

ECE 2210 Final given: Spring 16

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

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

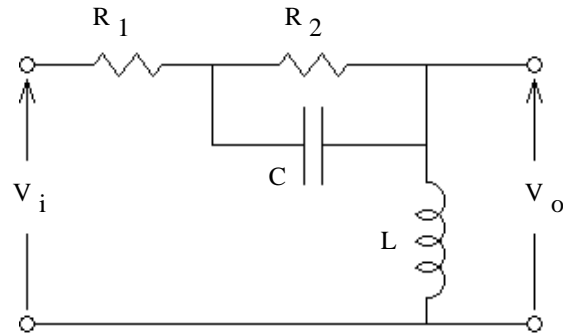
1. (17 pts) a) Find the s-type transfer function of the circuit shown.

V_i is the input and V_o is the output.

You **MUST** show work to get credit.

Simplify your expression for $H(s)$ so that the denominator is a simple polynomial.

$H(s) = ?$

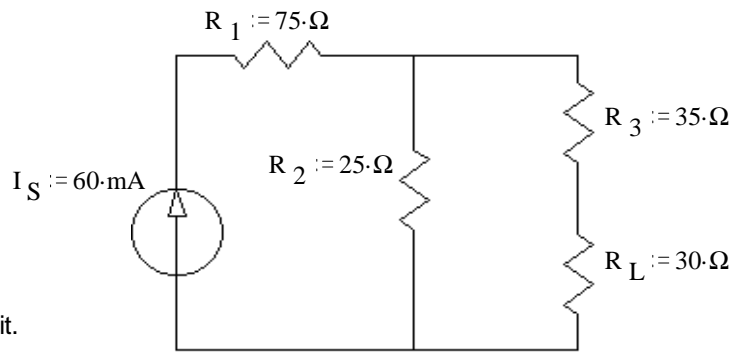


b) Find the characteristic equation of the circuit shown.

c) The solutions to the characteristic equation are called the _____ of the transfer function.

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

2. (22 pts) a) Find and draw the Thévenin equivalent of the circuit shown. The load resistor is R_L .



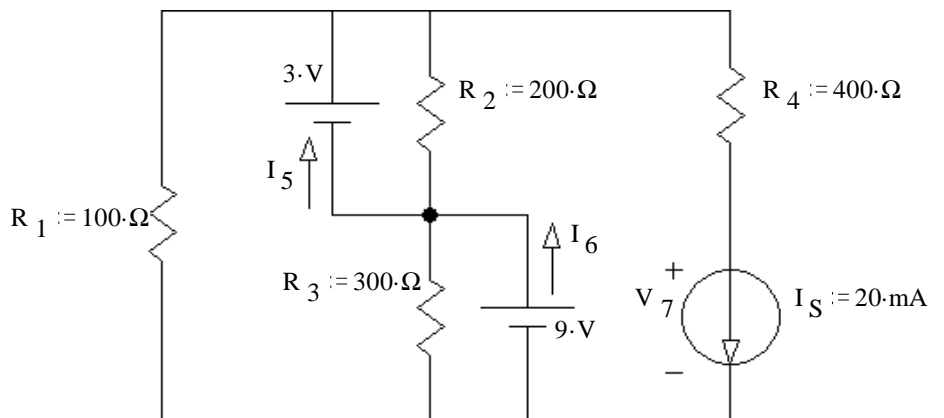
b) Find and draw the Norton equivalent of the same circuit.

c) Find the load voltage using your Thévenin equivalent circuit.

d) Choose a different value of R_L so as to maximize the power dissipated in R_L . Find that maximum power, P_L .

3. (18 pts)

a) Find: I_5 , I_6 & V_7



b) I_S Supplies how much power to the circuit?

