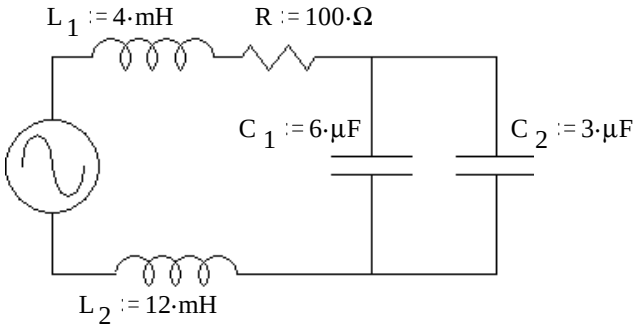
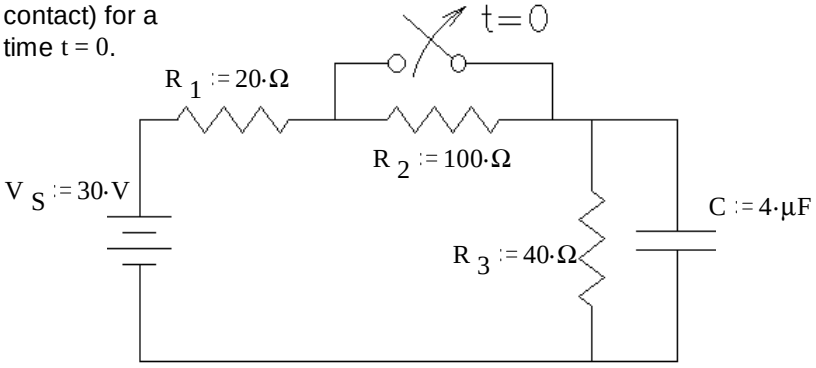
ECE2210 Final given: Spring 17

1. (10 pts) Find the resonant frequency (or frequencies) of the circuit shown (in cycles/sec or Hz).



2. (25 pts) The switch has been closed (making contact) for a long time and is switched open (as shown) at time $t = 0$.

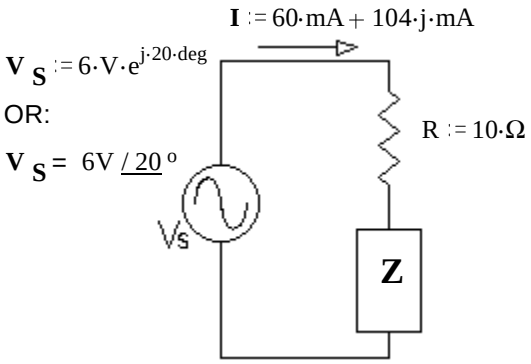
   a) Find the complete expression for $v_C(t)$.



   b) What is v_C when $t = \tau$? $v_C(\tau)$ = ?

   c) At time $t = \tau$ the switch is closed again. Find the complete expression for $v_C(t')$, where t' starts at $t = \tau$. Be sure to clearly show the time constant.

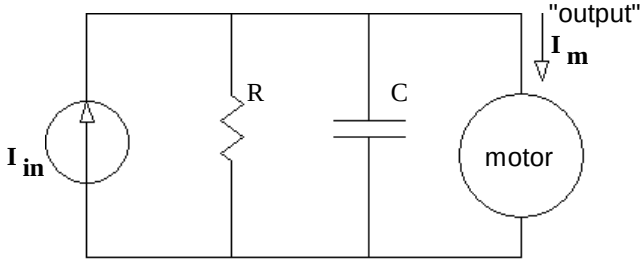
3. (14 pts) Find **Z**. Express in simplest polar or rectangular form.



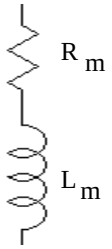
4. (15 pts) a) Find the s-type transfer function of the circuit shown. Consider the motor current ($\mathbf{I_m}$) as the "output".

