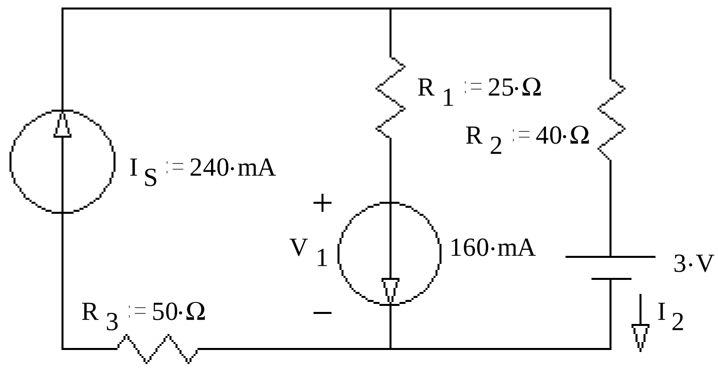
ECE 2210 Final given: Spring 18

Closed Book, Closed notes except preprinted blue sheet, Calculators OK.

Show all work to receive credit. Circle answers, show units, and round off reasonably

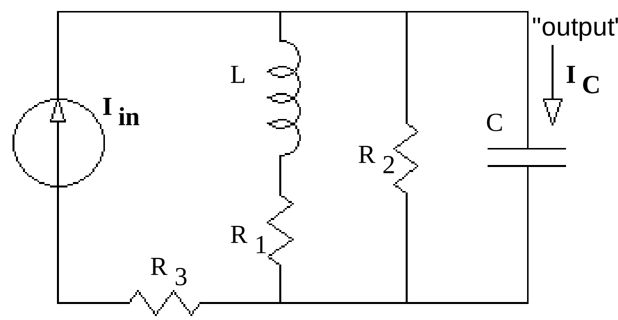
1. (15 pts) a) Find: V_1 & I_2



b) How much power does the 3V voltage source supply to the circuit?

2. (17 pts) a) Find the s-type transfer function of the circuit shown. Consider $\mathbf{I_{in}}$ as the input and $\mathbf{I_C}$ 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.
$\mathbf{H}(s)$ = ?

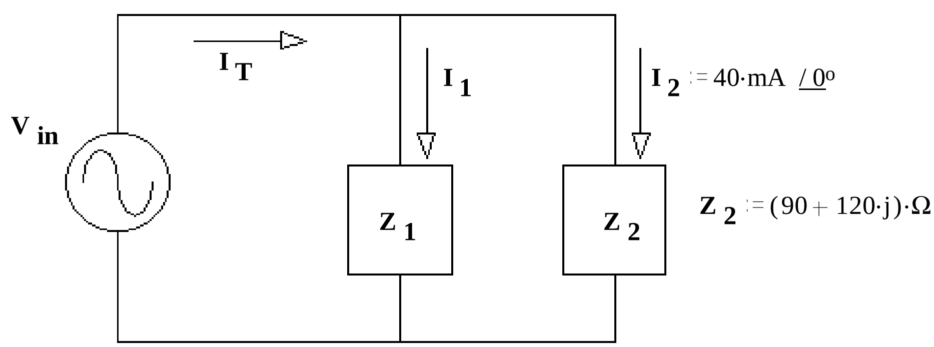


b) How many poles does this transfer function have?

c) Does the transfer function have one or more zeros? If yes, express it (them) in terms of R_1, R_2, R_3, C, & L.

3. (18 pts)

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



b) Find $\mathbf{I_T}$.

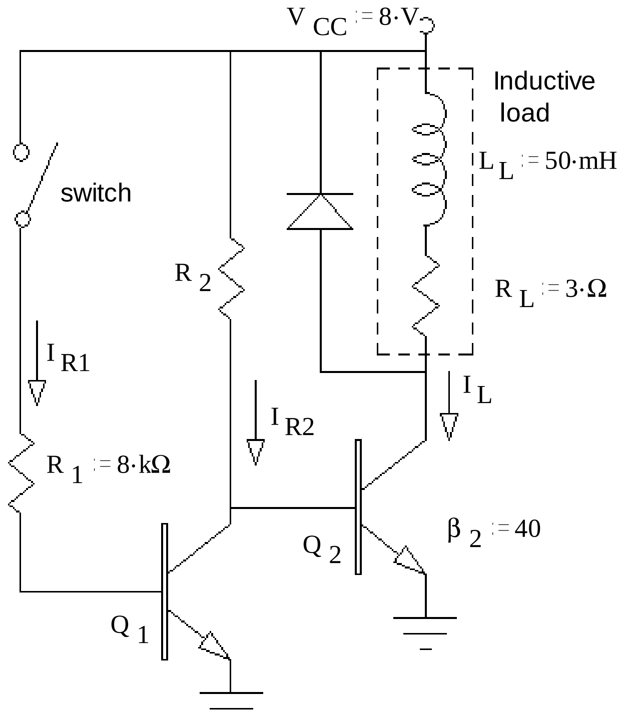
$\mathbf{Z_1} := 50\cdot\Omega\cdot e^{-j\cdot 10\cdot deg}$ 50 $\underline{/-10}^o$ Ω