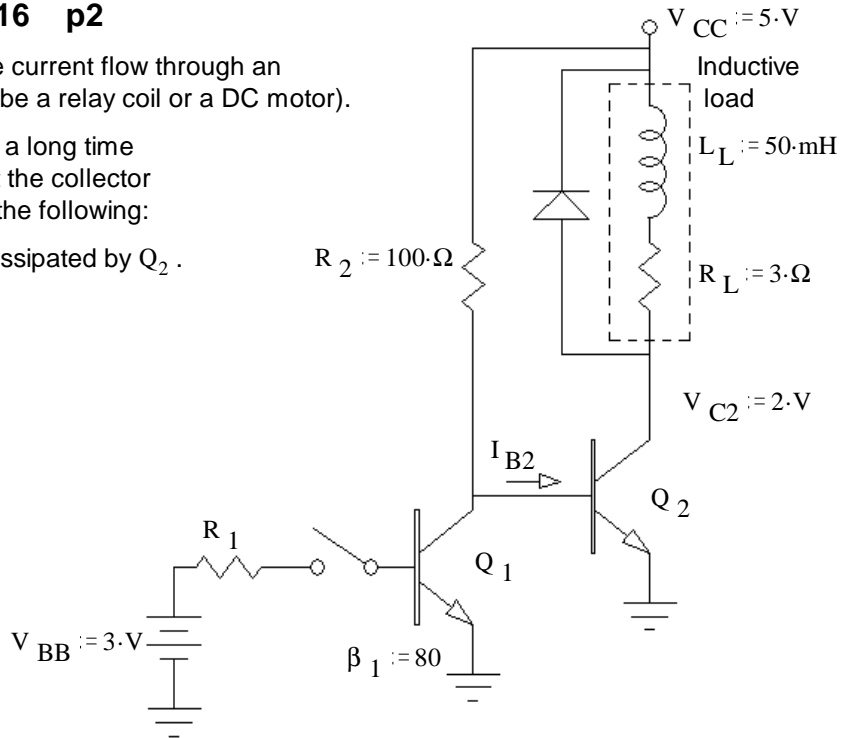
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4. (37 pts) A transistor is used to control the current flow through an inductive load (in the dotted box, it could be a relay coil or a DC motor).

a) Assume the switch has been open for a long time and you measure the nodal voltage at the collector of Q_2 as shown on the drawing. Find the following:

$P_{Q2} = ?$ (The approximate power dissipated by Q_2 .

$\beta_2 = ?$



b) When the switch is open, you would like transistor Q_2 to saturate.

What minimum β_2 would be required to achieve saturation?

c) You replace Q_2 . So $\beta_2 := 50$ Find $P_{Q2} = ?$

d) When the switch is closed, you would like transistor Q_1 to saturate.

Find the maximum value of R_1 , so that transistor Q_1 will be in saturation. $\beta_1 = 80$

Use this value of R_1 for the remainder of the problem

e) If the switch is closed for a long time, what voltage should you measure the collector of Q_2 ?

$V_{C2} = ?$

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

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

g) R_1 , is that found in part d). The switch is opened and closed a few times.

