

ECE 2100 Circuit Analysis
Summer I 2019
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.**
All electronic devices, *including watches*, must be stowed away.
3. You may only use the provided pencil.
All other writing instruments and erasers must be stowed away.
4. No hats or hoods may be worn during the exam.
5. Work each problem in the provided space.
6. **Show ALL work** required to arrive at a solution for either full or partial credit.
7. **READ** the entire question before answering.
8. Have your student ID on your desktop for inspection by the instructor.
9. **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 (7) PAGES.

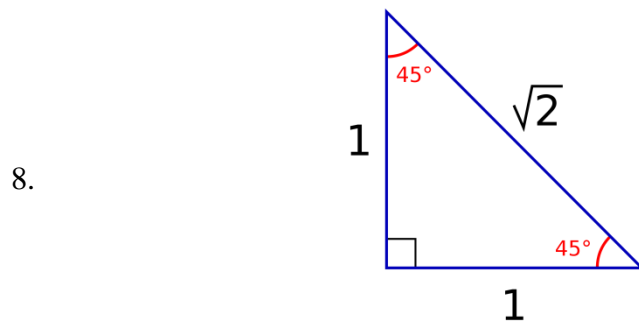
SIGNATURE: _____ DATE: _____

Note: Schematics prepared using LTspice (linear.com).

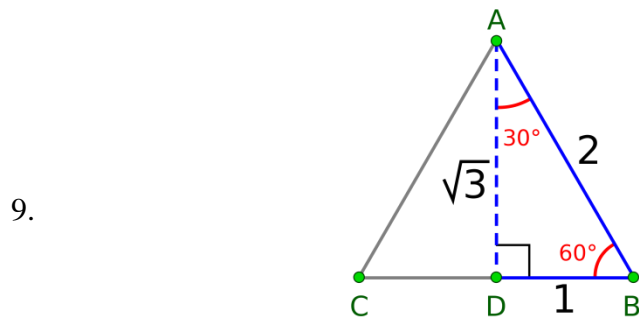
Potentially Useful Facts (updated 6 January 2017)

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. $\vec{Z}_L = j\omega L$
5. $\vec{Z}_C = \frac{1}{j\omega C}$
6. $\vec{S} = \vec{V}_{\text{RMS}} (\vec{I}_{\text{RMS}})^*$ (follows passive sign convention)

7.
$$V_{\text{RMS}} = \sqrt{\frac{1}{T} \int_0^T v^2(t) dt}$$



source (released to public domain):
<https://commons.wikimedia.org/wiki/File:45-45-triangle.svg>



source (released to public domain):
<https://commons.wikimedia.org/wiki/File:30-60-90.svg>

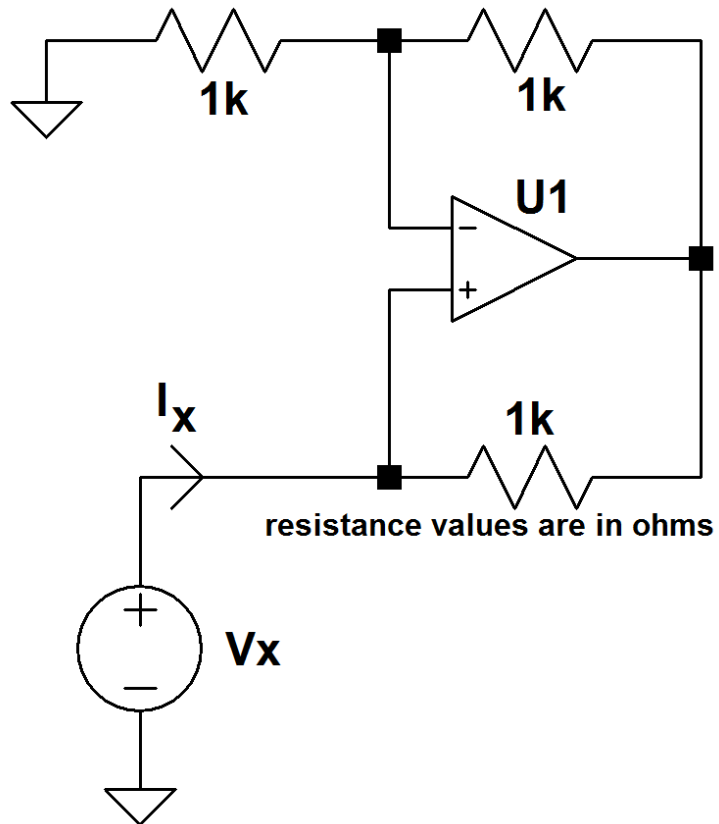
10. first-order DC circuit (natural and forced) response

$$x(t) = x(\infty) + [x(0) - x(\infty)]e^{-t/\tau}$$

Maximum exam score is 27 points.