c) Circle 1: i) The source current leads the source voltage ii) The source voltage leads the source current

d) By how much? I.E. what is the phase angle between the voltage and current?

4. (38 pts) A transistor is used to control the current flow through an inductive load (in the dotted box, it could be a relay coil or a DC motor).
   a) In order for current to flow in through the load, the switch should be: i) closed or ii) open (Circle one)

   b) Assume the switch has been in the position you circled above for a long time and transistor Q_2 is saturated. Find the power dissipated by transistor Q_2 (neglect base current and V_{BE}).
   $P_{Q2} = ?$



   c) Assume β_2 is as shown. Find the maximum value of R_2, so that Q_2 will be in saturation. $R_2 = ?$

Use this value of R_2 for the remainder of the problem

   d) If β_2 were actually half the value shown shown, how much power would be dissipated by transistor Q_2 (neglect base current and V_{BE})? $P_{Q2} = ?$

Use the value of $\beta_2 = 40$ for the remainder of the problem. (**NOT** the half-value)

   e) When the switch is changed from the position you circled in part a), the load current should go to zero. What is the minimum value of β_1 needed to saturate Q_1?

   f) If β_1 were actually half the value you found above, what would I_L be?
   Hints: Q_2 will now be partially on. Some of I_{R2} will flow through Q_1 and the rest will flow into the base of Q_2.

   g) The diode in this circuit conducts a significant current: (circle one)
   A) never. B) when the switch closes. C) whenever the switch is closed.
   D) always. E) when the switch opens. F) whenever the switch is open.

   h) Assuming the conditions of part a) (no half-β's), what is the maximum diode current you expect when the switch is cycled. (Answer 0 if it never conducts.)

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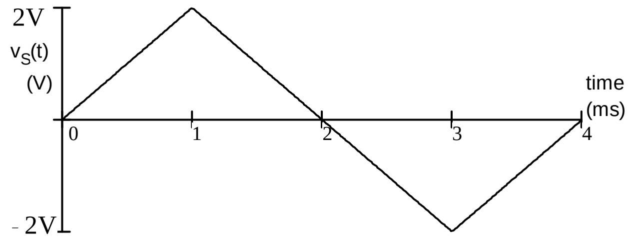
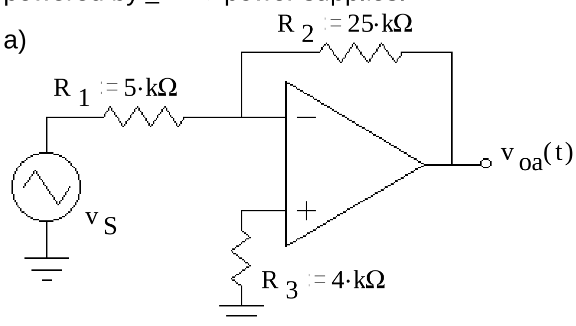
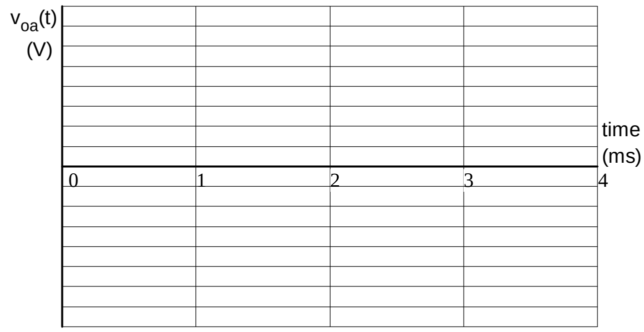
(32 pts) The same input signal (at right) is connected to several op-amp circuits below. Sketch the output waveform for each circuit. Clearly label important voltage levels on each output. If I can't easily make out what your peak values are, I'll assume you don't know. Don't forget to show inversions. All op-amps are powered by ± 12 V power supplies.