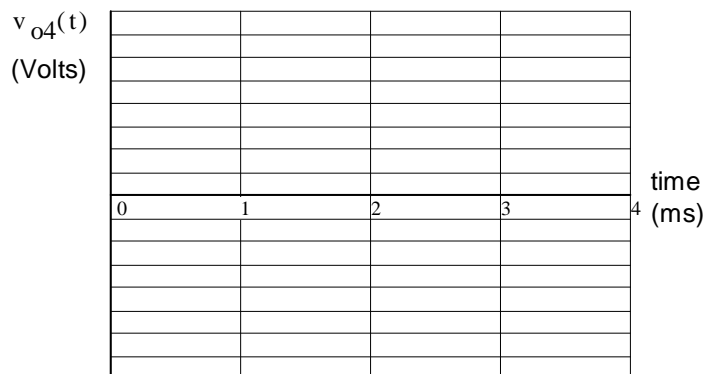
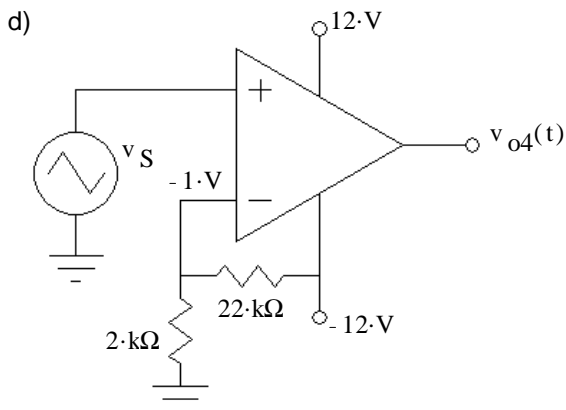
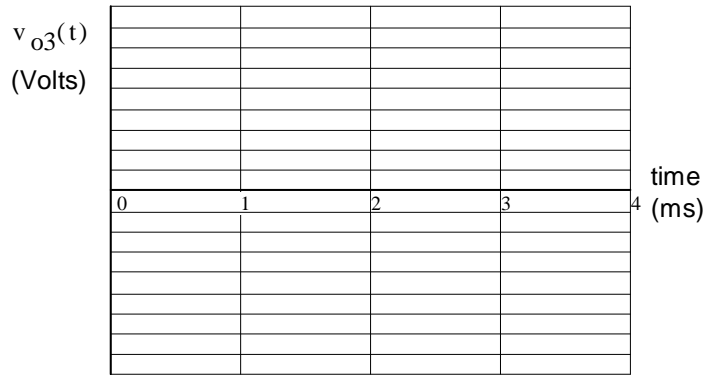
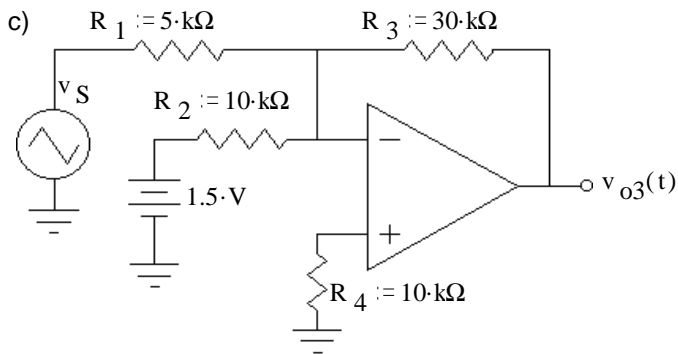
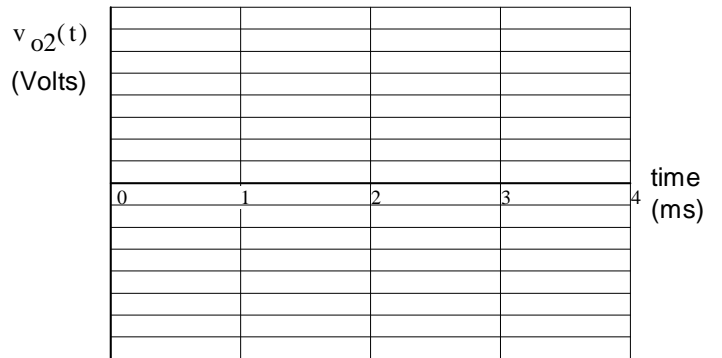
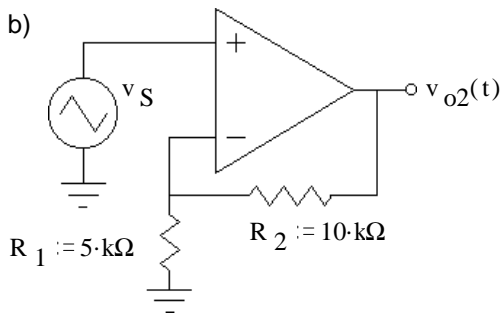
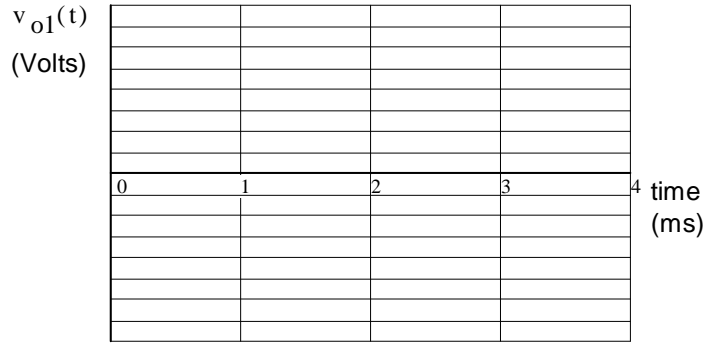
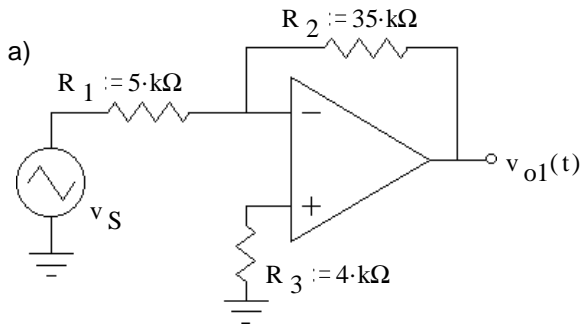
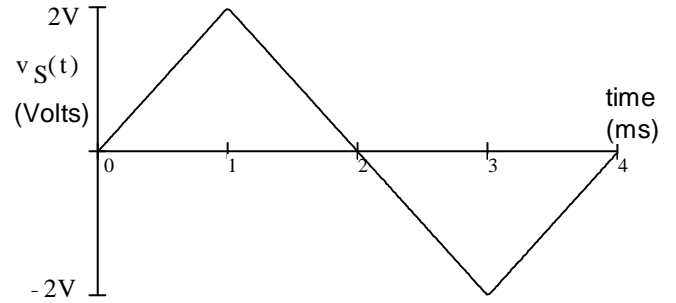
What is the maximum diode current you expect. (Answer 0 if it never conducts.)

