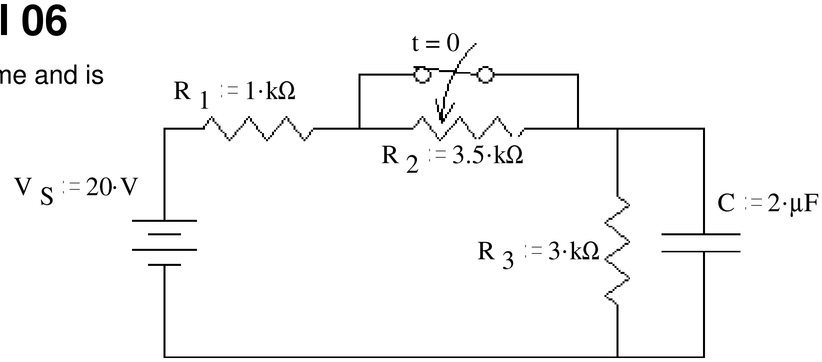
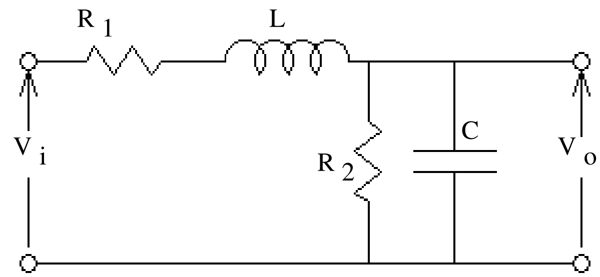
# ECE2210 Final given: Fall 06

1. (16 pts) The switch has been open for a long time and is closed (as shown) at time $t = 0$.
   Find the complete expression for $v_C(t)$.




2. (14 pts) a) Find the s-type transfer function of the circuit shown.
   $V_i$ 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.

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




   b) Find the characteristic equation of the circuit shown.

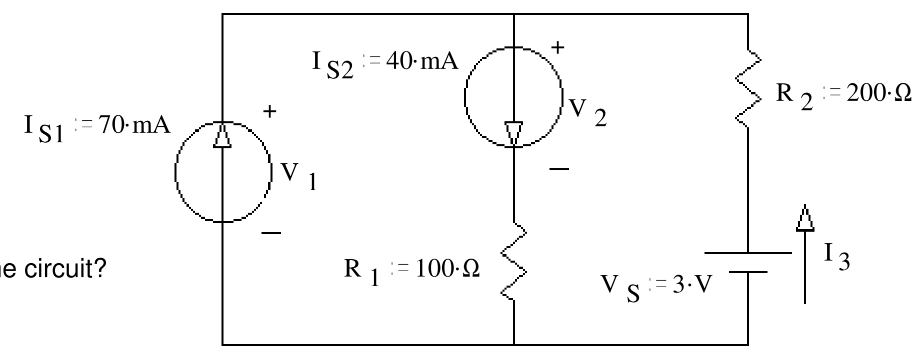
   c) The solutions to the characteristic equation are called the ___________ of the transfer function.

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

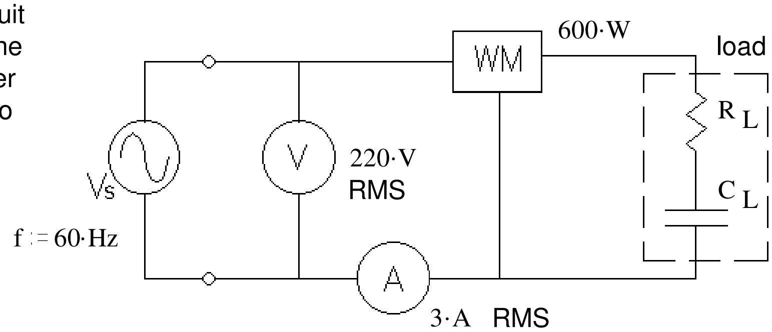
3. (16 pts)

   a) Find: $V_1$ $V_2$ & $I_3$

   b) $V_S$ Supplies how much power to the circuit?




