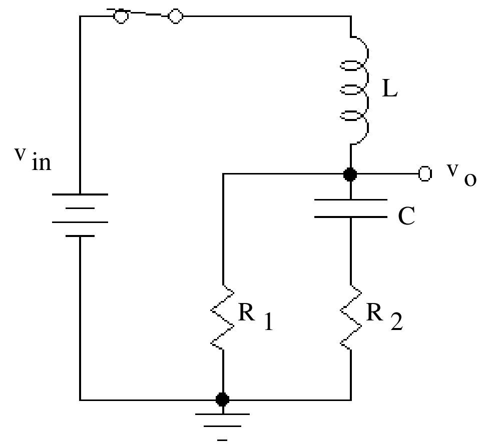
ECE1050 Final given: Fall 04

1. (16 pts) a) Find the transfer function of the circuit shown.
   v_{in} is the input and v_o is the output.
   You <u>MUST</u> show work to get credit.
   Simplify your expression for H(s) so that the denominator is a simple polynomial, but you DO NOT need to isolate the s^2 term, meaning it may be multiplied by a constant, like this:

   b) Find the characteristic equation of the circuit shown.

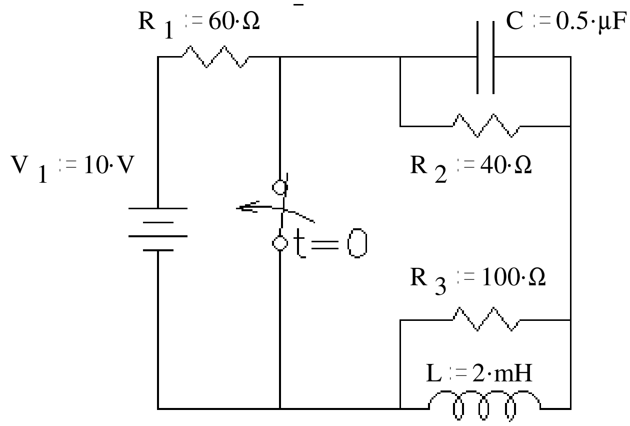


2. (20 pts) Consider the circuit at right. The switch has been openn for a long time and is closed at time t = 0.

   a) What are the final conditions of i_L and the v_C?
   $i_L(\infty)$ = ? $v_C(\infty)$ = ?

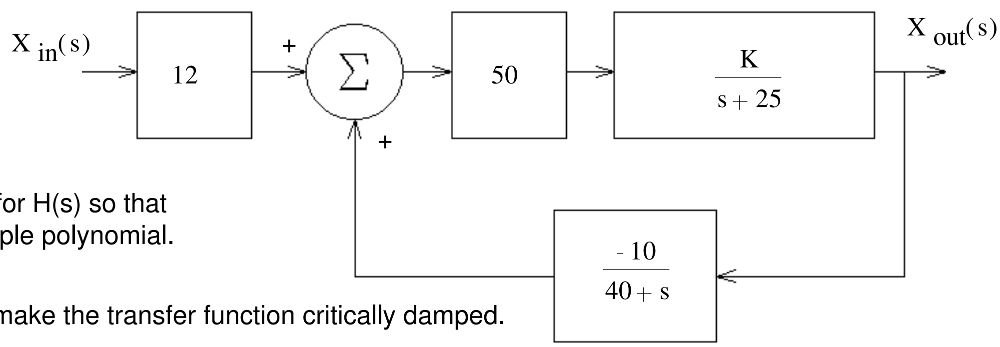
   b) Find the initial condition and intial slope of i_L that you would need to have in order to find all the constants in $i_L(t)$. Don't find $i_L(t)$ or it's constants, just the initial conditions.

   c) Find the initial condition and intial slope of v_C that you would need to have in order to find all the constants in $v_C(t)$. Don't find $v_C(t)$ or it's constants, just the initial conditions.



