LAU
الجامعة اللبنانية الأميركية
Lebanese American University

LAU
School of Engineering

Department of Electrical
and Computer Engineering

ELE 305: Introduction to Electrical Engineering

Exam 2 – Spring 2017

Duration: **1 hour 30 minutes**
Date: 12/04/2016
Start Time: 5:00 pm

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Dr. Jihad Jawad Fahs
Dr. Harag Margossian

Name: ________________________________ ID#: ______________________

INSTRUCTIONS:

- Answer each of the following questions in the space provided.
- You can use both sides of the sheets for answers.
- Solutions written outside this booklet will not be graded.
- This is a closed-book exam
- Programmable calculators and smart devices are not allowed.
- The number of points for each question is specified next to it.
- The total number of points is 100.

1	**2**	**3**	**4**	**5**	**Total**
/24	/16	/20	/20	/20	/100

Question 1 (24 pts)

Consider a sensor modeled by a voltage source V_0 (V_0 is between 0 and 10 mV) in series with its internal resistance $R = 100\ k\Omega$ (see Figure 1). The accessible output voltage of this sensor is V_{AB}. V_{AB} is measured using a voltmeter that is modeled as a resistance $R_e = 200\ k\Omega$ connected between A and B.

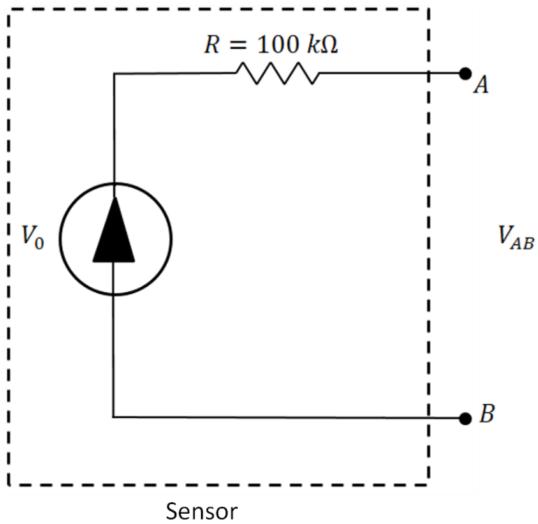

Figure 1

a. What is the range of voltages measured by the voltmeter?
b. The configuration below (see Figure 2) is used to amplify the monitored measurement. The operational amplifier is considered ideal. Calculate the gain of this circuit.
c. If the voltmeter is added between Vs and the ground, what is the range of voltages measured in this case?
d. What is the advantage of using the opAmp circuit in part c over the setup in part a?

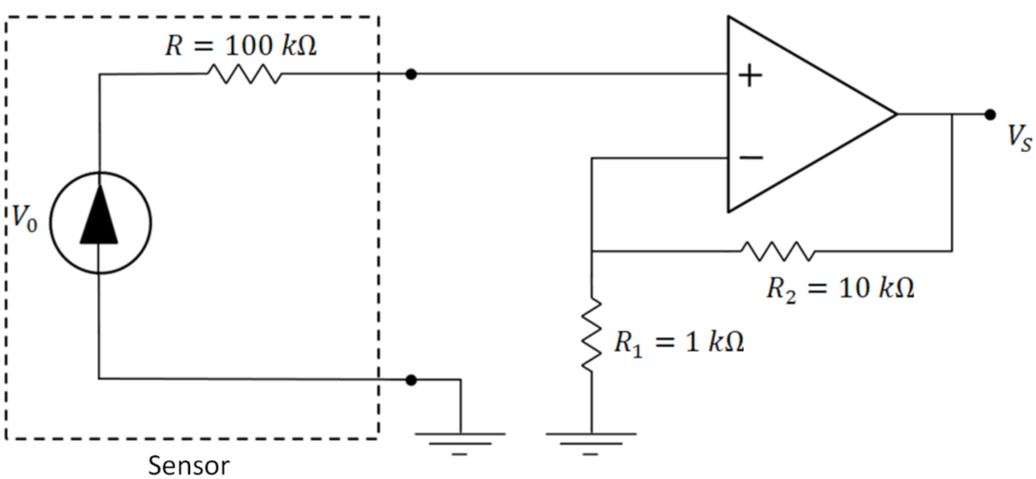

Figure 2

Question 2 (16 pts)

a. Find the equivalent capacitance C_{eq} between the terminals A and B in the circuit of Figure 3. Values of all capacitance are in μF.