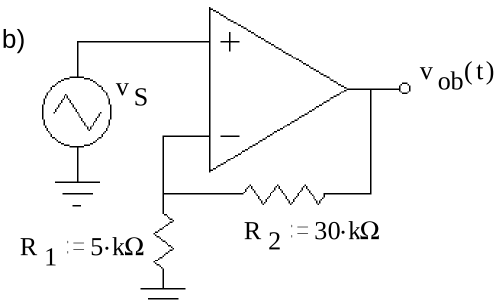


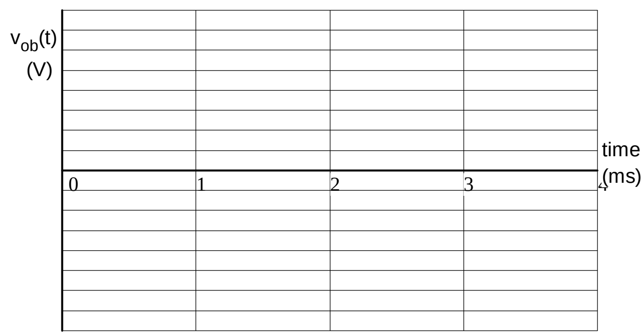
a)



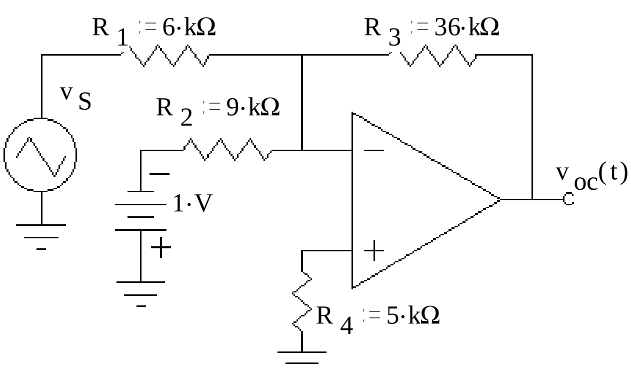


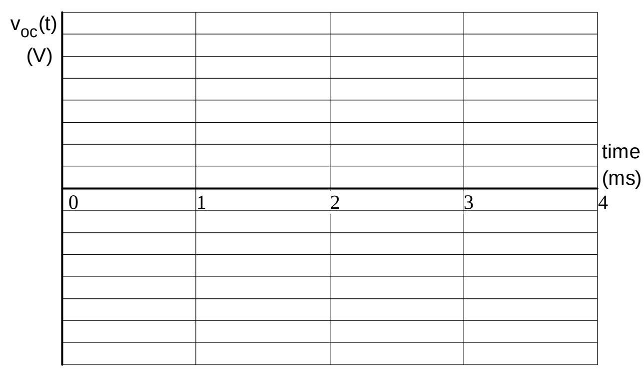
b)



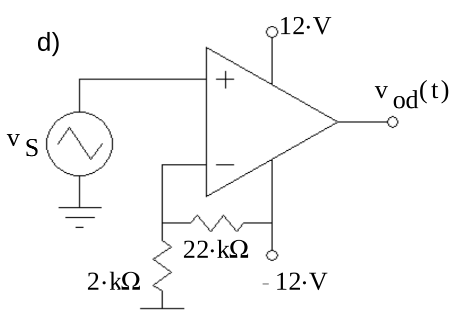


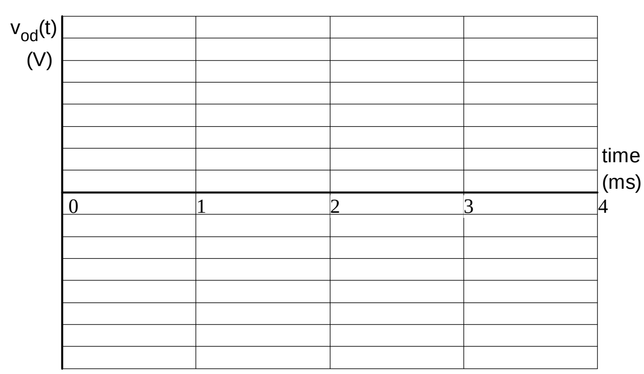
c) Please note the polarity of the 1V DC source.