h) Transistor Q_1 is bad and $\beta_1 := 40$ The switch is closed for a long time, how much current will flow into the base of Q_2 ?

$I_{B2} = ?$

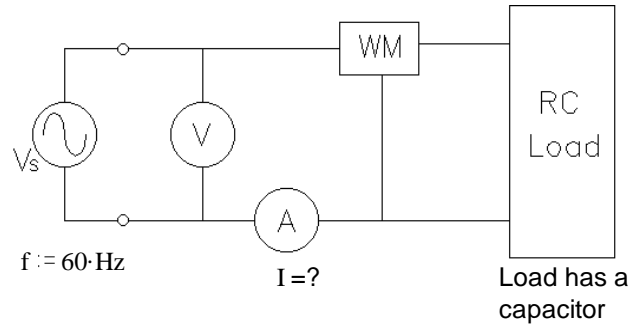
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5. (32 pts) The same input signal (at right) is connected to several op-amp circuits below. Sketch the output waveform for each circuit. Clearly label important voltage levels on each output. If I can't easily make out what your peak values are, I'll assume you don't know. Don't forget to show inversions. All op-amps are powered by $\pm 12\text{ V}$ power supplies.



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6. (20 pts) A load is made of a resistor and a capacitor. The RMS voltmeter measures 220 V, the wattmeter measures 560 W, and the power factor is 82%. Find the following:
- The reading on the RMS ammeter.



- The apparent power. $|S| = ?$

- The reactive power. $Q = ?$

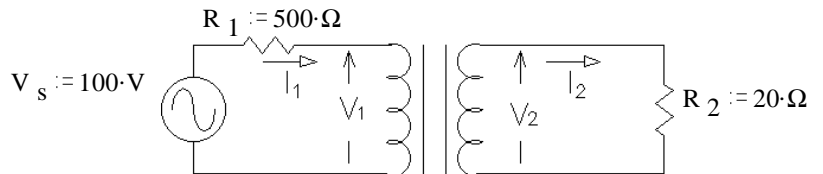
- The complex power. $S = ?$

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

- The load box 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 find its value. This component should not affect the real power consumption of the load.