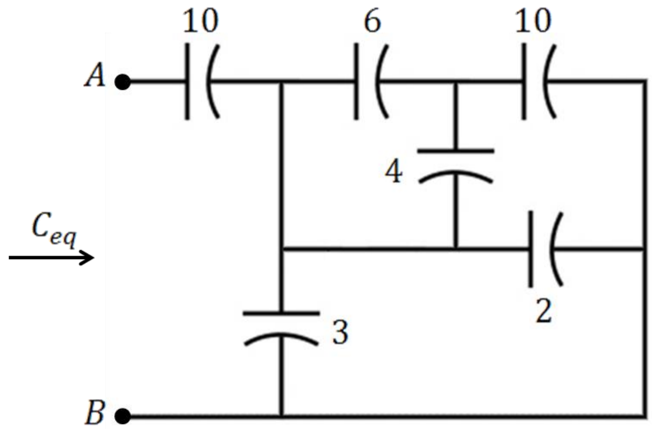

Figure 3

b. Consider the circuit in Figure 4.a. The current flowing through the capacitor is shown in Figure 4.b. Find the energy stored in the capacitor at $t = 1.3\, ms$, $t = 2.4\, ms$ and $t = 5.5\, ms$. *Hint*: if you could not solve part (a), use $C_{eq} = 10\ \mu F$.

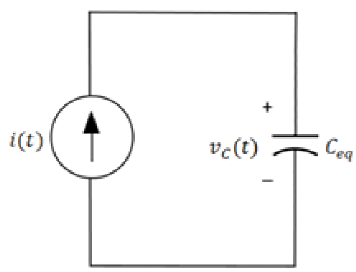

Figure 4.a

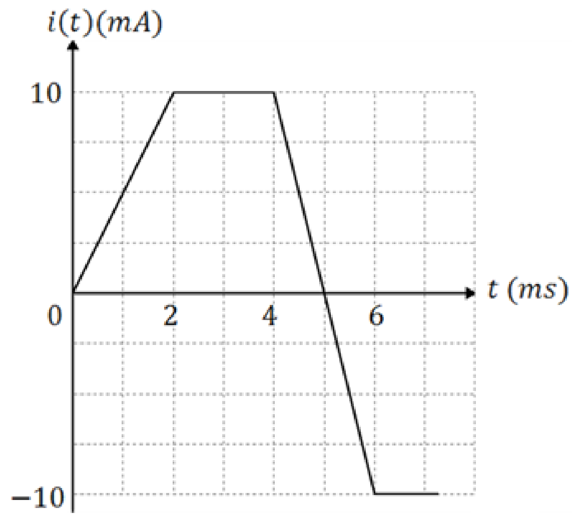

Figure 4.b

Question 3 (20 pts)

Use nodal analysis to find V$_o$. $V_{s_1} = \frac{2}{3} < 0^0$ and $V_{s_2} = \sqrt{2} < -135^0$.

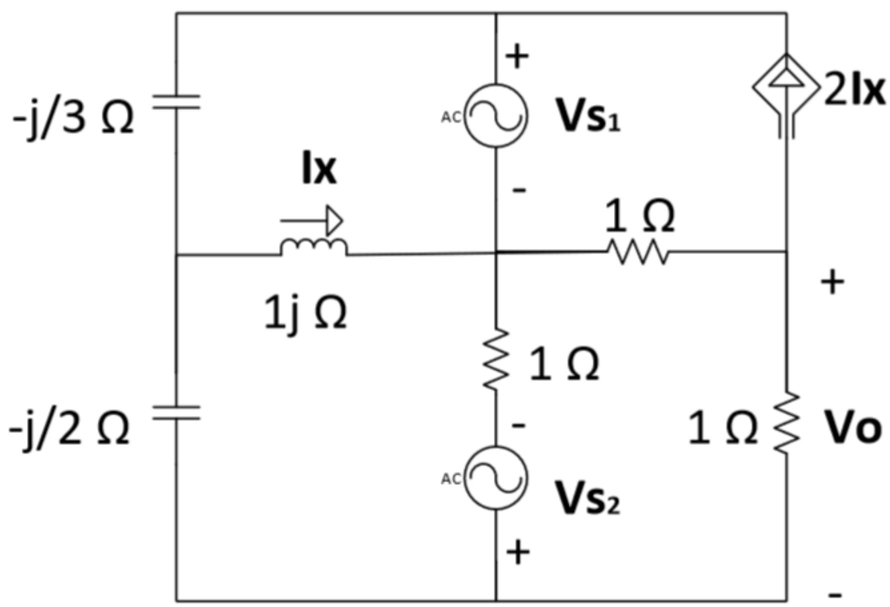

Figure 5

Question 4 (20 pts)

