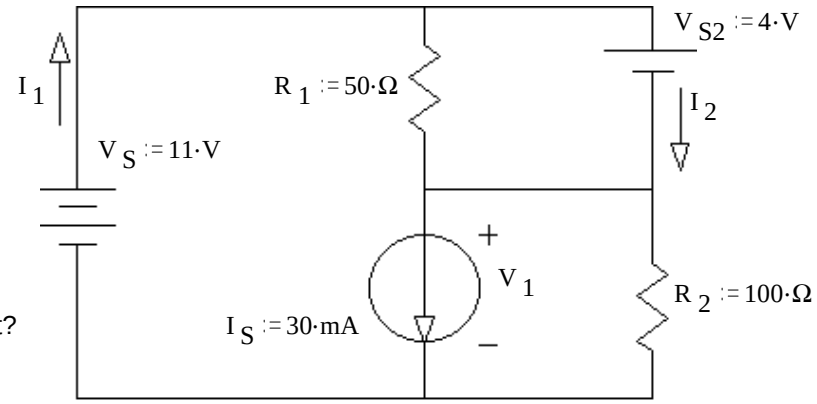
ECE2210 Final given: Spring 14

1. (18 pts)

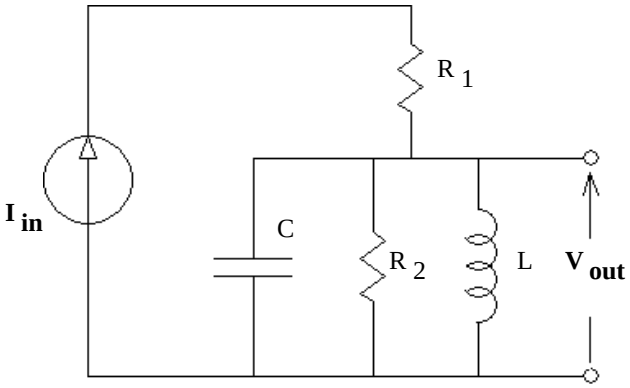
a) Find: V_1 I_2 & I_1



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

2. (12 pts) a) Find the s-type transfer function of the circuit shown. $\mathbf{I_{in}}$ is the input and $\mathbf{V_{out}}$ is the "output".

You MUST show work to get credit. Simplify your expression for H(s) so that it is a ratio of simple polynomials.

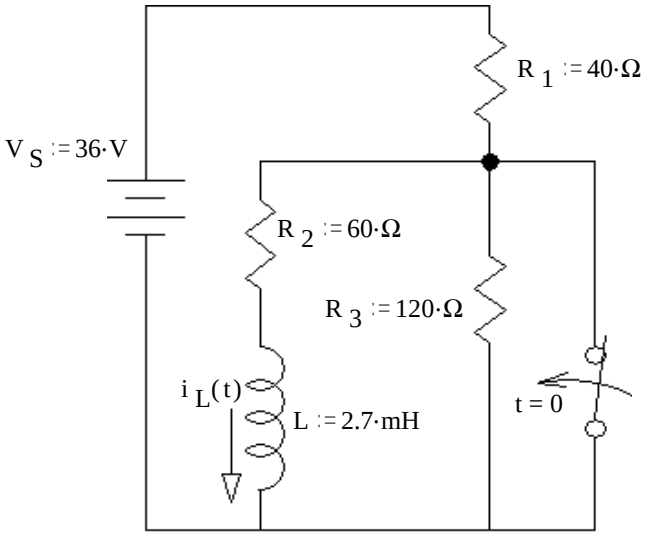


b) How many poles does this transfer function have?

c) Does the transfer function have any zeroes? If yes, express them in terms of the circuit parts.

3. (30 pts) The switch has been open for a long time and is closed (as shown) at time $t = 0$.