4. (24 pts) R, & C together are the load in the circuit shown. The RMS voltmeter measures 220 V, the RMS ammeter measures 3 A, and the wattmeter measures 600 W. Find the following: Be sure to show 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 complex power. **S** = ?

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

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

5. (24 pts) a) Assume that diode $D_1$ & $D_3$ DO conduct.
Assume that diode $D_2$ does NOT conduct.

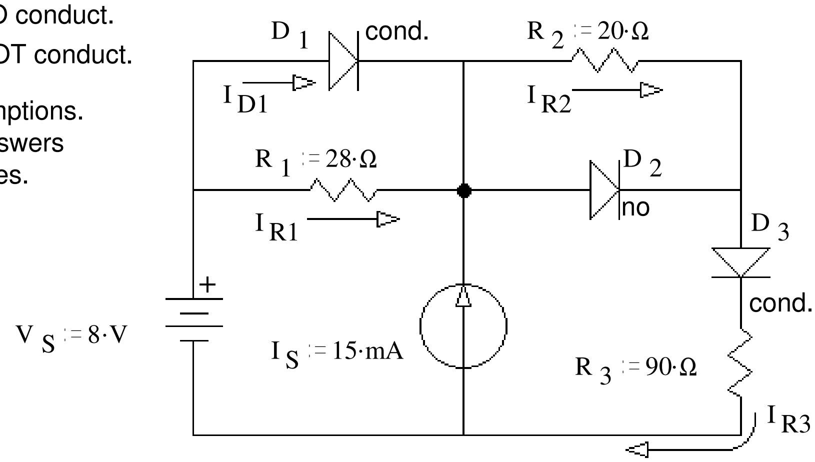
Find $I_{R1}$, $I_{R2}$, $I_{R3}$, $I_{D1}$, & based on these assumptions. Stick with these assumptions even if your answers come out absurd. Hint: think in nodal voltages.

$I_{R1}$ = ___________

$I_{R2}$ = ___________

$I_{R3}$ = ___________

$I_{D1}$ = ___________




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.)

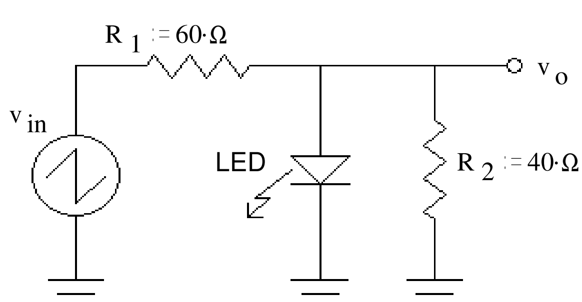
c) Based on your numbers, does it look like the assumption about $D_2$ was correct? yes no

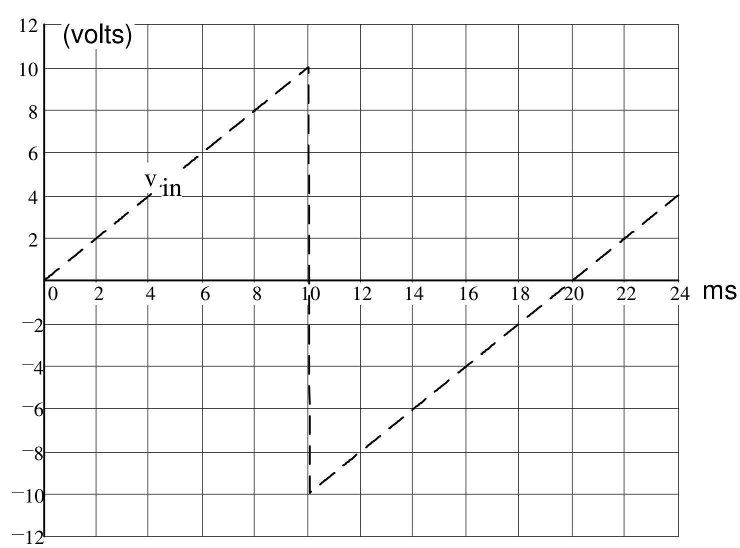
How do you know? (Specifically show a value which is or is not within a correct range.)