   You MUST show work to get credit. Simplify your expression for $H(s)$ so that the denominator is a simple polynomial.

$$\mathbf{H}(s) = \frac{\mathbf{I_m}(s)}{\mathbf{I_{in}}(s)} = ?$$



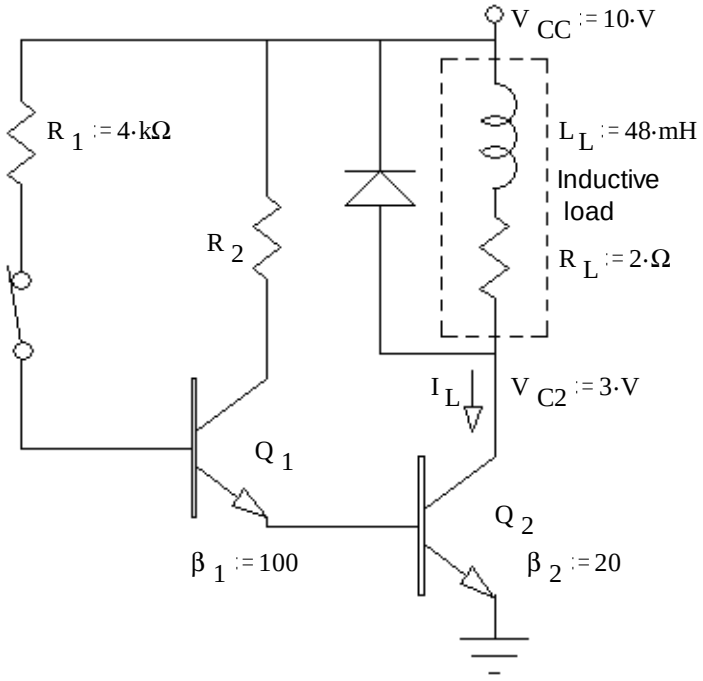
The motor may be modeled as a resistor in series with an inductor, like this:



   b) How many poles does this transfer function have?

   c) How many zeroes does this transfer function have? If it has 1 or more, express them (probably in terms of R_1, C, R_m, and L_m).

5. (30 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 = ?

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} = ?

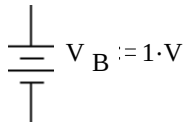
e) Find the power dissipated in transistor Q_2 with the β you just calculated (Q_2 in saturation). P_{Q2} = ?

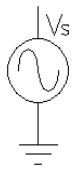
f) The diode in this circuit conducts a significant current: (circle one)

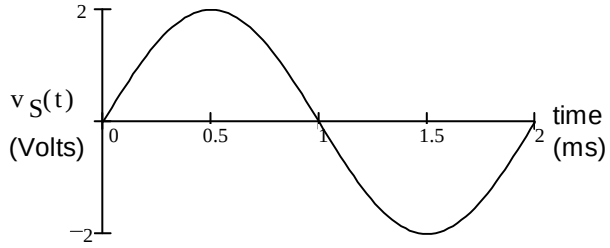
A) never. C) whenever the switch is closed. E) when the switch first opens.
B) when the switch first closes. D) always. F) whenever the switch is open.

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).

6. (34 pts) You have two input voltages to work with.
A 1V battery and the waveform (at right).

