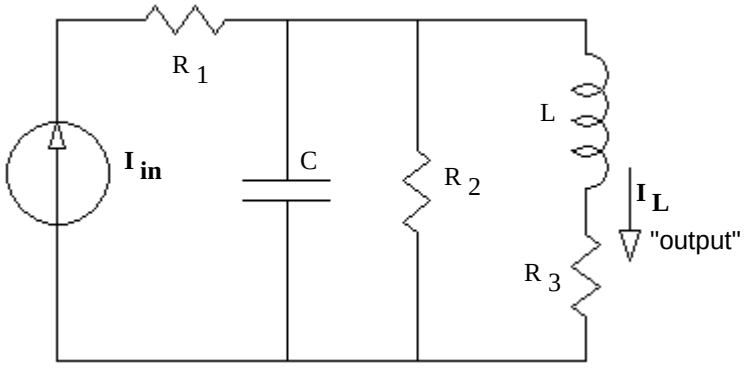
ECE 2210 Final given Spring 22

1. (18 pts) a) Find the s-type transfer function of the circuit shown. Consider $\mathbf{I_{in}}$ as the input and $\mathbf{I_L}$ as the "output".

   You MUST show work to get credit. Simplify your expression for H(s) so that the denominator is a simple polynomial with no coefficient before the highest-order s term in the denominator.

   $\mathbf{H}(s)$ = ?

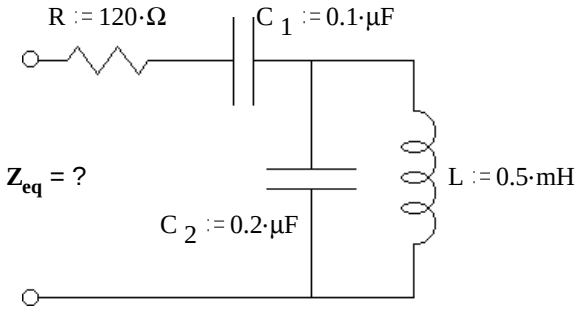


b) How many zeroes does this transfer function have?

c) How many poles does this transfer function have?

2. (18 pts) $\mathbf{Z_{eq}}$ is the total impedance between the two terminals.
   Find $\mathbf{Z_{eq}}$ in polar form (give me numbers).
   You must show work and/or intermediate results.

   $f := 12 \cdot kHz$



$\mathbf{Z_{eq}}$ = _____ /_____ ^{o}

Polar Form

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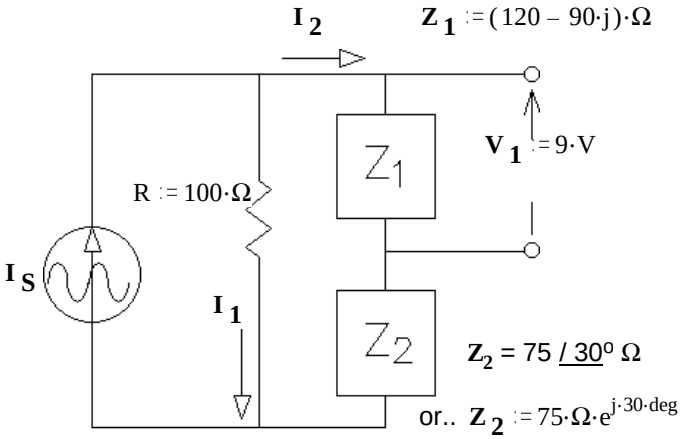
3. (22 pts) To get partial credit, show each step and each answer along the way.

a) Find, $\mathbf{I_2}$ in polar form.



b) Find $\mathbf{I_1}$

c) Find $\mathbf{I_S}$

d) Circle 1: i) $\mathbf{I_1}$ leads $\mathbf{I_2}$ ii) $\mathbf{I_1}$ lags $\mathbf{I_2}$