d) Based on your numbers above, does it look like the assumption about $D_3$ was correct? yes no (circle one)

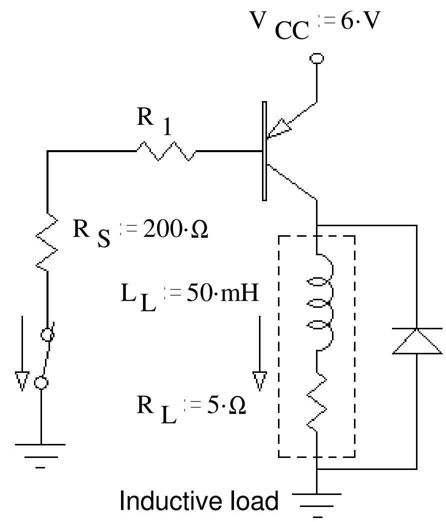
How do you know? (Specifically show a value which is or is not within a correct range.)

6. (13 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.



7. (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?

$I_L$ = ?

b) $\beta := 65$ 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 $I_L$, and $V_{CE}$ and $P_Q$.

$\beta$ ~ 65

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

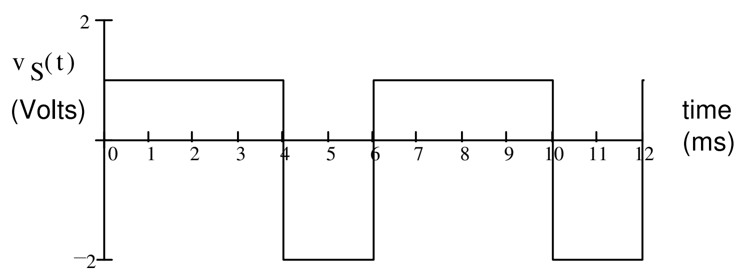
d) The diode in this circuit conducts a significant current:

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.

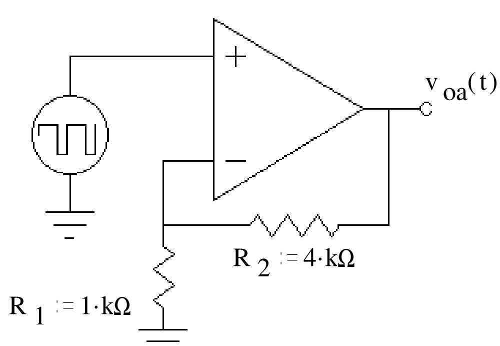
(circle one)

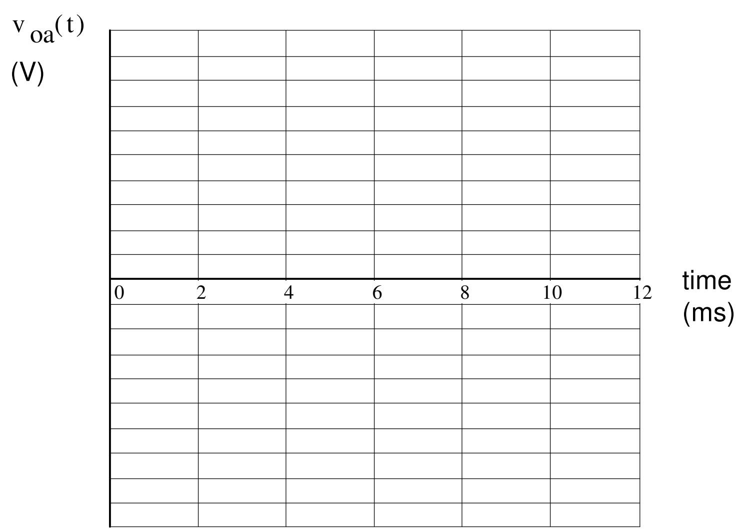
e) The switch is opened and closed a few times. What is the maximum diode current you expect. (Answer 0 if it never conducts.)