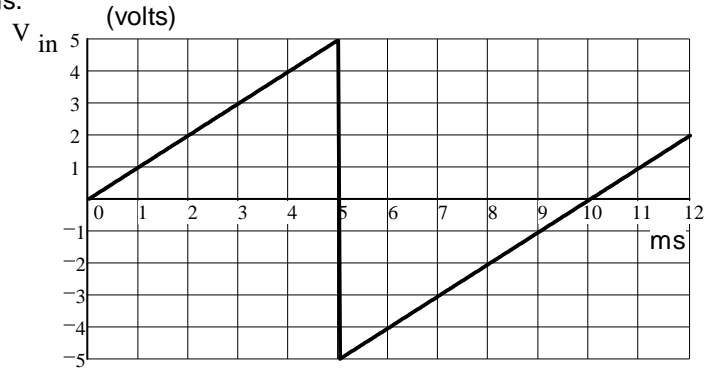
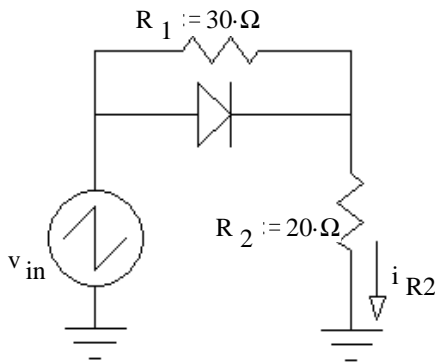
7. (14 pts) The transformer shown in the circuit below is ideal. It is rated at 120/12 V, 8 VA, 60 Hz Find the following:

- $I_1 = ?$
- $V_2 = ?$



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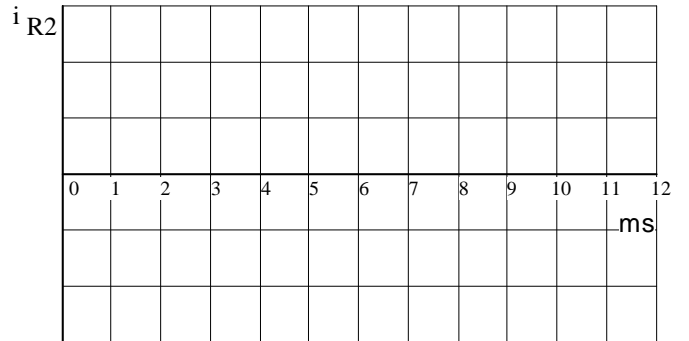
8. (20 pts) A voltage waveform is applied to the circuit shown. Accurately draw the R_2 current waveform (i_{R2}) that you expect to see. Label important times and current levels.



9. 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

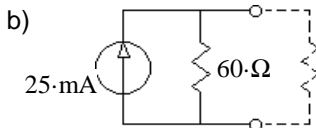
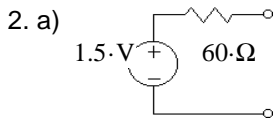
The grades will be posted on line in pdf form in alphabetical order under the alias that you provide here. I **will not** post grades under your real name or an alias that looks like a real name or u-number. It will show the homework, lab, and exam scores of everyone who answers here.



Answers

1. a) $H(s) = \frac{s^2 + \frac{1}{C \cdot R_2}}{s^2 + \left(\frac{R_1}{L} + \frac{1}{R_2 \cdot C}\right) \cdot s + \left(1 + \frac{R_1}{R_2}\right) \cdot \frac{1}{L \cdot C}}$

b) $0 = s^2 + \left(\frac{R_1}{L} + \frac{1}{R_2 \cdot C}\right) \cdot s + \left(1 + \frac{R_1}{R_2}\right) \cdot \frac{1}{L \cdot C}$ c) poles
 d) $s = 0$ and $-\frac{1}{C \cdot R_2}$



c) 0.5·V
 b) 9.375·mA

3. a) 155·mA 170·mA 4·V
 b) -80·mW

4. a) 2·W 23.3 b) 37.2 c) 0.32·W
 d) 3.8·kΩ e) 5·V f) D)
 g) 1.6·A h) 19·mA

6. a) 3.1·A b) 683·VA c) -391·VAR
 d) (560 - 391·j)·VA e) leading
 g) 328·mH inductor in parallel with load

7. a) 40·mA b) 8·V

