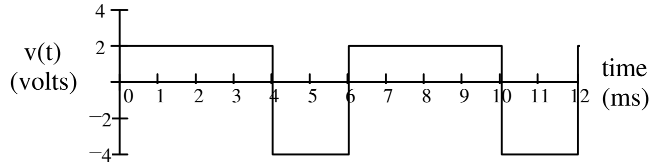
ECE2210 Final given: Fall 07

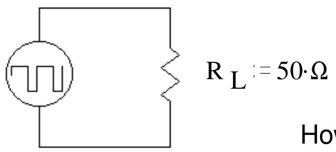
1. (17 pts) For waveform shown, find:



a) Average DC (V_{DC}) value

b) RMS (effective) value

c) The voltage is hooked to a resistor, as shown, for 6 seconds.



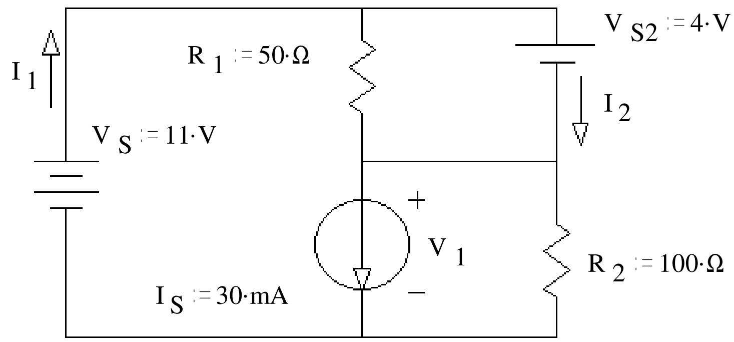
How much energy is transfered to the resistor during that 6 seconds?

d) What happened to that energy?

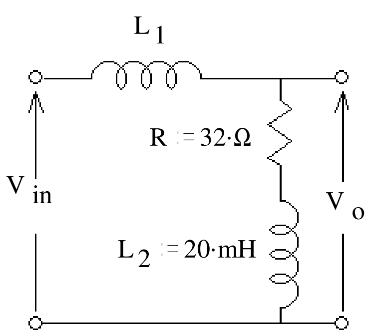
2. (18 pts)

a) Find: V_1 I_2 & I_1

b) V_{S2} Supplies how much power to the circuit?



3. (28 pts) a) Draw the asymptotic Bode plot (the straight-line approximation) of the filter circuit below. Accurately draw it on the graph provided. V_{in} is the input and V_O is the output of this circuit. Graph is in rad/sec. You must show the steps you use to get the Bode plot. That is, show things like the corner frequency(ies) , the approximations of the transfer function in each frequency region, calculations of dB, etc..



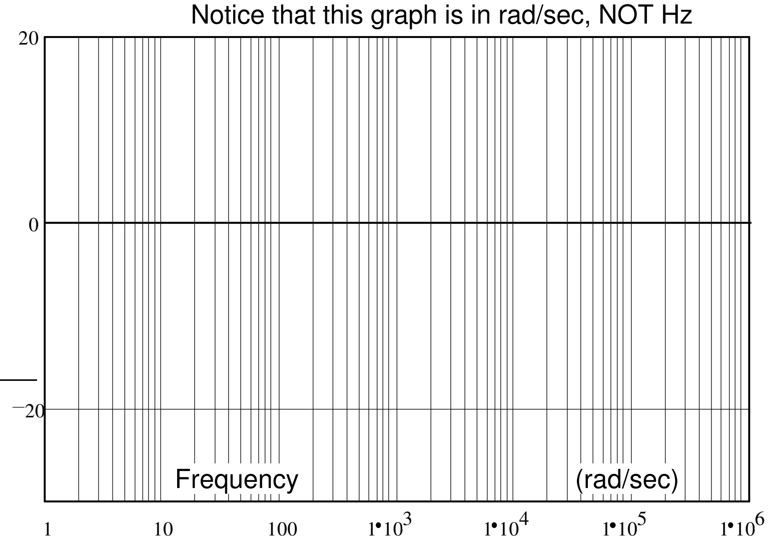
I've found the transfer function: $H(\omega) = \dfrac{R + j\cdot\omega\cdot L_2}{R + j\cdot\omega\cdot 8\cdot L_2}$

Notice that this graph is in rad/sec, NOT Hz

Magnitude plot $|H(\omega)|$ dB

Straight-line approximation ____

Actual _ _ _ _



b) The asymptotic Bode plot is not exact. The actual magnitude of the transfer function can be a little different than the straight-line approximation. Draw in the actual frequency response curve with a dashed line. For the frequency(ies) where the curves are most different, indicate the actual dB on the plot.

c) If there are any corners in the Bode plot associated with **poles** in the transfer function, list that/those corner frequency(ies) below (ω_p).