Why? Show numbers: _____ > _____ _____ < _____

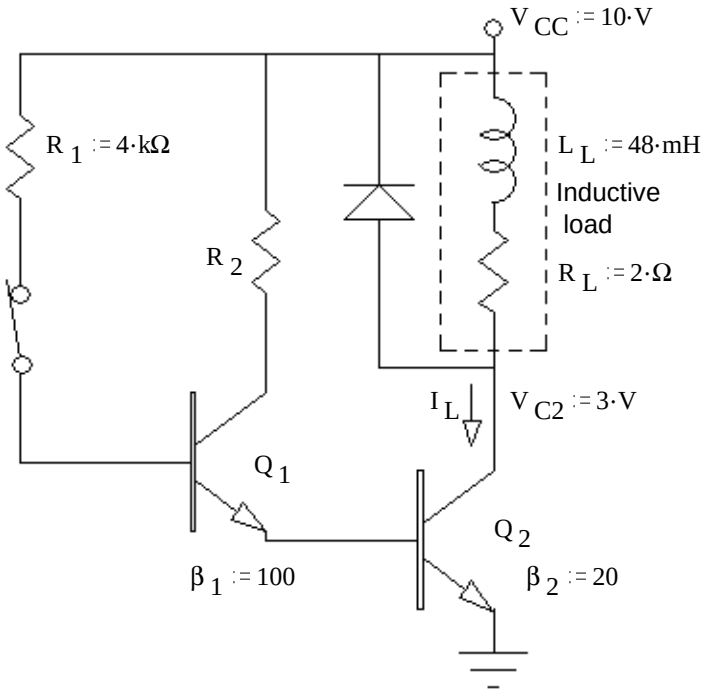
Or explain by other means:

e) If you wanted to build $\mathbf{Z_1}$ in the simplest way, what parts would you need?

4. (32 pts) A couple of transistors are used to control the current flow through an inductive load.

   a) The switch has been closed for a long time. You measure the voltage at the collector of Q_2 to be the value shown (referenced to ground). Find the power dissipated in transistor Q_2 .

   P_{Q2} = ?



   b) Q_1 is in saturation, what is the value of R_2?
   You may assume that the emitter current of Q_1 is approximately equal to the collector current of Q_1.

   R_2 = ?

4, Continued c) Determine if Q_1 actually is saturated. Show how you find this.

Is Q_1 actually saturated? Circle one: yes no

d) Find the minimum value β_2 so that Q_2 will be in saturation. β_{2min} = ?

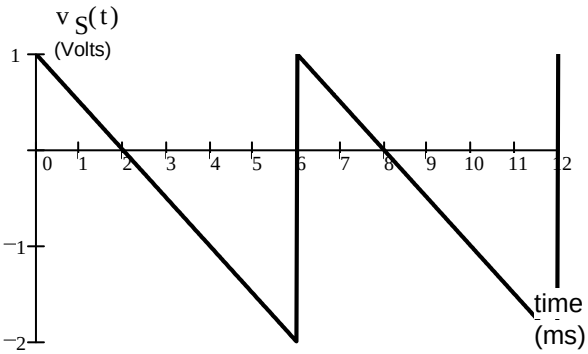
e) Find the power dissipated in transistor Q_2 with the β you just calculated (Q_2 in saturation). P_{Q2} = ?

f) The diode in this circuit conducts a significant current: (circle one)

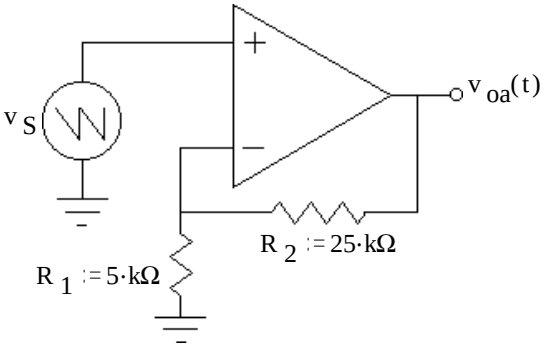
A) never.
B) when the switch first closes.
C) whenever the switch is closed.
D) always.
E) when the switch first opens.
F) whenever the switch is open.