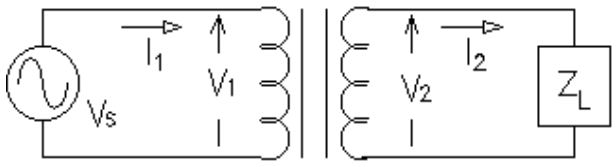
a) Find the complete expression for $i_L(t)$.



b) Find i_L at time $t = 1.2\tau$. $i_L(1.2\cdot\tau) = ?$

c) At time $t = 1.2\tau$ the switch is opened again. Find the complete expression for $i_L(t')$, where t' starts at $t = 1.2\tau$. Be sure to clearly show the time constant.

4. (20 pts) A transformer is rated at 480V / 120V, 1kVA. Assume the transformer is ideal and all voltages and currents are RMS.



a) What is the current rating of the primary?

b) What is the current rating of the secondary?

c) The secondary has 100 turns of wire. How many turns does the primary have?

d) $\mathbf{V_L} := 80\cdot V$ How big is the source voltage ($|\mathbf{V_S}|$)?

$|\mathbf{Z_L}| = 8\cdot\Omega$

$pf := 75\cdot\%$ lagging

$\mathbf{V_L} := 80\cdot V$

e) The secondary load (Z_L) has a magnitude of $8\ \Omega$ at a power factor of 75%. Find the secondary current, $\mathbf{I_2}$ (magnitude **and <u>angle</u>**).

f) Find the primary current, $\mathbf{I_1}$ (magnitude **and <u>angle</u>**).

g) How much average power does the load dissipate? P_L = ?

h) How much average power does the power source ($\mathbf{V_S}$) supply? P_S = ?

i) What is the load as seen by $\mathbf{V_S}$? (magnitude **and <u>angle</u>**)

k) Is this transformer operating within its ratings? Show your evidence.

5. (20 pts) Assume that diodes D_1 and D_3 DO conduct. Assume that diode D_2 does NOT conduct.

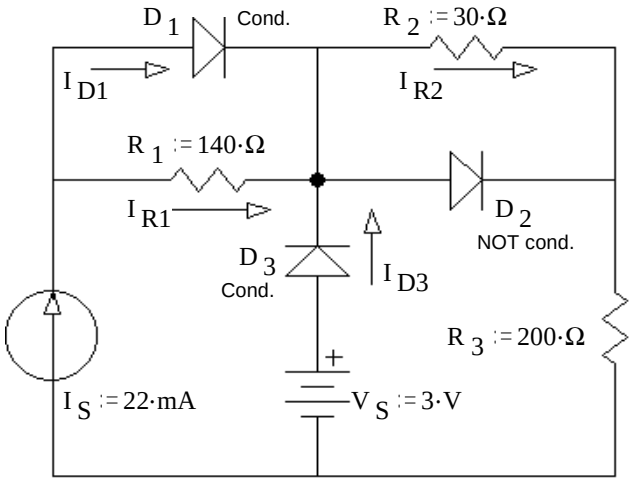
a) Find I_{R1}, I_{D1}, I_{R2}, & I_{D3} based on these assumptions. Stick with these assumptions even if your answers come out absurd.

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.)

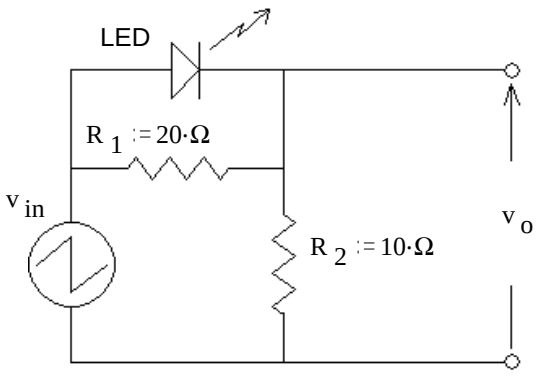
c) Was the assumption about D_2 correct? yes no (circle one)