3. (20 pts) a) A feedback system is shown in the figure. What is the transfer function of the whole system, with feedback.

$$H(s) = \frac{X_{out}(s)}{X_{in}(s)} = ?$$



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

   b) Find the value of K to make the transfer function critically damped.

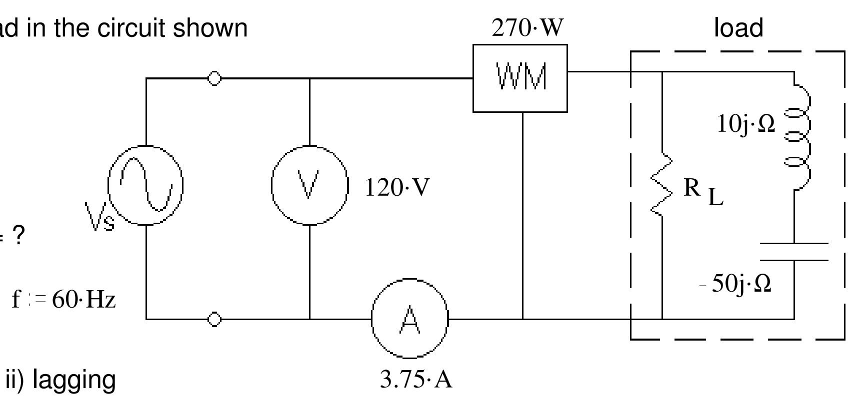
   c) If K is **less** than this value the system will be: underdamped or overdamped Circle one

4. (17 pts) R, L, & C together are the load in the circuit shown
   The RMS voltmeter measures 120 V.
   The RMS ammeter measures 3.75 A.
   The wattmeter measures 270 W.
   Find the following: Be sure to show the correct units for each value.

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

   b) The reactive power. Q = ?

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



   d) The 3 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</u>. This component should not affect the real power consumption of the load.

5. (19 pts) In the circuit shown, use the constant-voltage-drop model for the silicon diode.

   a) Assume that diode D_1 does NOT conduct.
   Assume that diode D_2 does conduct.

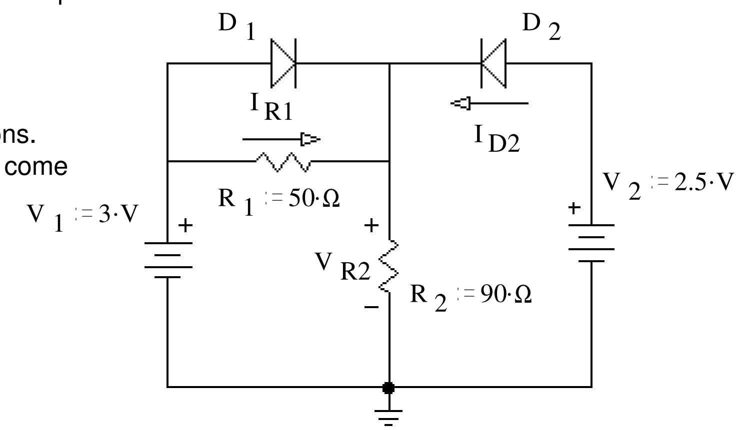
   Find V_{R2}, V_{R1}, I_{R1}, & I_{D2}, based on these assumptions.
   Stick with these assumptions even if your answers come out absurd. Hint: think in nodal voltages.

