ECE 2100 Circuit Analysis
Fall 2016
Final Exam

NAME: _____

INSTRUCTIONS:

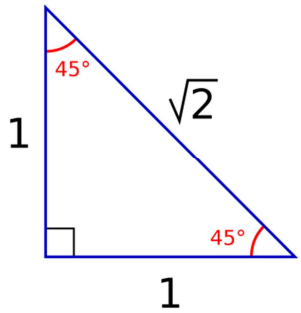
1. **THIS EXAM IS CLOSED BOOK AND CLOSED NOTES**. A "Potentially Useful Facts" sheet is provided.
2. **NO ELECTRONIC DEVICES ARE ALLOWED**.
3. Work each problem in the provided space.
4. Show ALL work required to arrive at a solution for either full or partial credit. *This includes clearly showing voltage polarities, current directions, etc.*
5. READ the entire question before answering.
6. CIRCLE YOUR ANSWERS.
7. Have your student ID on your desktop for inspection by the instructor.
8. SIGN the honesty pledge at the bottom of the page. Exams without a signature will receive no credit.

I have neither given nor received assistance from anyone in regards to completion of this exam. I have followed the instructions as provided on this sheet. I HAVE VERIFIED THAT THIS EXAM HAS (8) PAGES.

SIGNATURE: _____ DATE: _____

Note: some problems might be adapted from the course text or other sources. Schematics prepared using LTspice (linear.com).

Potentially Useful Facts

1. $A\angle\theta = Ae^{j\theta} = A\cos\theta + A\sin\theta\, j$
2. $v = L\frac{di}{dt}$ (follows passive sign convention)
3. $i = C\frac{dv}{dt}$ (follows passive sign convention)
4. $\overrightarrow{\boldsymbol{Z_L}} = j\omega L$
5. $\overrightarrow{\boldsymbol{Z_C}} = \frac{1}{j\omega C}$
6. $\vec{\boldsymbol{S}} = \overrightarrow{\boldsymbol{V_{RMS}}}\left(\overrightarrow{\boldsymbol{I_{RMS}}}\right)^*$ (follows passive sign convention)
7. $V_{\text{RMS}} = \sqrt{\frac{1}{T}\int_0^T v^2(t)dt}$
8. 

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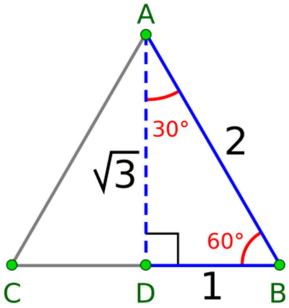
9. 

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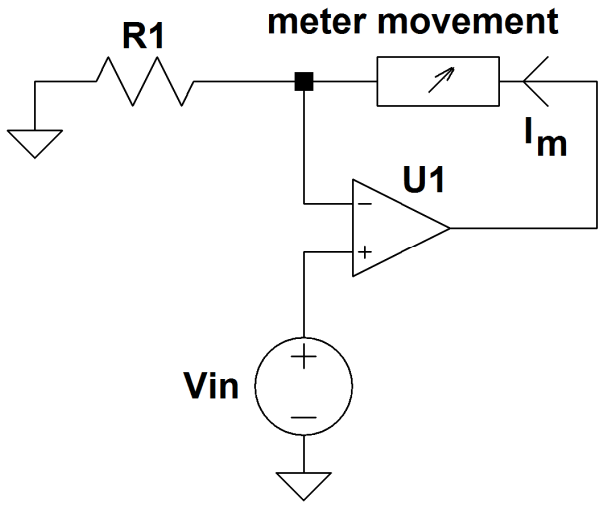
https://commons.wikimedia.org/wiki/File:30-60-90.svg
10. first-order circuit (natural and step) response
$x(t) = x(\infty) + [x(0) - x(\infty)]e^{-t/\tau}$

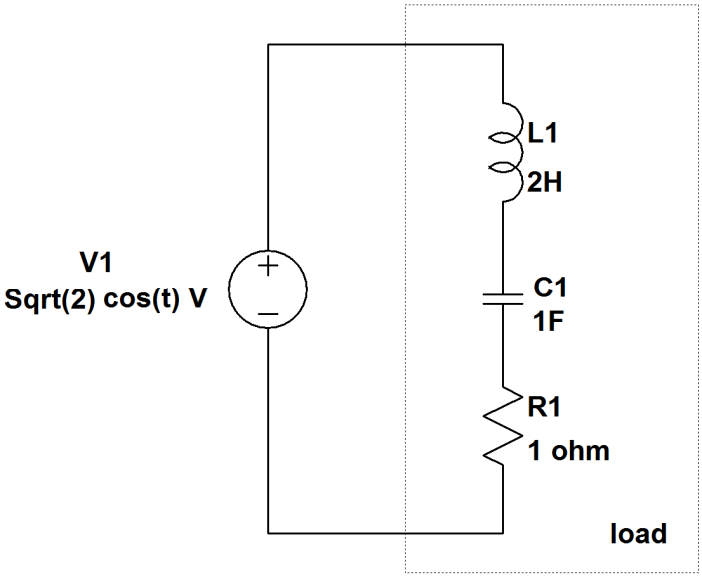
Maximum exam score is 30 points.