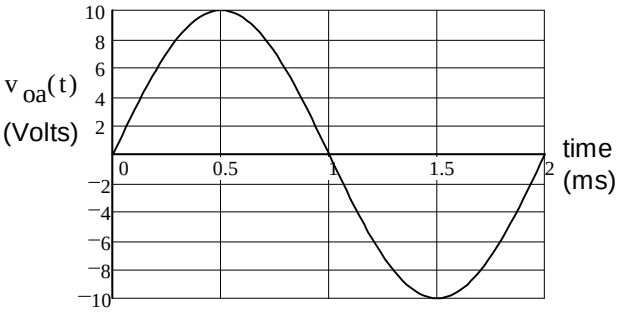




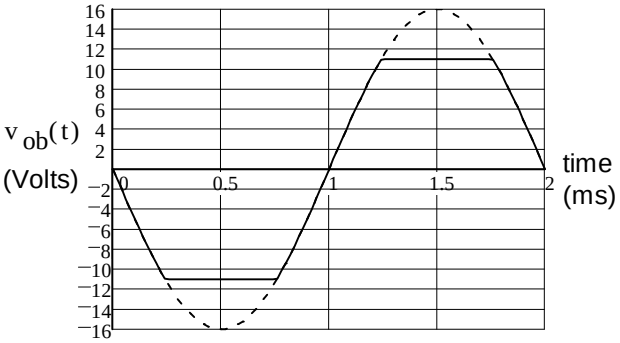


The problems below are op-amp design problems. The answer should be a schematic of a circuit showing the values of all the parts. Use reasonable resistor values (in the 100Ω to 1 MΩ range). Also show how one or both of the sources are hooked up to your circuit. Most circuits won't need both.

a) Design a circuit which will output the waveform at right.

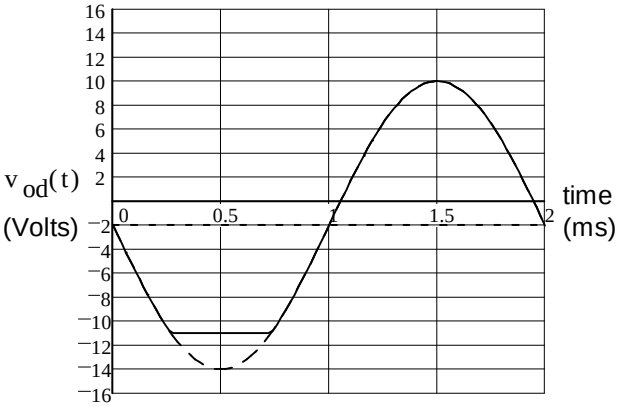


b) Design a circuit which will output the waveform at right.

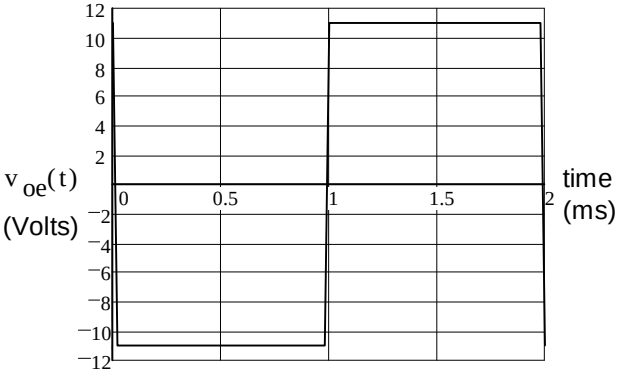


c) What power supply or supplies are being used with your op-amps?

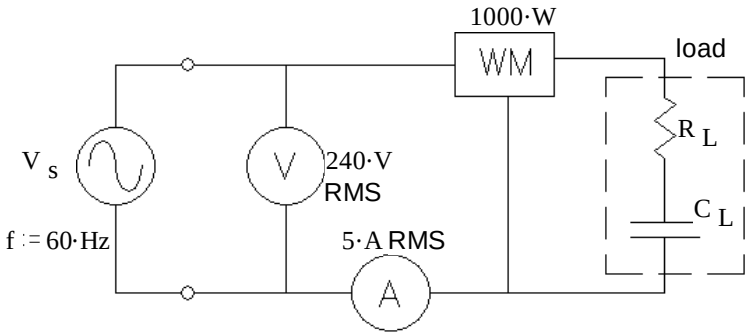
d) Design a circuit which will output the waveform at right.



e) Design a circuit which will output the waveform at right.
Hint: Think nonlinear.



7. (20 pts) R_L, & C_L together are the load in the circuit shown. The voltmeter, ammeter, and wattmeter measurements are shown. Find the following: Include the correct units for each value.



a) The real power. P = ?

b) The value of the load resistor. R_L = ?

c) The apparent power. $|S|$ = ?

d) The reactive power. Q = ?

e) The value of the capacitor. C_L = ?