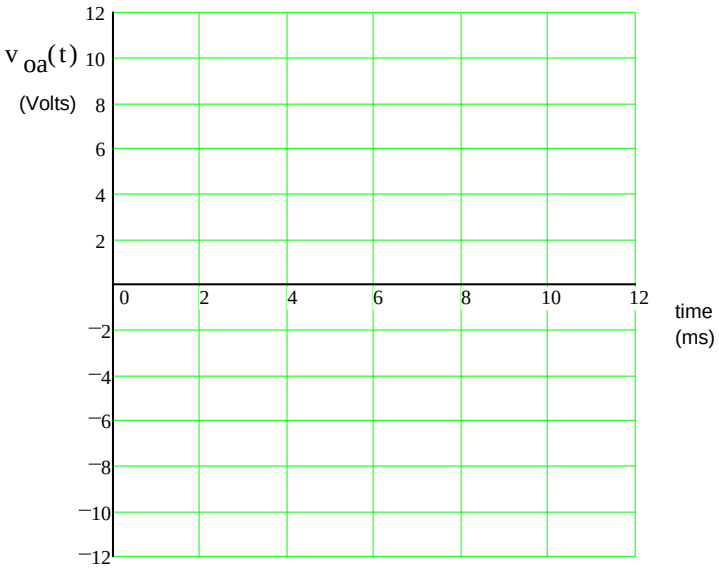
g) What is the maximum diode current you expect when the switch is cycled. (Answer 0 if it never conducts.)
Assume the β_2 of part d (Q_2 in saturation when on).

5. (32 pts) The same input signal (at right) is connected to several op-amp circuits. Sketch the output waveforms for a) and b). Clearly label important voltage levels on the output. If I can't easily make out what your peak values are, I'll assume you don't know. The op-amps are powered by ± 10 V power supplies.

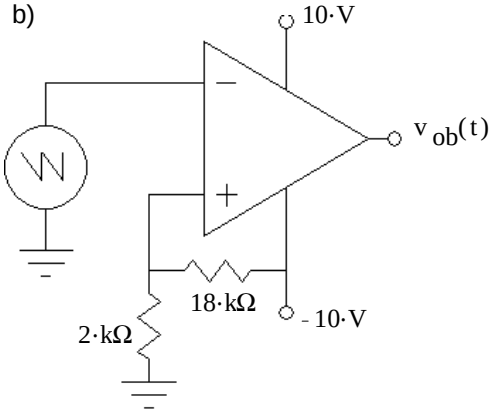


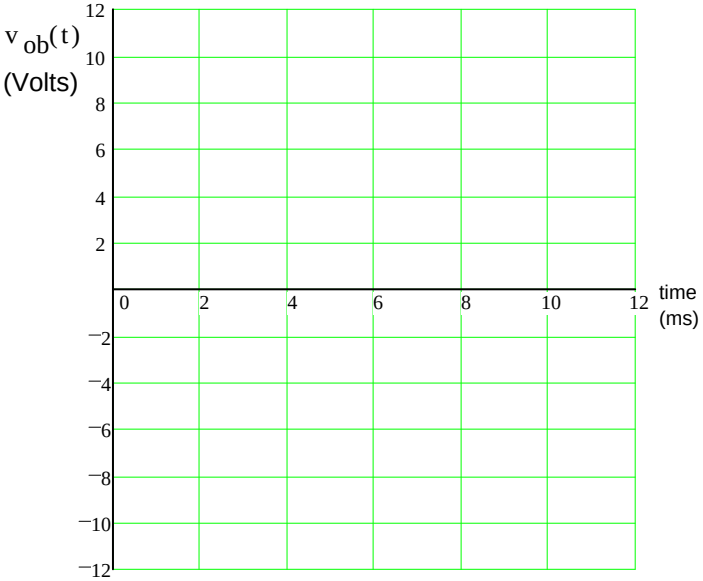
a)