   V_{R2} = ________

   V_{R1} = ________

   I_{R1} = ________

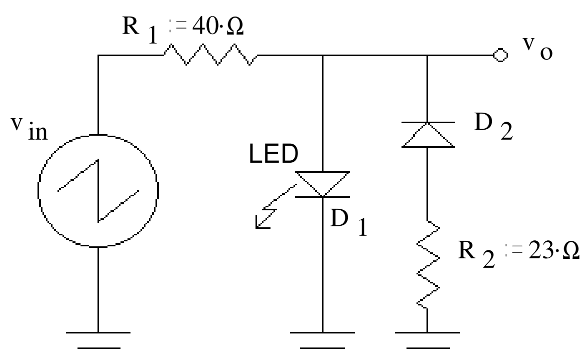
   I_{D2} = ________

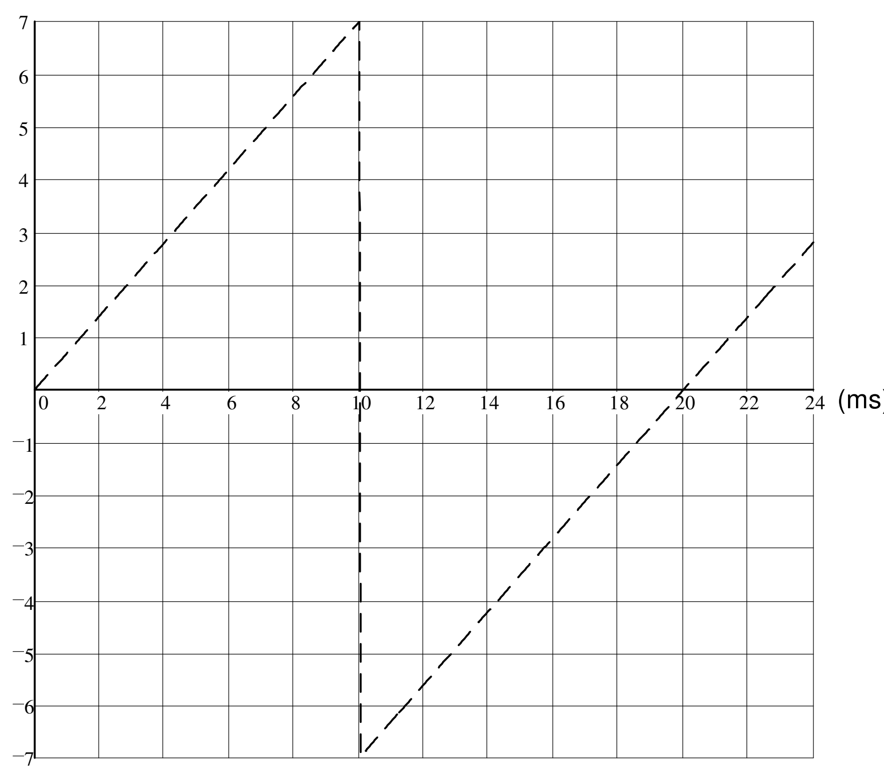


   b) Based on your numbers above, does it look like the assumption about D_1 was correct? yes no (circle one)
   How do you know? (Specifically show a value which is or is not within a correct range.)

   c) Based on your numbers above, does it look like the assumption about D_2 was correct? yes no (circle one)
   How do you know?

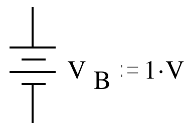
6. (18 pts) A voltage waveform (dotted line) is applied to the circuits shown. Accurately draw the output waveform (v_o) you expect to see. Label important times **and** voltage levels.

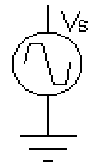


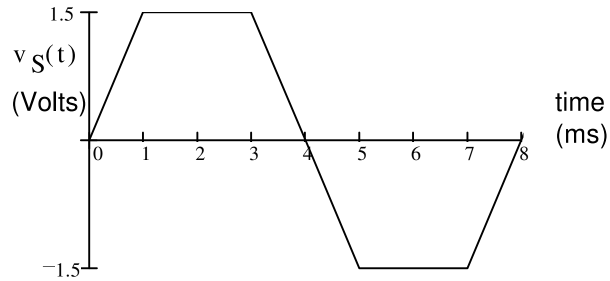


Label important times **and** voltage levels.

7. (34 pts) You have two input voltages to work with.
   A 1V battery and the waveform (at right).