Consider the circuit below. You are given $V_s = \frac{1}{\sqrt{2}} < 135^0$ and $I_s = 1 < 90^0$

a) Find the Norton equivalent of the circuit between the nodes A and B as seen by the impedance $\bar{Z}_L$.
b) If the reactive power of $\bar{Z}_L$ must be zero, what value of $\bar{Z}_L$ should be used to ensure maximum power transfer?

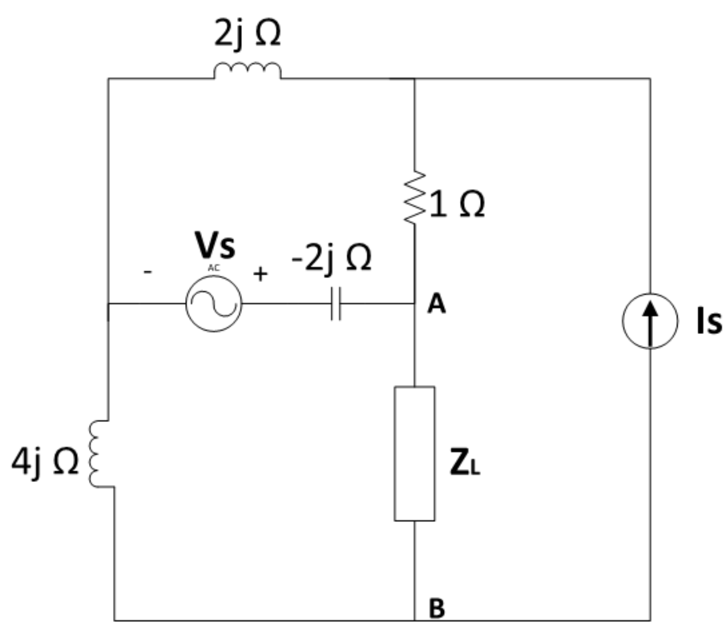

Figure 6

Question 5 (20 pts)

Consider the power system shown below. The loads are connected at 240 V rms.

a) Calculate the real and reactive power supplied by the source.
b) Repeat the calculation with the power factor of load 2 being 0.9 lagging instead of 0.7 lagging.
c) Which of the two power factors is better? Explain why.

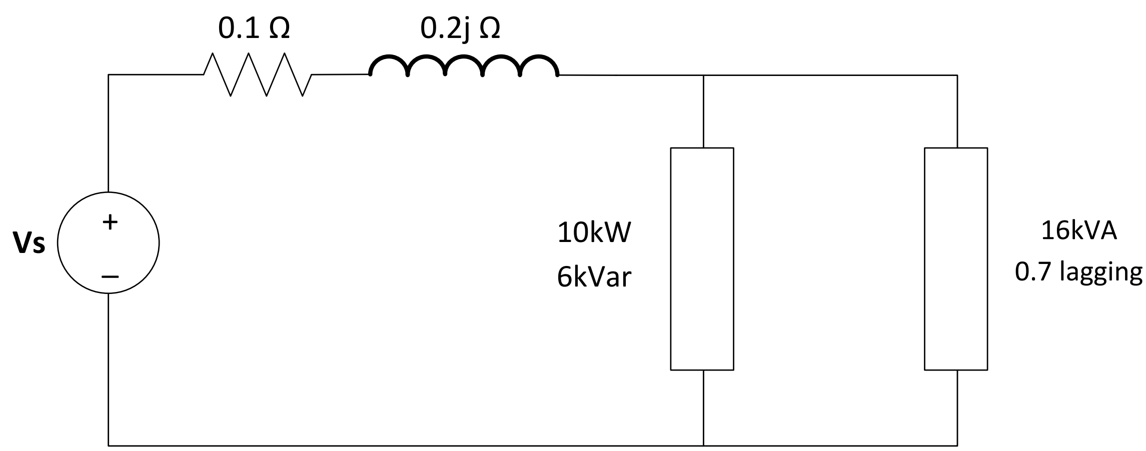

Figure 7