1. (5 points) An ideal operational amplifier can be used to make a voltmeter as shown.

    a. Assume that the meter movement has a full scale current Im of 10mA and a resistance of **10 ohms**. Find the value of R1 to make a 10V full scale voltmeter; that is, the meter movement shows a full scale current if Vin=10V.
    b. Repeat part (a) for a meter movement having a full scale current Im of 10mA and a resistance of **20 ohms**.
    c. Is the input resistance of the voltmeter ideal? Explain.

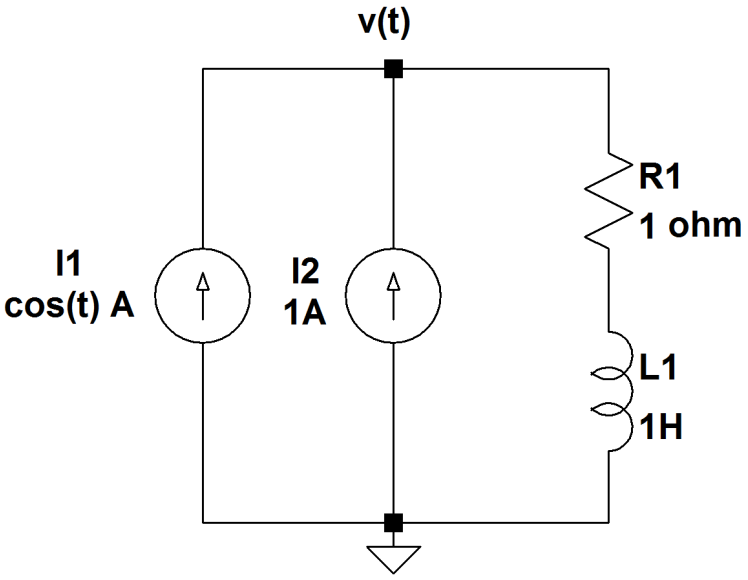


2. (5 points) Consider the following circuit. Find the complex power of the load (consisting of *L1*, *C1*, and *R1)*.

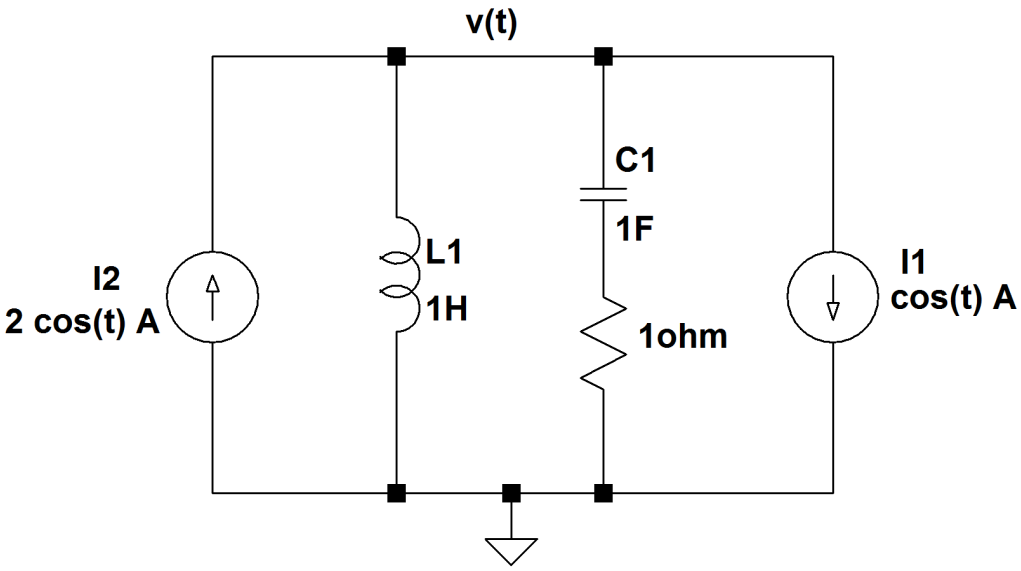


3. (5 points) The complex power of a load is $\vec{S}$=10 + 10j VA. If the load voltage is 1V RMS with frequency ω=1 rad/s, find the value of a component to place in parallel with the load to obtain a unity power factor.

4. (5 points) Find node voltage *v(t)* in the sinusoidal steady state using the superposition principle.



5. (5 points) Find node voltage *v(t)* in the sinusoidal steady state using nodal analysis.



6. (5 points) Find voltage *v(t)* for $t \geq 0$ assuming that the switch is opened at t=0 after being closed a long time.