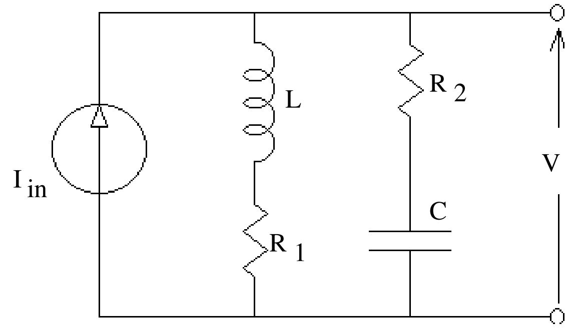
d) If there are any corners in the Bode plot associated with **zeroes** in the transfer function, list that/those corner frequency(ies) below (ω_z).

e) What is the value of L_1?
Hint: Find the Transfer function in terms of L_1, L_2, R, & ω and compare what you get to my transfer function.

4. (16 pts) a) Find the s-type transfer function of the circuit shown.

   I_{in} 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.



   Hint: The "output" is a voltage and the input is a current. What is voltage over current?

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

   b) Find the characteristic equation of the circuit shown.

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

   d) How many zeroes does the transfer function have?

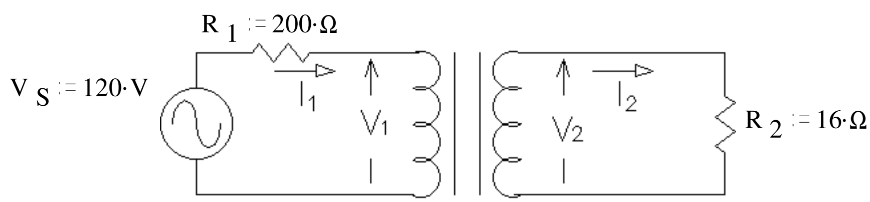
Assume the transformers are ideal and all voltages and currents are RMS.

5. (14 pts) The transformer shown in the circuit below is ideal. It is rated at 240/48 V, 20 VA, 60 Hz
   Find the following:

   a) $I_1 = ?$

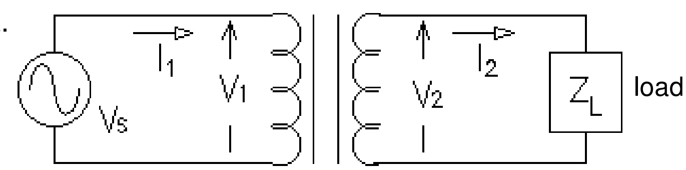
   b) $V_2 = ?$

   c) $I_2 = ?$



6. (6 pts) A transformer is rated at 240V/120V, 1.2kVA.

   How much power does the load consume?



$|\mathbf{V_S}| = 120 \cdot V$ $|\mathbf{Z_L}| = 16 \cdot \Omega$

pf := 80·% lagging

Use constant-voltage-drop models for the diodes and LEDs on this exam.

7. (20 pts) Assume that diodes D_1 and D_3 DO conduct. Assume that diode D_2 does NOT conduct.

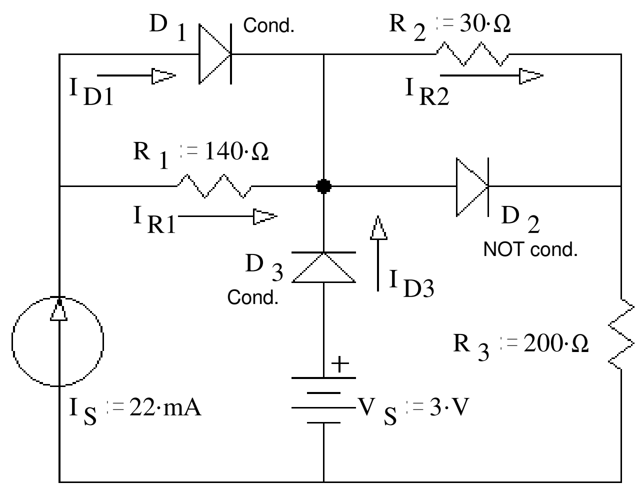
   a) Find I_{R1}, I_{D1}, I_{R2}, & I_{D3} based on these assumptions. Stick with these assumptions even if your answers come out absurd.

