Determine the source voltage Vsource.

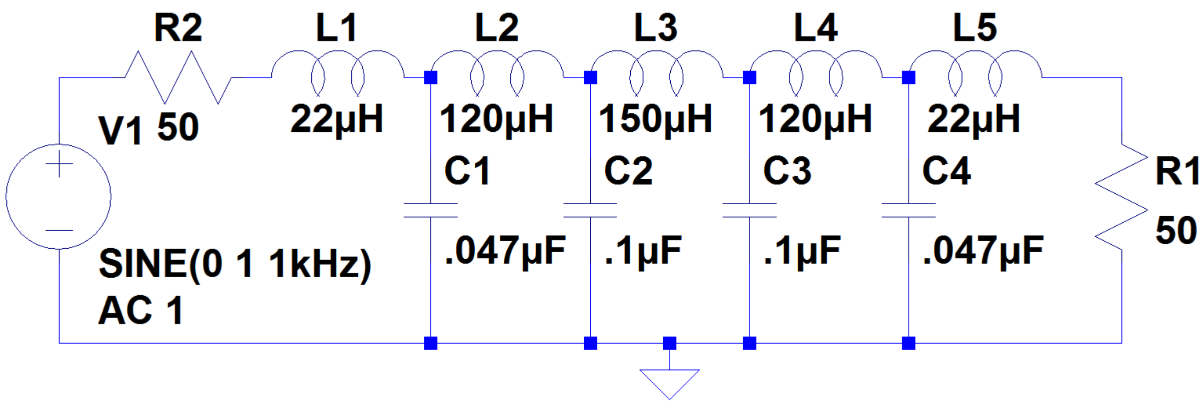
b. Determine the source resistance Rsource.

Problem 5 (5 Points) – Measurements

The black box circuit from the previous problem is redrawn at the right (with the box outline shown). What wires from your Analog Discovery board should be connected to this circuit (and where) to obtain the voltage information in the table? List the wires below and show their connection points on the circuit diagram. *There is more than one correct answer.*



Problem 6 (10 Points) – Filter



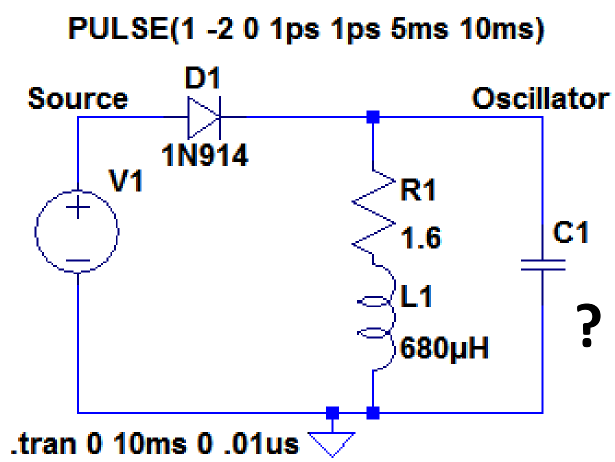
The filter shown above is a good approximation to what is known as a Butterworth Filter. The components were chosen from commercially available inductances and capacitances to be close to the ideal values found using Butterworth's analysis. This circuit diagram is used to build the circuit, not simulate it because it does not include all necessary ideal components.

a. Using the information from the Digilent Parts Kit spec sheet (found near the beginning of this quiz), redraw the circuit for DC (f = 0) conditions.