8. (33 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 +15V & -15V power supplies.

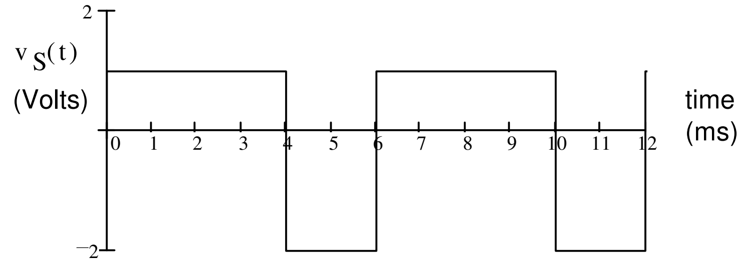



a)

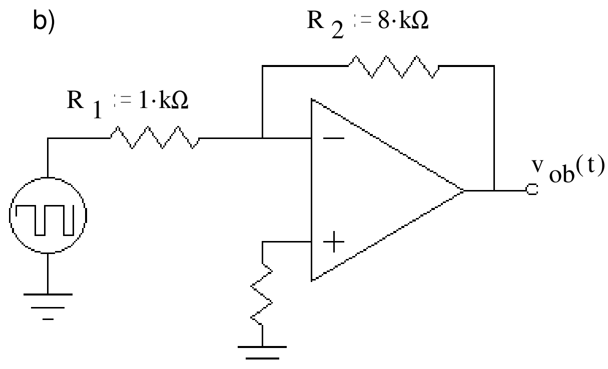


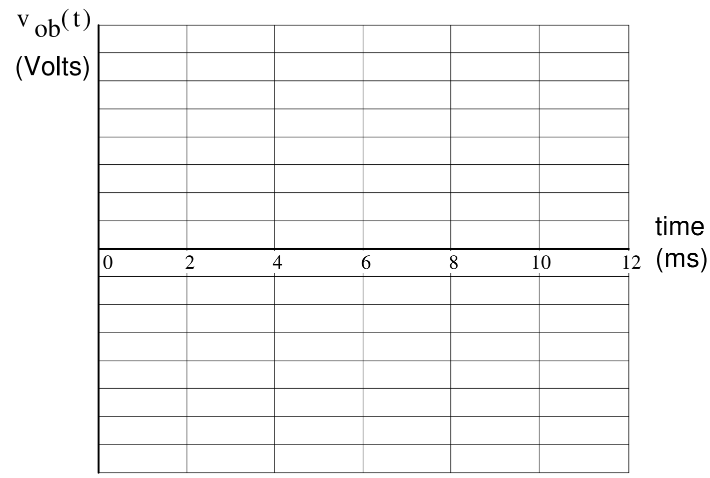



7. continued, the input is repeated at right. The op-amp is connected to +15V & -15V power supplies.