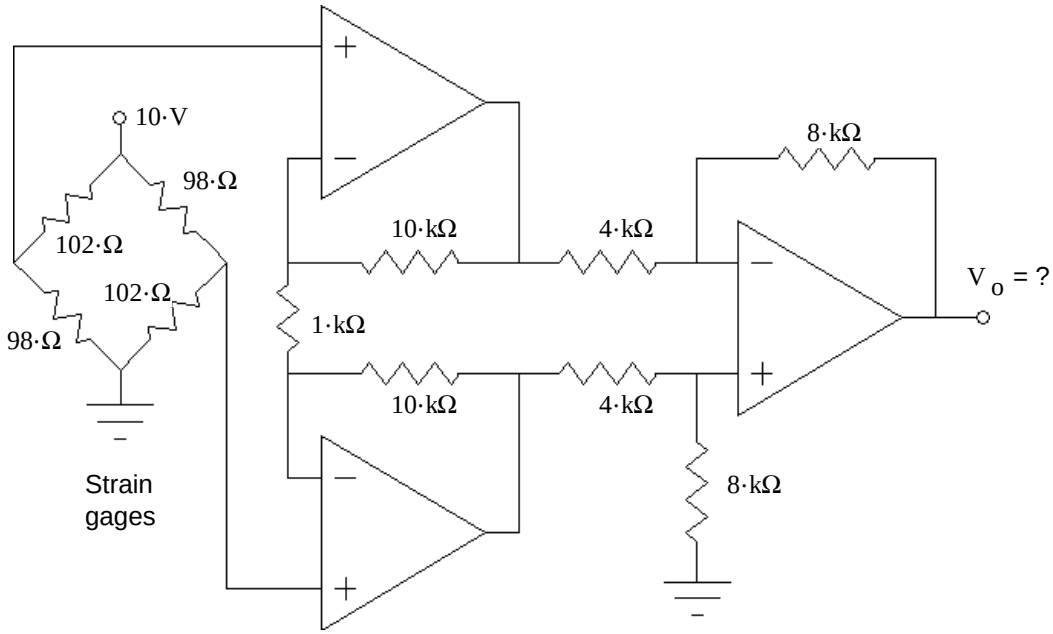


b)





c) The op-amps are powered by ± 10 V power supplies. What output do you expect? SHOW WORK
No waveform sketch required.



Answers

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1. a) $$\frac{\frac{1}{L\cdot C}}{s^2+\left(\frac{1}{R_2\cdot C}+\frac{R_3}{L}\right)\cdot s+\frac{1}{L\cdot C}\cdot\left(\frac{R_3}{R_2}+1\right)}$$

b) 0

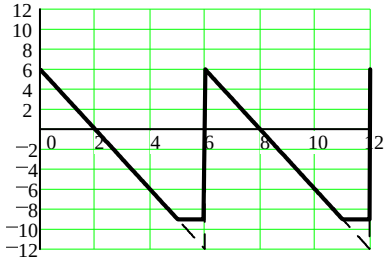
c) 2

2. 128.3Ω /-20.7°

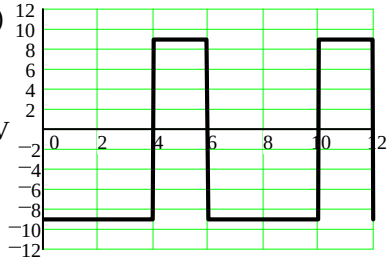
3. a) 60 / 36.87° mA
b) 115.4 / 21° mA
c) 173.85 / 26.43° mA
d) ii) 21° < 36.9°
e) Resistor and Cap

4. a) 10.5·W
b) 52·Ω or 52.52·Ω
c) yes
d) 28
e) 0.98·W
f) E)
g) 4.9·A

5. a)