   I_{R1} = ____________

   I_{D1} = ____________

   I_{R2} = ____________

   I_{D3} = ____________



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

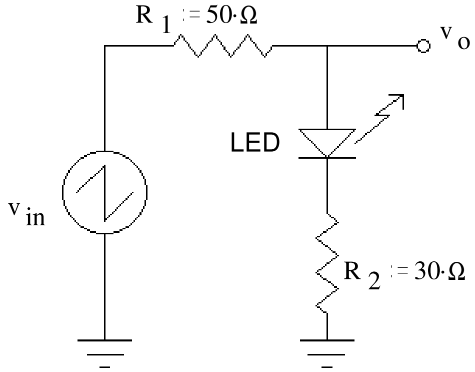
   c) Was the assumption about D_2 correct? yes no (circle one)

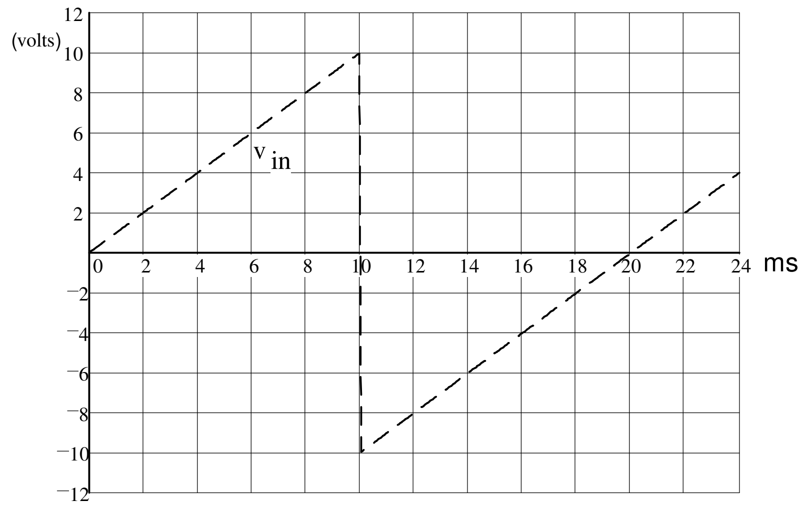
   How do you know? (Specifically show a value which is or is not within a correct range.)

   d) Was the assumption about D_3 correct? yes no (circle one)

   How do you know? (Specifically show a value which is or is not within a correct range.)

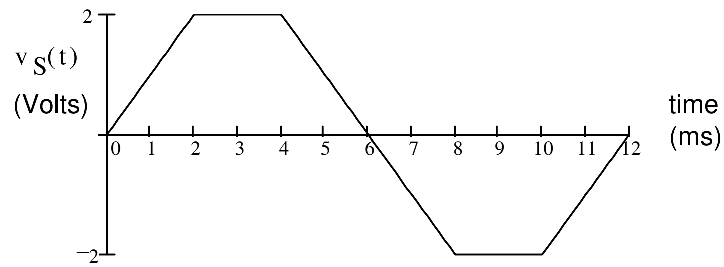
8. (14 pts) A voltage waveform (dotted line) is applied to the circuit shown. <u>Accurately</u> draw the output waveform (v_o) you expect to see. Label important times **and** voltage levels.