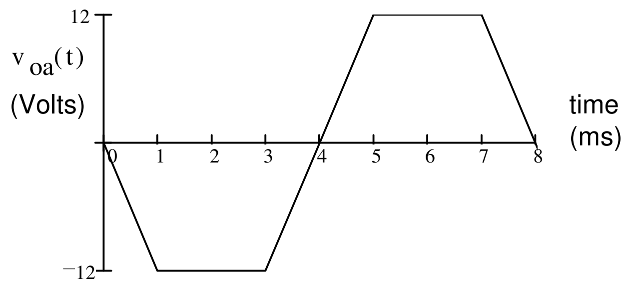




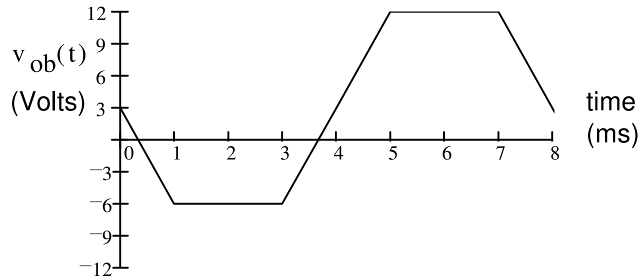


The problems below are op-amp design problems. The answer should be a schematic of a circuit showing the values of all the parts. Use reasonable resistor values (in the 100Ω to 1 MΩ range). Also show how one or both of the sources are hooked up to your circuit. Most circuits won' t need both.

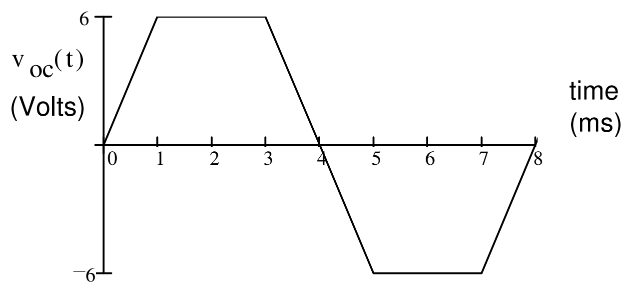
a) Design a circuit which will output the waveform at right.



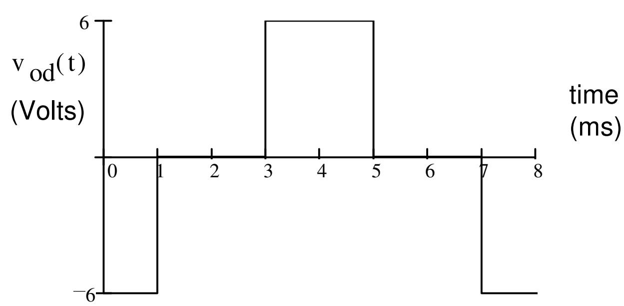
b) Design a circuit which will output the waveform at right.



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



d) Design a circuit which will output the waveform at right.
Hint: Think differentiation.



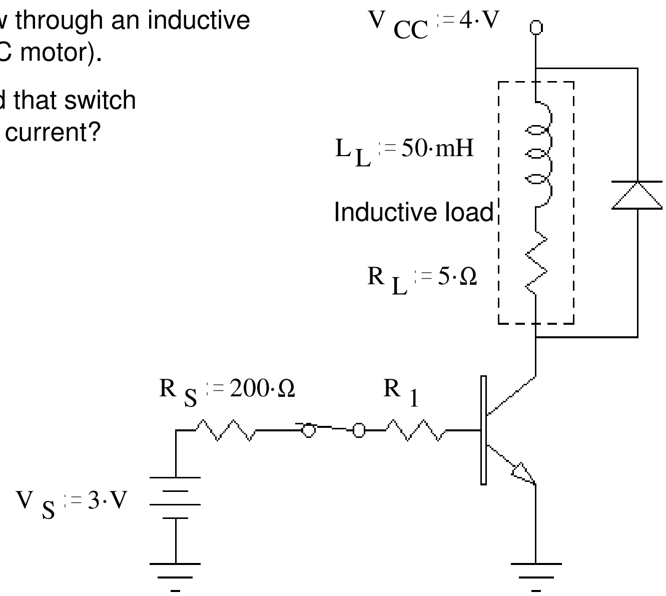
"Problems" out of order

9. Do you want your grade and scores posted on my door and on the internet? Yes No (Circle one)

   If your answer is yes, then provide some sort of alias or password: ________________________

   The grades will be posted on my door in alphabetical order under the alias that you provide here. I will not post grades under your real name. The internet version will be a pdf file or an excel spreadsheet which you can download. Both will show all your homework, lab, and exam scores.