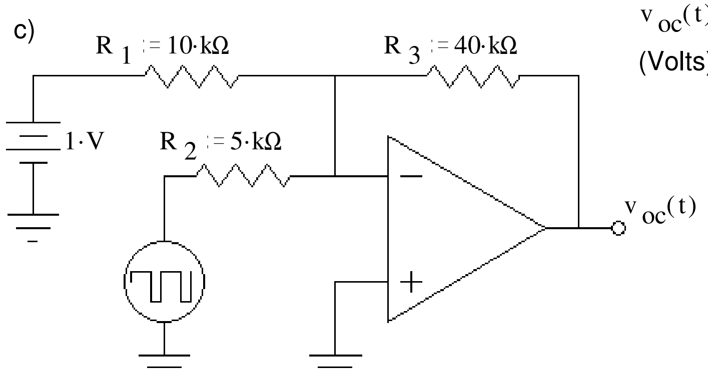


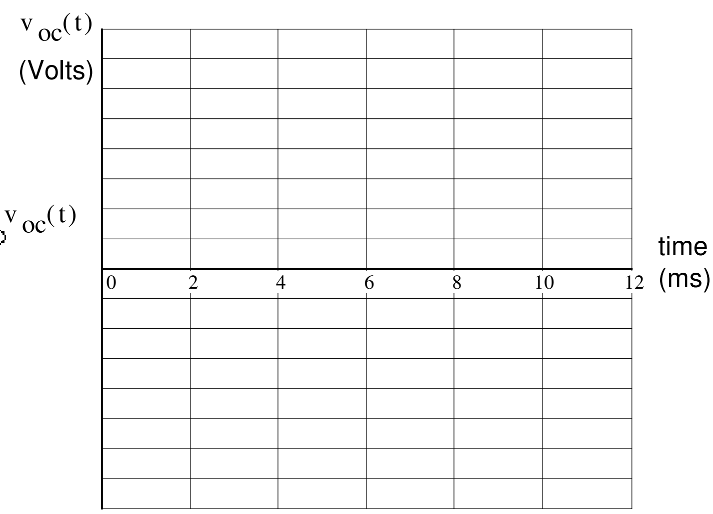

b)



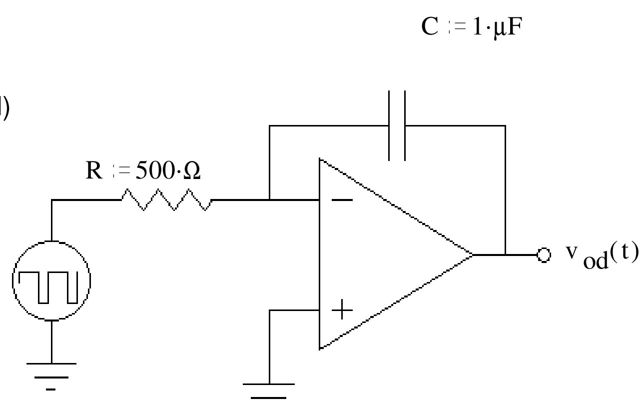



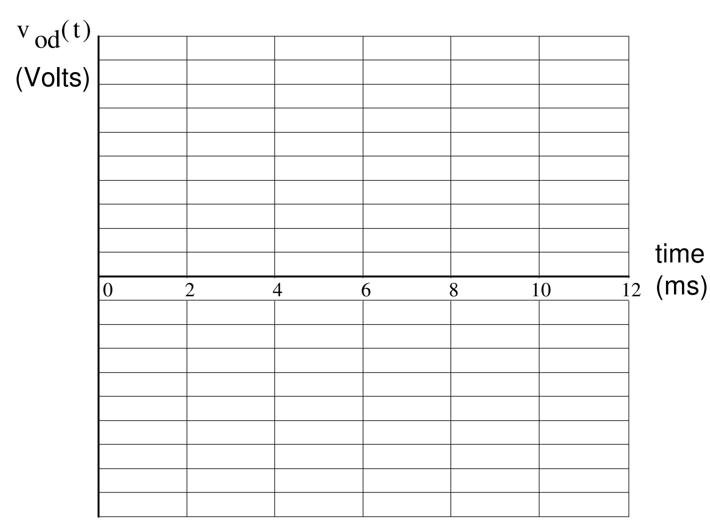

c)




d)



9. (18 pts) a) Draw the asymptotic Bode plot (the straight-line approximation) of the transfer function below. Accurately draw it on the graph provided.

To be eligible for partial credit, 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, etc..