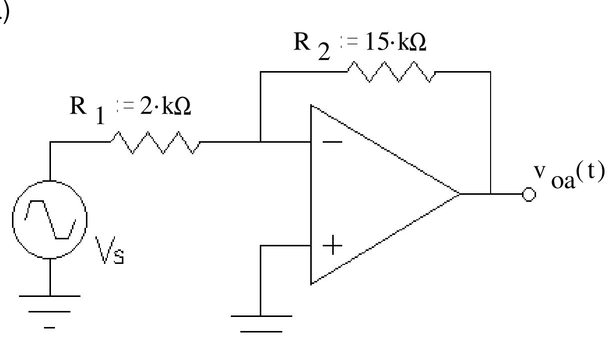


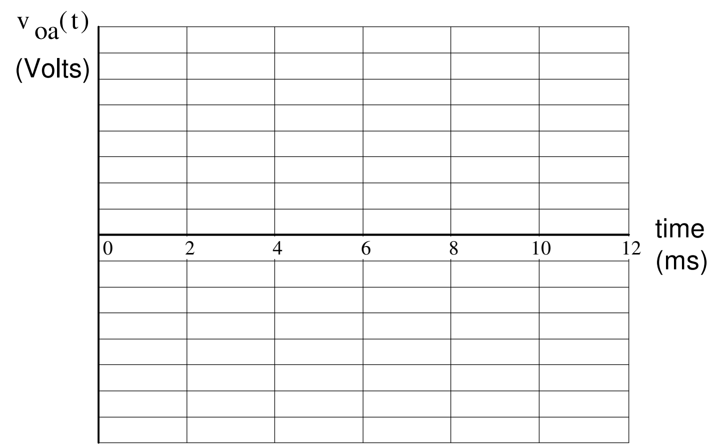
Label important times **and** voltage levels.

9. (25 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. The op-amp is connected to +12V & -12V power supplies.

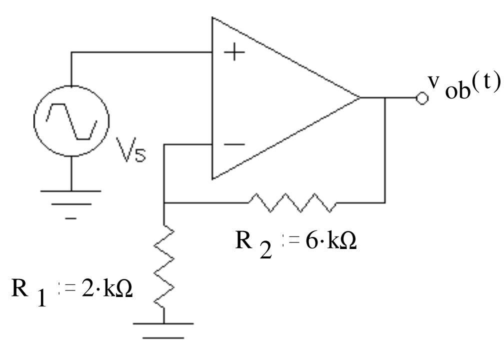


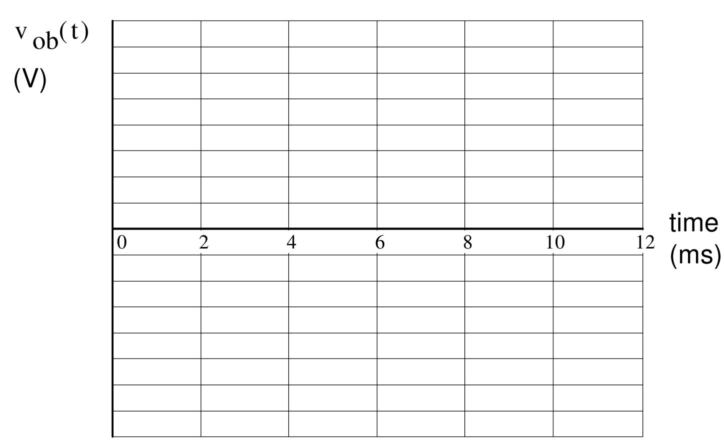
a)



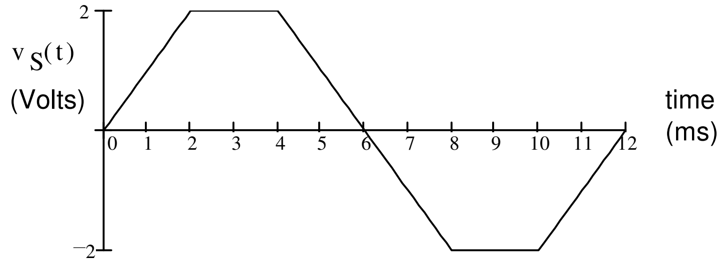


b)