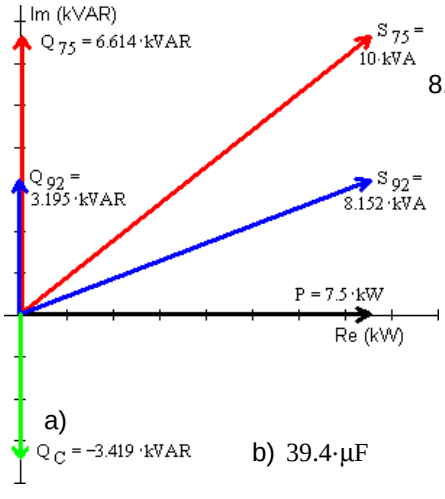


b)



c) 8.4·V

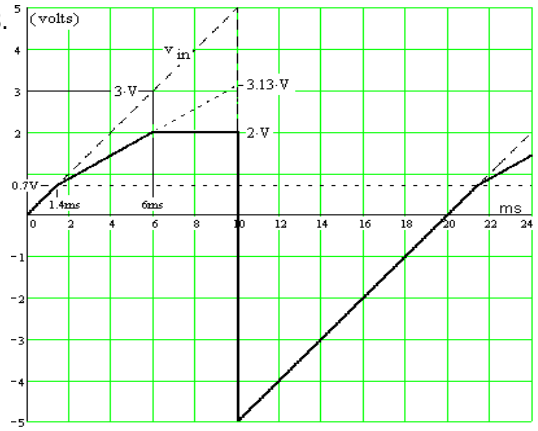
6.



b) 39.4·µF

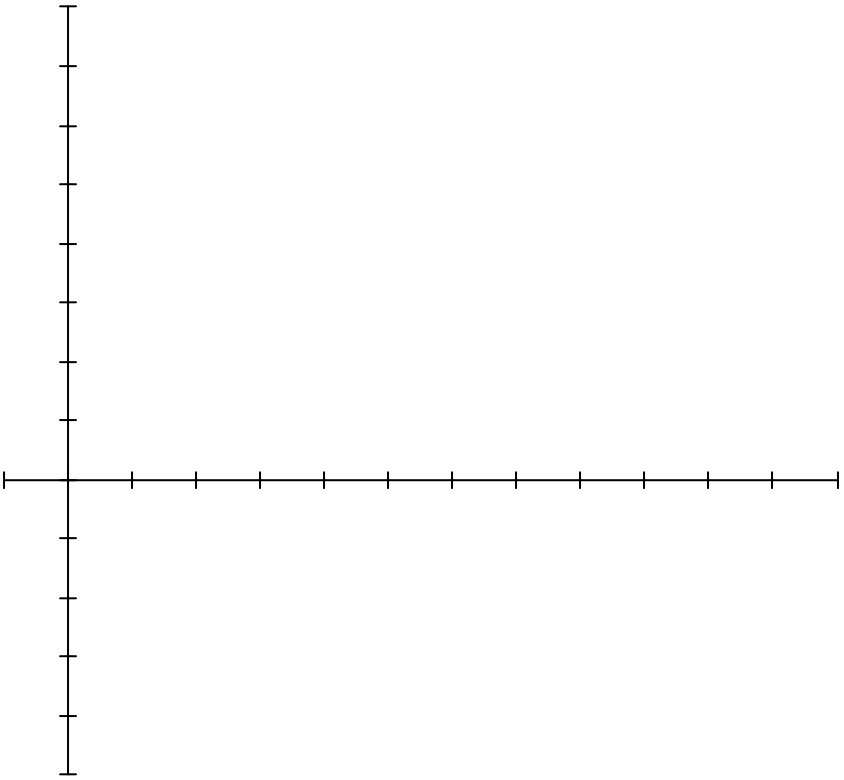
7. a) 480·mA
b) 13.44·V
c) 1.92·A
d) currents are too big

8.



6. (22 pts) A load draws 10kVA at 0.75 pf, lagging when hooked to 480V. A capacitor is hooked in parallel with the load and the power factor is corrected to 0.92, lagging. Find the reactive power (VAR) of the capacitor.

   Draw a phasor diagram as part of the solution and label all the powers.
   Be sure to use correct signs & units for each value.