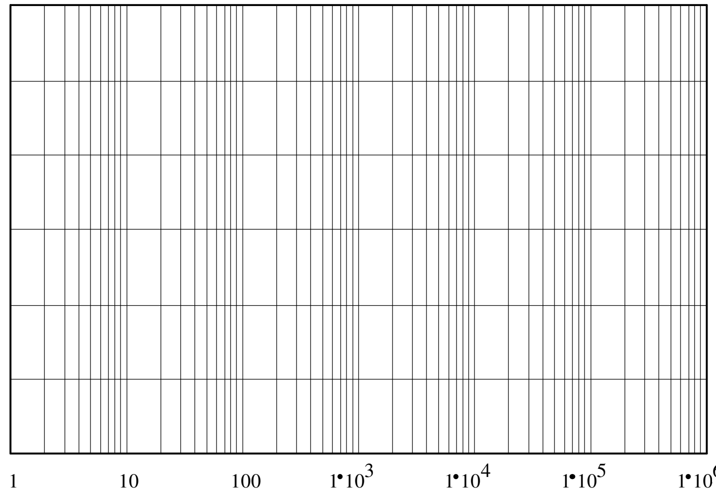
dB

Magnitude plot

$|H(f)|$

Straight-line approximation ____

Actual _ _ _ _




Frequency (Hz) f (Hz)

$$H(f) := \frac{633\cdot Hz\cdot\left(1+\frac{0.0005}{Hz}\cdot j\cdot f\right)}{(40\cdot Hz + j\cdot f)}$$

b) The asymptotic Bode plot is not exact. Using a dotted line, sketch the actual magnitude of the transfer function |H(f)| on the plot above. Indicate the point(s) where the difference between the two lines is the biggest (draw an arrow) and write down the actual magnitude(s) at that (those) point(s).

10. 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 which you can download. Both will show the homework, lab, and exam scores of everyone who answers yes here.

## Answers

1. $15\cdot V - 7\cdot V\cdot e^{\frac{-t}{1.5\cdot ms}}$

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

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) No

3. a) $9\cdot V$ $5\cdot V$ $-30\cdot mA$ b) $-90\cdot mW$

4. a) $600\cdot W$ b) $66.7\cdot\Omega$ c) $660\cdot VA$

d) $-275\cdot VAR$ e) $(600-275\cdot j)\cdot VA$ f) $0.909$ g) leading h) $467\cdot mH$ inductor in parallel with load

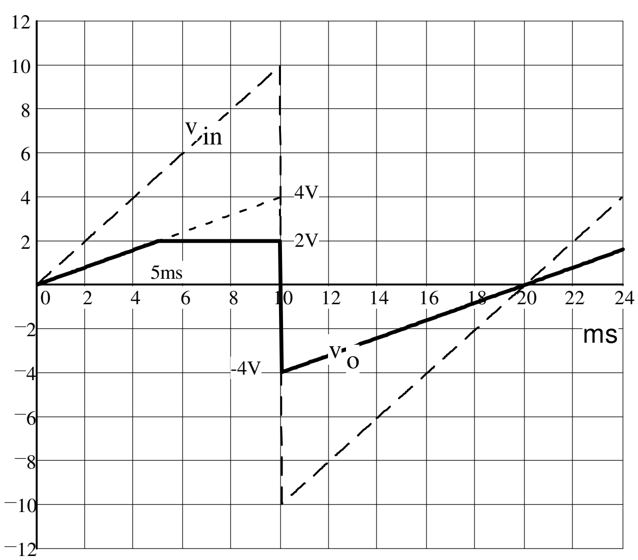
5. a) $25\cdot mA$ $60\cdot mA$ $60\cdot mA$ $20\cdot mA$

b) yes $I_{D1} = 20\cdot mA > 0$

c) no $V_{D2} = 1.2\cdot V < 0.7V$

d) yes $I_{D1} = 60\cdot mA > 0$

6.