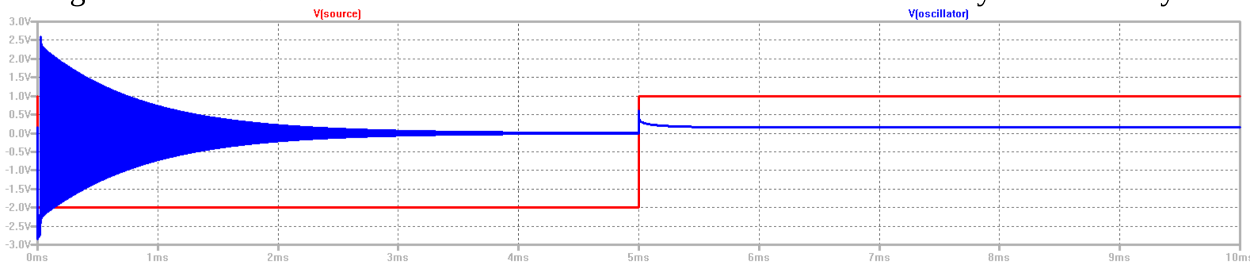
b. Using your circuit, find the amplitude of a very, very low frequency sine wave voltage that will be observed across resistor R1.

Stephen Butterworth (1885–1958) was a British physicist who invented the Butterworth filter, a class of electrical circuits that are used to separate different frequencies of electrical signals.

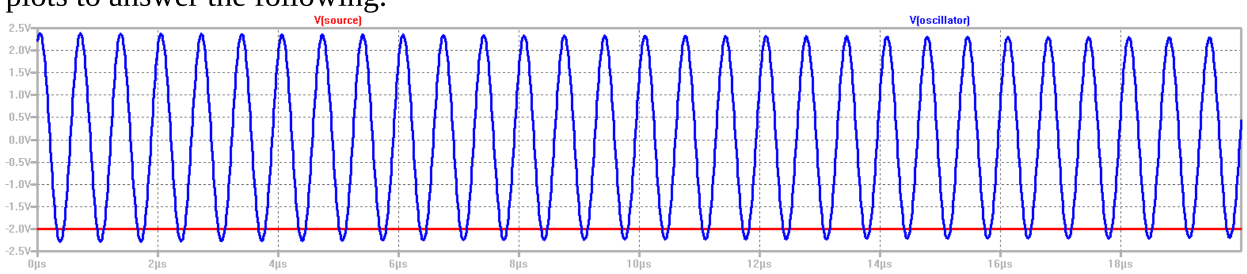
Problem 7 (15 Points) – LC Resonant Circuit Experiment



The circuit at the right is similar to the one we studied in classes 5 and 7. A different inductor is used and the capacitor in the simulation is the parasitic capacitance of the inductor, not a separate component. The resistance is also the DC Resistance of the inductor. Thus, the three ideal circuit components in the diagram are used to model how an actual physical inductor behaves in a circuit. The pulsed source is the usual pulsed square wave that is -2V when low and +1V when high. A complete cycle of the Source and Oscillator voltages is shown below. The time scale is 1ms/Div and the voltage scale is 0.5V/Div. Recall that there are 10 divisions both horizontally and vertically.



Clearly, the decaying oscillation is too fast to be observed using the time scale above, so the scale was expanded to show 2µs/Div during the time from 30µs to 50µs Use the information in plots to answer the following:

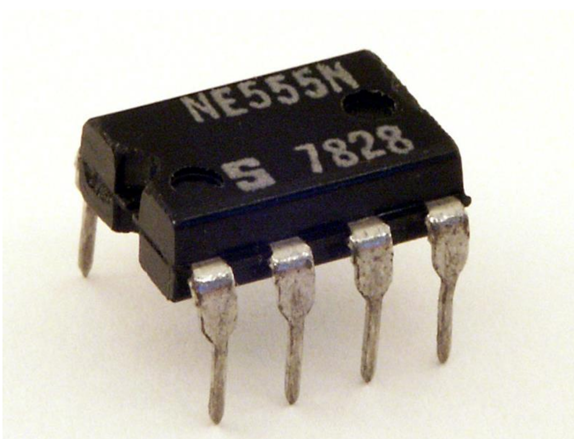


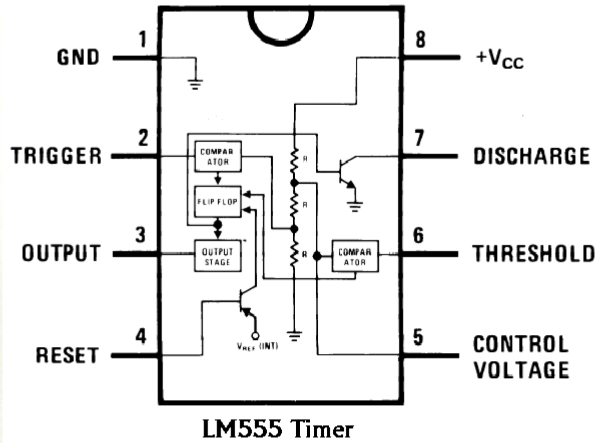
a. What is the frequency of the Source square wave voltage?

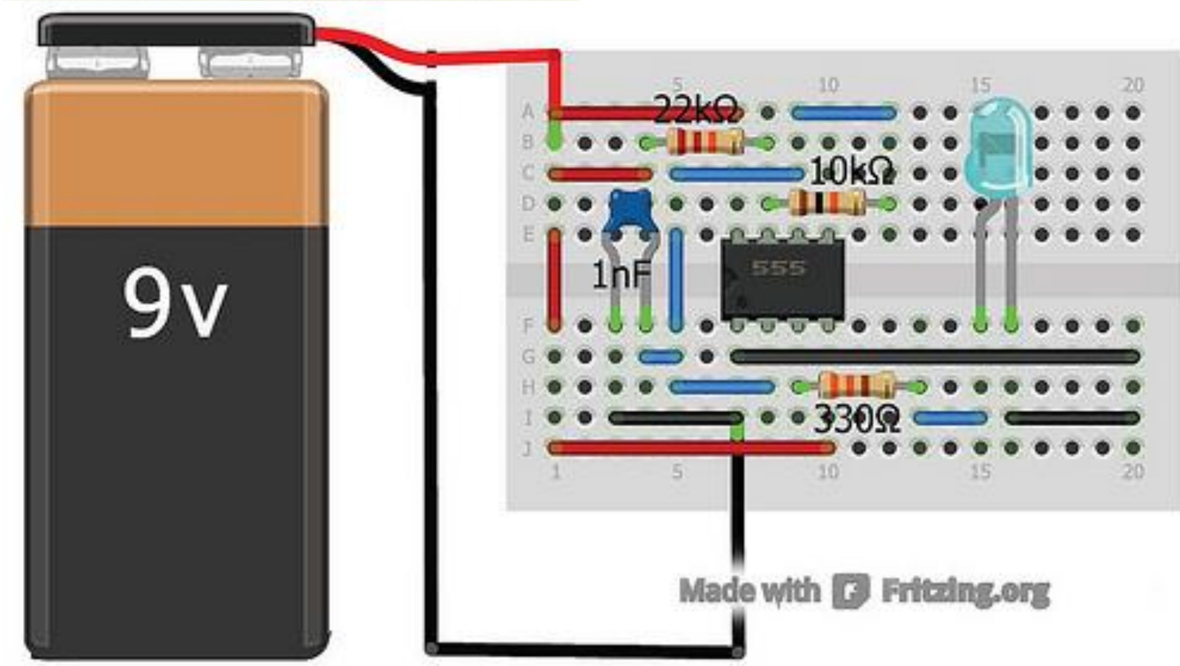
b. What is the frequency of the damped oscillation voltage?

c. What is the value of the inductor's parasitic capacitance?

Problem 8 (5 Points) – 555 Timer







On a 555 Timer chip, what pin do we connect to for the output voltage? That is, where do we connect the load? *Circle the correct answer. Hint: You may have already been told this.*

1. Pin 1
2. Pin 2
3. Pin 3
4. Pin 4
5. Pin 5
6. Pin 6
7. Pin 7
8. Pin 8