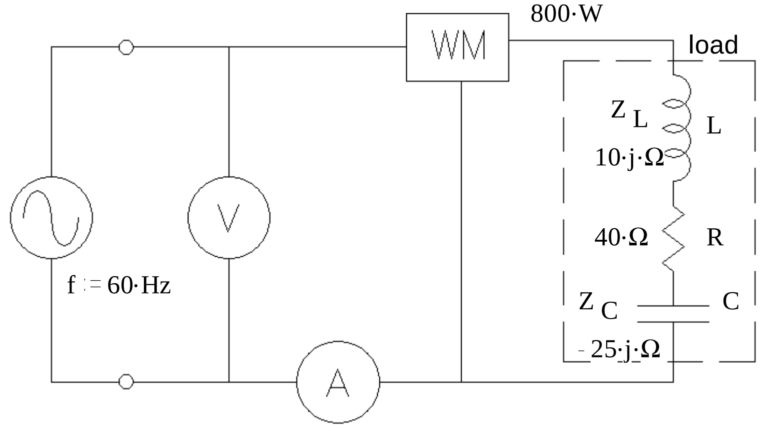


d)





6. (26 pts) L, R, & C together are the load in the circuit shown. The wattmeter measures 800 W. Find the following: Be sure to show the correct units for each value. a) What does the ammeter measure?



b) The total reactive power. Q = ?

c) The complex power. **S** = ?

d) The apparent power. |**S**| = ?

e) What does the voltmeter measure? (give the number)

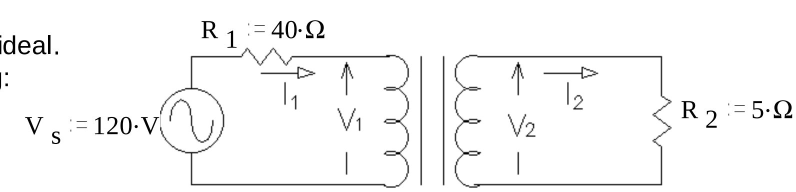
f) The power factor. pf = ?

g) The power factor is: i) leading ii) lagging (circle one)

h) The two components of the load are in a box which cannot be opened. Add (draw it) another component to the circuit above which can correct the power factor (make pf = 1). Show the correct component in the correct place and <u>find its value on the next page</u>. This component should not affect the real power consumption of the load.

7. (16 pts)The transformer shown in the circuit below is ideal. It is rated at 120/30 V, 80 VA, 60 Hz Find the following:

a) I_1 = ?



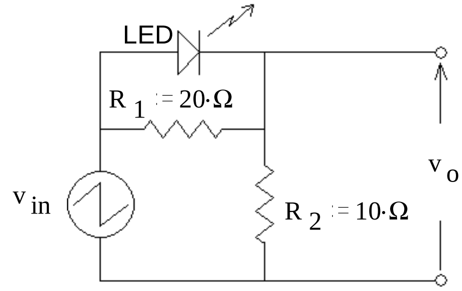
b) V_2 = ?

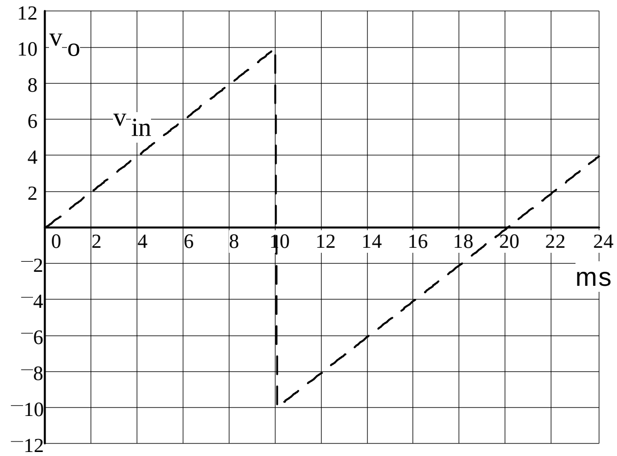
c) Is this transformer operating within its ratings?
How do you know? (Specifically show a values which are or are not within a correct range.)

Do you want your grade and scores posted on the Internet?
If your answer is yes, then provide some sort of alias: ____________________________
otherwise, leave blank

The grades will be posted on line in pdf form in alphabetical order under the alias that you provide here. I **will not** post grades under your real name or an alias that looks like a real name or u-number. The pdf spreadsheet will show the homework, lab, and exam scores of everyone who answers here.