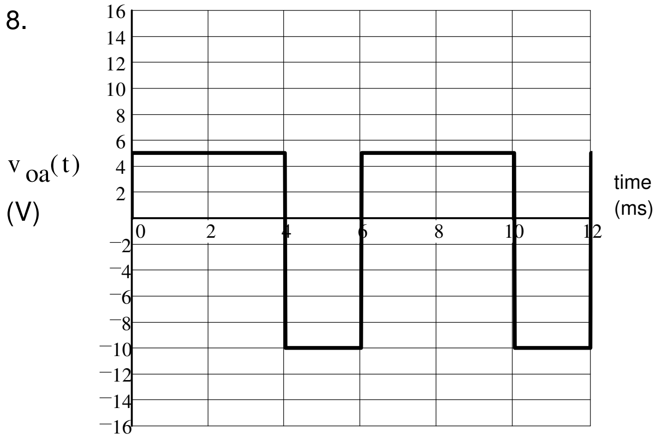

7. a) $1.16\cdot A$ b) $97\cdot\Omega$

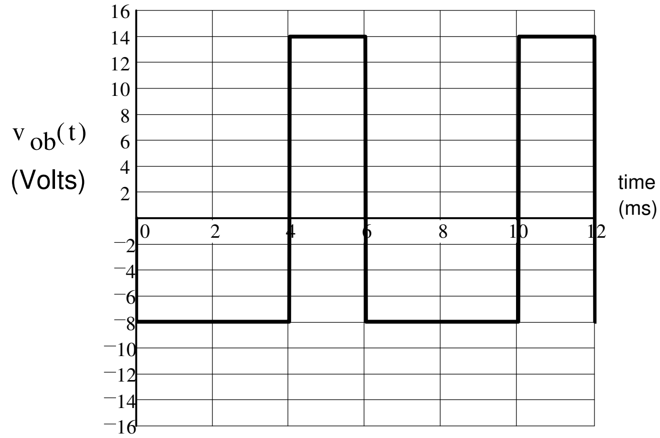
c) $714\cdot mA$ $2.43\cdot V$ $1.74\cdot W$

d) B e) $1.16\cdot A$

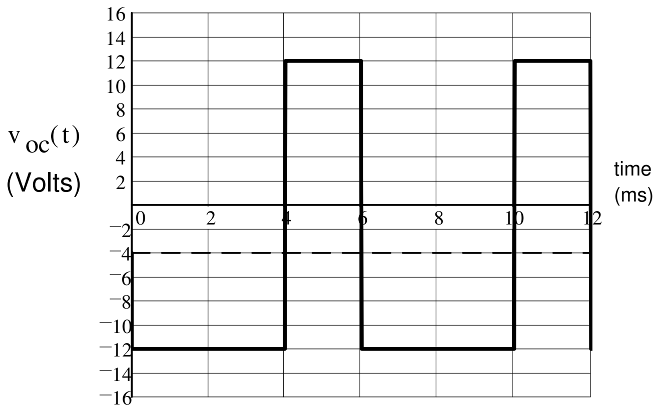
## More Answers

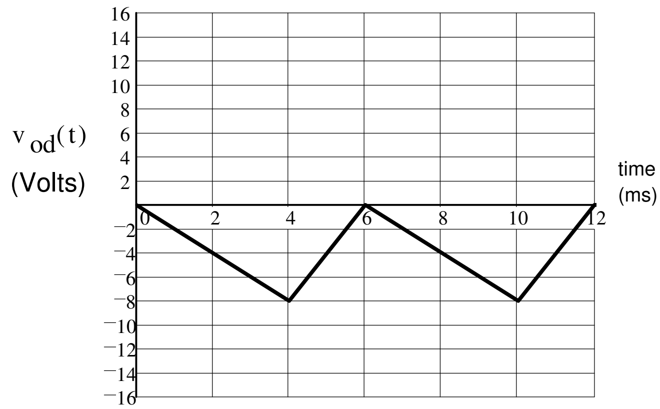
8.




Extra credit if you show slew effects




Magnitude plot

$|H(f)|$

Straight-line approximation ____

Actual _ _ _ _