1. (5 points) The op-amp is ideal.

Find the Thevenin input resistance of the op-amp circuit, that is, the ratio V_x/I_x .



THERE ARE TWO PROBLEMS ON THIS PAGE

2. (5 points) The complex power of a load is $\vec{S}=1 - j$ VA. If the load voltage is 1V RMS and the frequency is 1 rad/s, find the value of a component to put in parallel with the load so that the new load has a unity power factor.

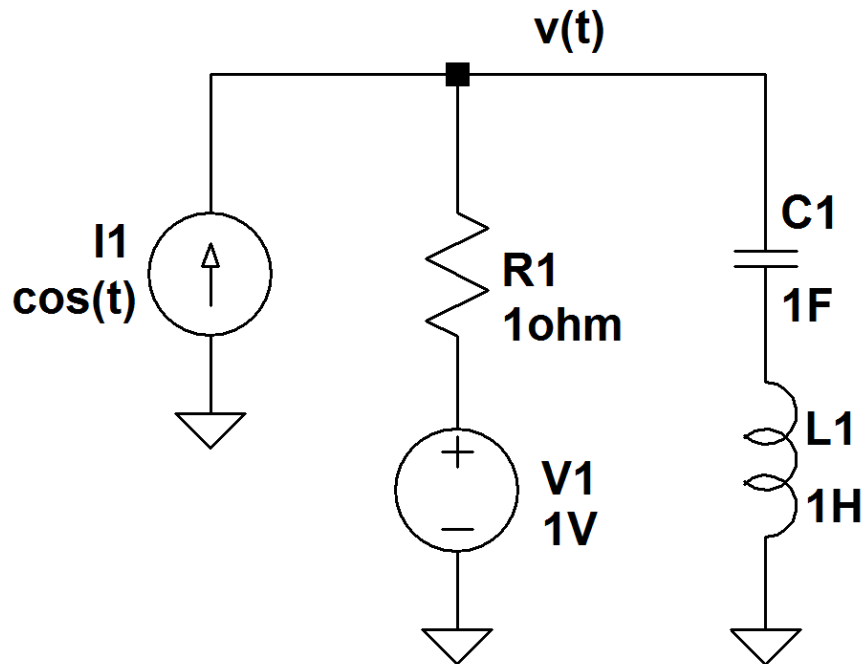
Your work must be clear – as always, watch units!

3. (2 points) Consider the system

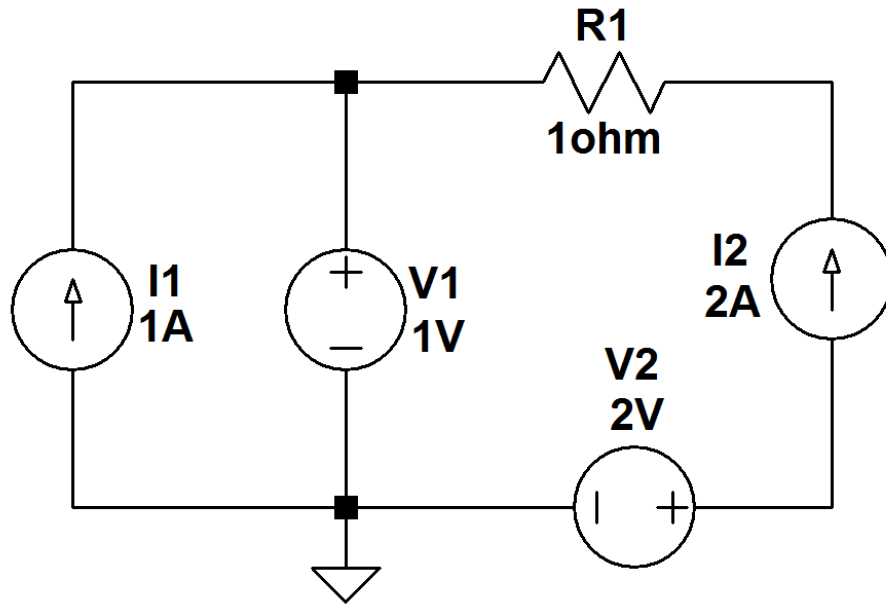
$$y(t) = T[x(t)] = \frac{dx(t)}{dt}$$

where $x(t)$ is the time-varying system input and $y(t)$ is the system output.
Is this system linear? **Justify your response.** No partial credit.

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



5. (5 points) Find the power of each circuit element.
 You **must** show the voltage across (with polarity) and current through (with direction) each element. Put answers in table.



ELEMENT	POWER
I1	
V1	
V2	
R1	
I2	

6. (5 points). The switch is closed at $t=0$.
Find $v(t)$ for $t \geq 0$ assuming that the capacitor is uncharged at $t=0$.