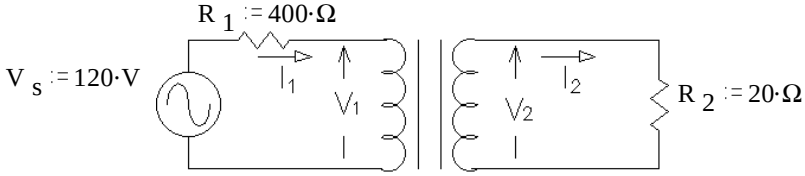
f) The complex power. S = ?

g) The power factor. pf = ?

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

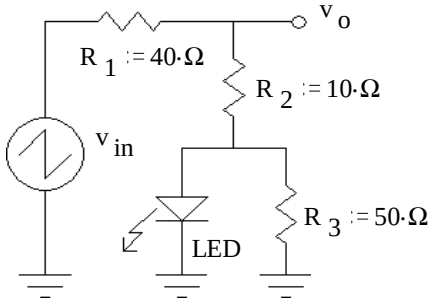
8. (14 pts) The transformer shown in the circuit below is ideal. It is rated at 120/20 V, 8 VA, 60 Hz. Find the following:

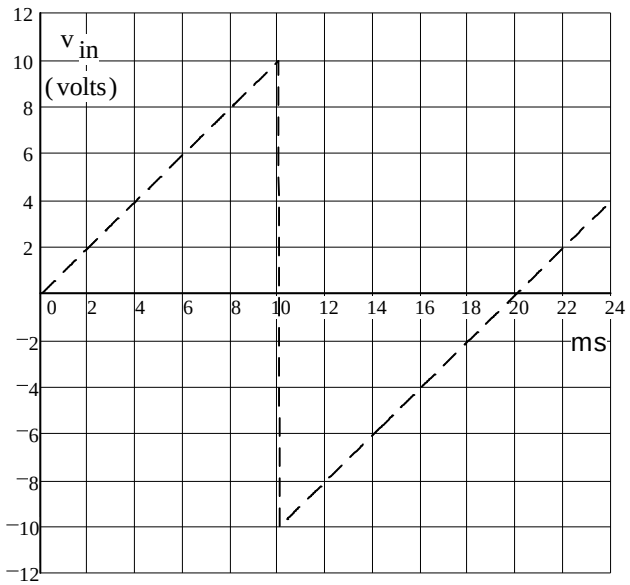
a) I_1 = ?



b) V_2 = ?

9. (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.





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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.

Answers

1. 419·Hz 2. a) $7.5\cdot V + 12.5\cdot V\cdot e^{-\frac{t}{120\cdot\mu s}}$ b) 12.1·V c) $20\cdot V - 7.9\cdot V\cdot e^{-\frac{t}{53.33\cdot\mu s}}$

3. $(28.3 - 32.1\cdot j)\cdot\Omega$ $42.8\Omega \angle -48.7^o$ 4. a) $\frac{\frac{1}{L_m\cdot C}}{s^2 + \left(\frac{R_m}{L_m} + \frac{1}{R\cdot C}\right)\cdot s + \frac{1}{L_m\cdot C}\cdot\left(1 + \frac{R_m}{R}\right)}$ b) 2 c) 0

5. a) 10.5·W b) 52·Ω OR 52.52·Ω
   c) $\frac{I_{C1}}{I_{B1}} < 100$ YES d) 28
   e) 0.98·W f) E) g) 4.9·A

6. a) Non-inverting amp with $R_f = 4R_1$.
   b) Inverting amp with $R_f = 8R_1$. c) ± 12V
   d) Summer with $R_f = 6R_1$ & $R_f = 2R_2$, waveform is hooked to R_1, battery + terminal is hooked to R_2 and **-** to ground.
   e) Comparator, waveform is hooked to inverting (-) input, noninverting (+) input is hooked to ground.

7. a) 1000·W b) 40·Ω c) 1.2·kVA
   d) -663·VAR e) 100·µF
   f) $(1 - 0.663\cdot j)\cdot kVA = 1.2\ kVA \angle -33.6^o$ h) i)

8. 107·mA b) 12.9·V

9.