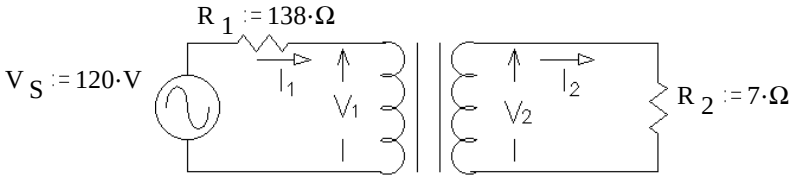


   Note: If you can't find the reactive power (VAR) of the capacitor, mark an X : _____ and use -2500VAR for part b).

   b) Find the value of the capacitor assuming $f = 60\text{Hz}$.

7. (18)The transformer shown in the circuit below is ideal. It is rated at 220/55 V, 100 VA, 60 Hz
Find the following:

a) I_1 = ?

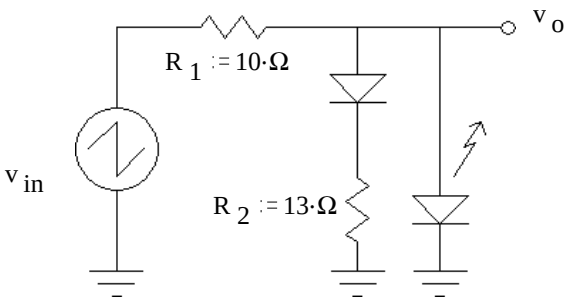


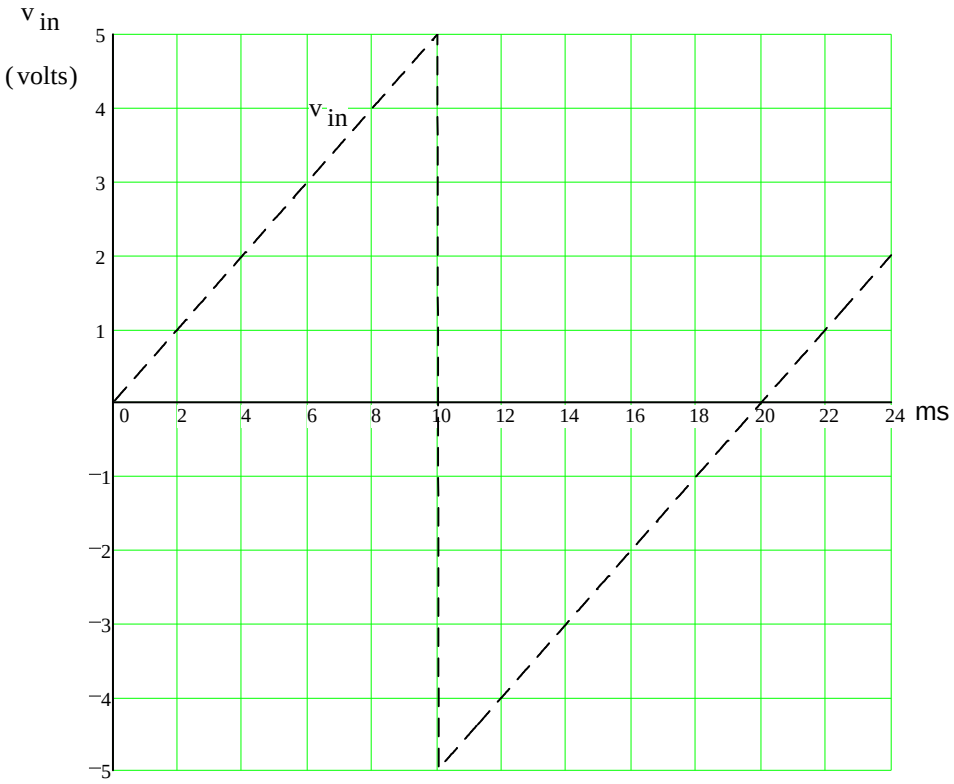
b) V_2 = ?

c) I_2 = ?

d) Is this transformer operating within its ratings? Show your evidence.

8. (18 pts) A voltage waveform (dotted line) is applied to the circuit shown. Accurately draw the output waveform (v_o) you expect to see. Label important times **and** voltage levels.





If you're not specific about your times and voltages, I'll assume you don't know !

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Total _____ / 180 pts

Answers are on page 7