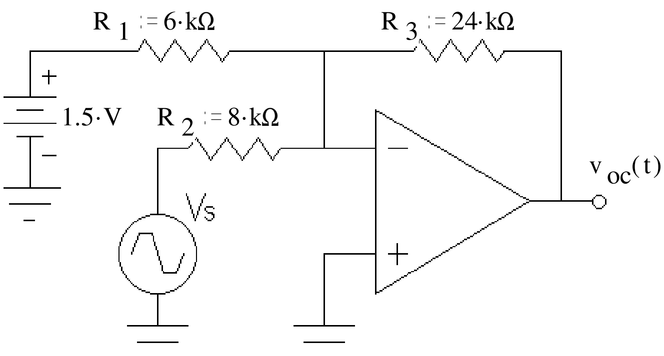


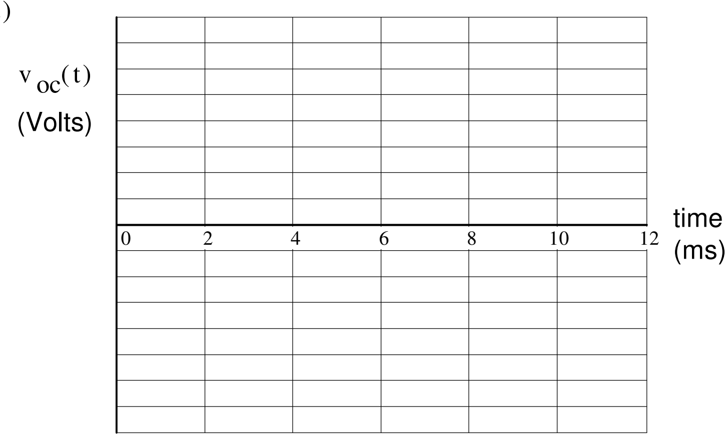


9. continued, the input is repeated at right. The op-amp is connected toto +12V & -12V power supplies.

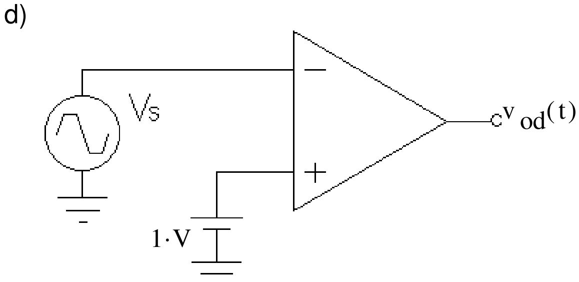


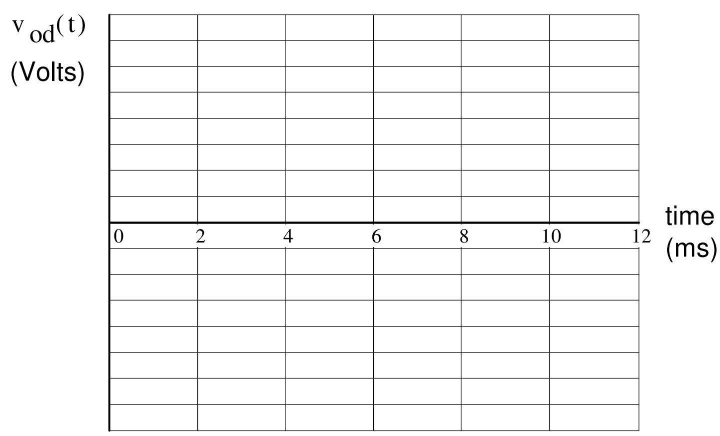
c)





d)





10. (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).

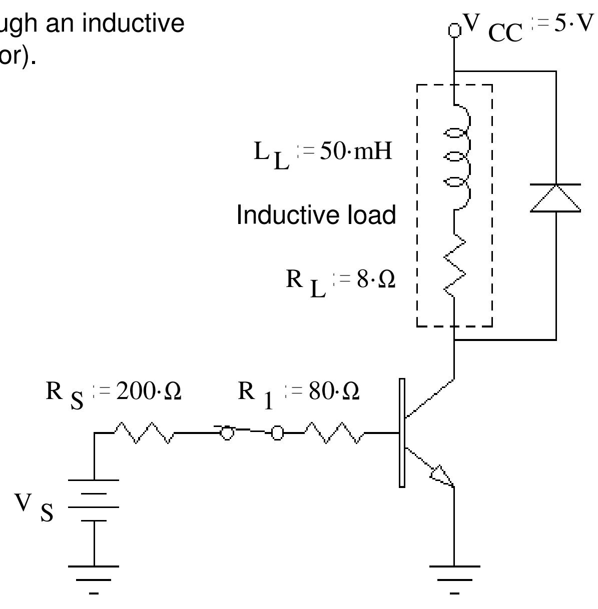
a) Assume the transistor is in saturation (fully on) and that switch has been closed for a long time. What is the load current?

I_C = ?

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

Use this V_S for the rest of the problem.

c) You got a bad transistor. $\beta := 50$
Find the new I_C, and V_{CE} and 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.