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

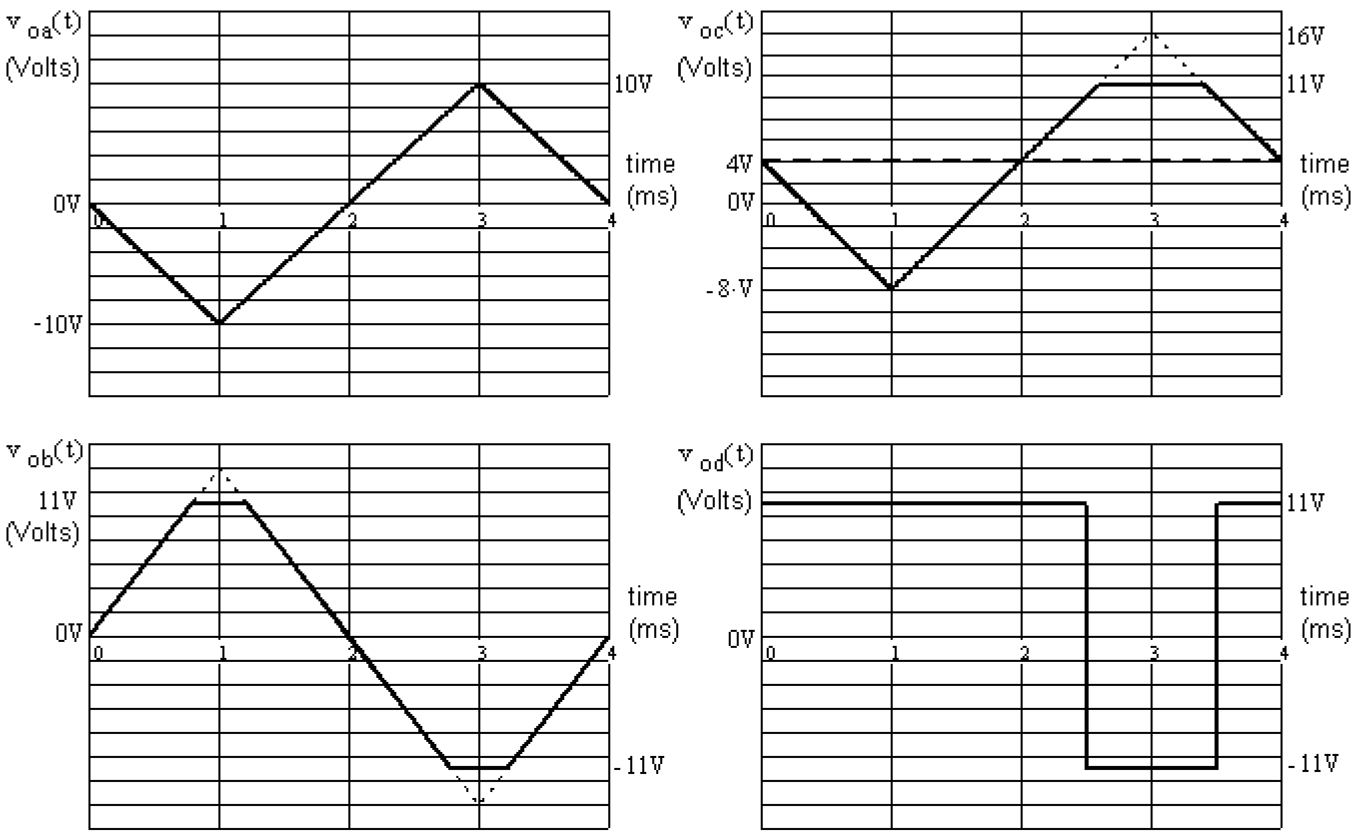




Answers

2. a) $$\frac{s^2 + \frac{R_1}{L}\cdot s}{s^2 + \left(\frac{1}{R_2\cdot C} + \frac{R_1}{L}\right)\cdot s + \frac{1}{L\cdot C}\cdot\left(\frac{R_1}{R_2} + 1\right)}$$ b) 2 c) 0 $-\frac{R_1}{L}$

5.



1. a) $80\cdot mA$ $2.2\cdot V$ b) $-240\cdot mW$

3. a) 6V <u>/53.13</u>° b) 143mA <u>/48.6</u>° c) ii) d) 4.49°

4. a) ii) b) $0.52\cdot W$ c) $112\cdot\Omega$ d) $5.33\cdot W$ e) 76.1 f) $1.21\cdot A$

g) B) h) $2.6\cdot A$ 6. a) $4.47\cdot A$ b) $-300\cdot VAR$ c) $(800 - 300\cdot j)\cdot VA$

d) $854.4\cdot VA$ e) $191\cdot V$ f) 0.936 g) i) h) $323\cdot mH$

7. a) $1\cdot A$ c) $20\cdot V$ c) NO

8.