8. (22 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 transistor is in saturation (fully on) and that switch has been closed for a long time. What is the load current?

   $I_C = ?$

   b) $\beta := 80$ find the maximum value of R_1, so that the transistor will be in saturation.

   Use this R_1 for the rest of the problem.

   c) You got a bad transistor. $\beta := 40$
   Find the new I_C, and V_{CE} and P_Q.

   $I_C = ?$ $V_{CE} = ?$ $P_Q = ?$

   The power dissipation was too high for the transistor and it burned out. You replace the transistor with a new one that has $\beta \geq 80$

   d) The diode in this circuit conducts a significant current:
   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.

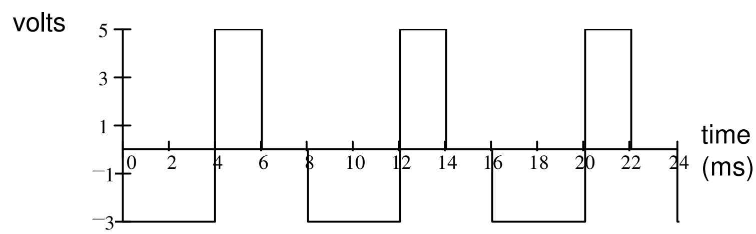
   (circle one)

   e) The switch is opened and closed a few times. What is the maximum diode current you expect. (Answer 0 if it never conducts.)

10. (14 pts) For waveform shown, find:

   a) Average DC (V_{DC}) value

   b) RMS (effective) value



Answers

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

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

2.a) $v_C(\infty) = 0\cdot V$ $i_L(\infty) = 0\cdot mA$ b) $100\cdot mA$ $-2000\cdot\frac{A}{sec}$ c) $4\cdot V$ $-80000\cdot\frac{V}{sec}$

3.a $$H(s) = 12\cdot\frac{(50\cdot K)\cdot s + K\cdot 2000}{s^2 + 65\cdot s + 500\cdot K + 1000}$$ b) 0.113 c) overdamped

4. a) 53.3Ω $10j\cdot\Omega - 50j\cdot\Omega = -40j\cdot\Omega$ so load is capacitive b) -360VAR c) leading
   d) Add a 106mH inductor in parallel with load

5. a) 1.8V 1.2V 24mA -4mA b) no, $V_{D1} = 1.2V > 0.7V$ c) no, $I_{D2} = -4mA < 0$

6. Straight lines between the following points:
   (0ms, 0), (2.86ms, 2V), (10ms, 2V), (10ms, -3V), (19ms, -0.7V), (22.86ms, 2V), flat at 2V

7.a) inverting amp with $R_f = 8R_1$ b) summer with $R_f = 6R_1$ waveform is hooked to R_1 & $R_f = 3R_2$ battery **-** terminal is hooked to R_2 and + to ground
   c) non-inverting amp with $R_f = 3R_1$ d) differentiator with $R_f = 6V/(C(1500V/s))$, if $C = 1\mu F$ then $R_f = 4k\Omega$

8. a) $0.76\cdot A$ b) $42.1\cdot\Omega$ c) $380\cdot mA$ $21\cdot V$ $0.798\cdot W$ c) B d) $0.76\cdot A$

10. a) -0.25V b) 3.28V

ECE 1050 Final

Name ____________________________
Scores:
page 1-2 _________ / 36 pts
page 3-4 _________ / 37 pts
page 5-6 _________ / 37 pts
page 7-8 _________ / 34 pts
page 8-9 _________ / 22 pts
page 10 _________ / 14 pts

Total _________ / 180 pts