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

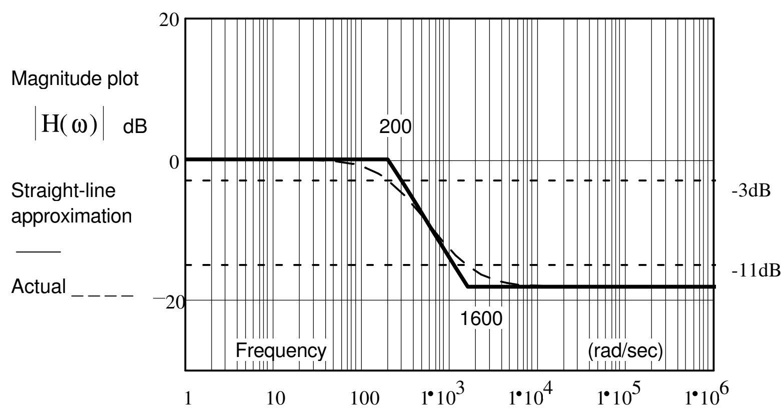
11. Do you want your grade and scores posted on my door and on the Internet?

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

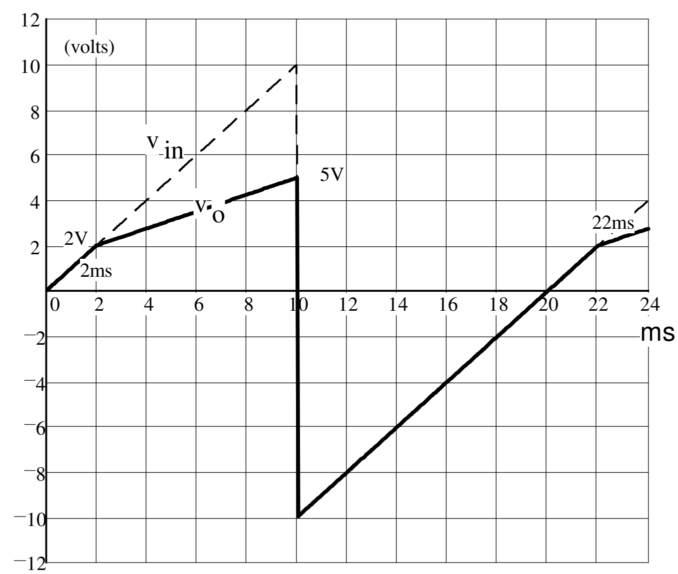
The grades will be posted on my door in alphabetical order under the alias that you provide here. I will not post grades under your real name. The Internet version will be a pdf file which you can download. Both will show the homework, lab, and exam scores of everyone who answers yes here.

Answers

1. a) $0 \cdot V$ b) $2.83 \cdot V$ c) $0.96 \cdot J$
   d) Converted to heat
2. a) $7 \cdot V$ $20mA$ $100 \cdot mA$
   b) $-80mW$ (negative because it absorbs power from the circuit)
3. a&b) at right
   c) 200 rad/sec d) 1600 rad/sec e) $140 \cdot mH$



4. a) $$\frac{R_2 \cdot s^2 + \left(\frac{R_2 \cdot R_1}{L} + \frac{1}{C}\right) \cdot s + \frac{R_1}{L \cdot C}}{s^2 + \frac{R_2 + R_1}{L} \cdot s + \frac{1}{L \cdot C}}$$
   b) $0 = s^2 + \frac{R_2 + R_1}{L} \cdot s + \frac{1}{L \cdot C}$ c) poles d) 2
5. a) $200 \cdot mA$ b) $16 \cdot V$ c) $1 \cdot A$
6. $180 \cdot W$
7. a) $5 \cdot mA$ $17 \cdot mA$ $10 \cdot mA$ $-12 \cdot mA$
   b) yes $I_{D1} = 17 \cdot mA > 0$
   c) yes $V_{D2} = 0.3 \cdot V < 0.7V$
   d) no $I_{D3} = -12 \cdot mA < 0$
8.



9. a) Inverted input waveform that would peak at -15V and then at +15V, but is clipped at -11V and +11V.
   b) Like input waveform but 4 times bigger so it peaks at +8V and then at -8V.
   c) Inverted 6V amplitude input waveform offset by -6V so that it would peak at -12V (but is clipped at -11V), positive peak is at 0V, no clipping.
   d) Starts at +11V , goes down to -11V at 1ms and stays there until 5ms. At 5ms it goes back up to +11V and stays there the rest of the time. Extra credit if you show slew effects.
10. a) $600 \cdot mA$ b) $2.8 \cdot V$ c) $375 \cdot mA$ $2 \cdot V$ $0.75 \cdot W$ d) B e) $600 \cdot mA$