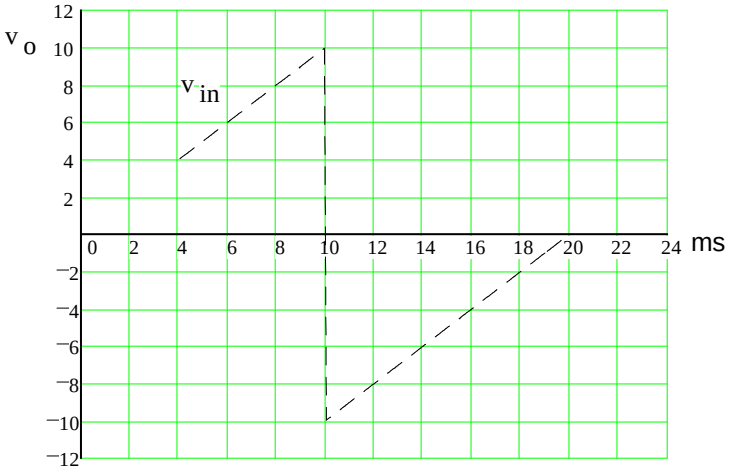
How do you know? (Specifically show a value which is or is not within a correct range.)

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

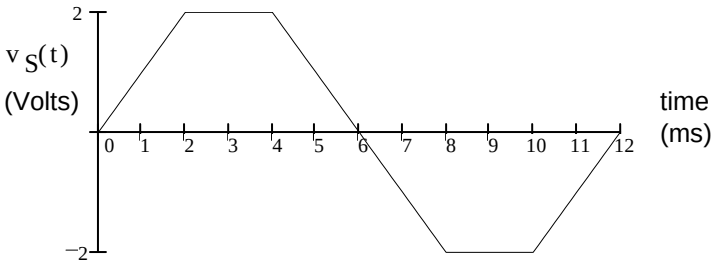
How do you know? (Specifically show a value which is or is not within a correct range.)

6. (18 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 **<u>and</u>** voltage levels.

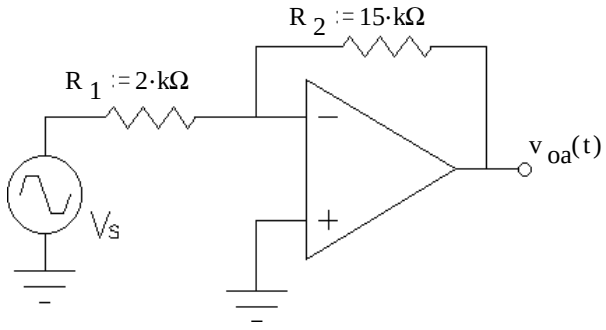


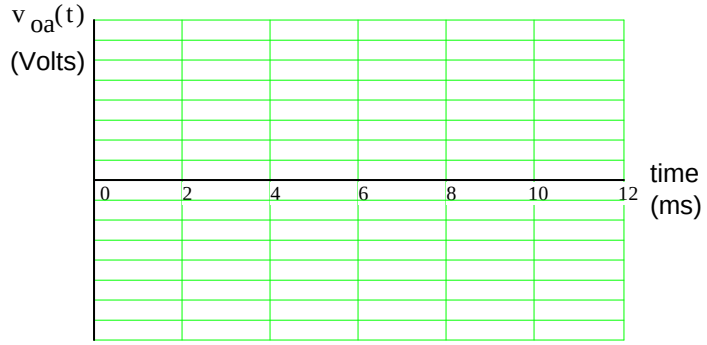


7. (23 pts) The same input signal (at right) is connected to several op-amp circuits below. Sketch the output waveform for each circuit. Clearly label important voltage levels on each output. If I can't easily make out what your peak values are, I'll assume you don't know. Don't forget to show inversions. The op-amp is connected to +12V & -12V power supplies.

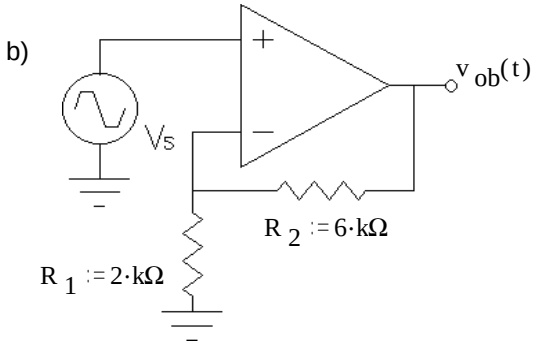


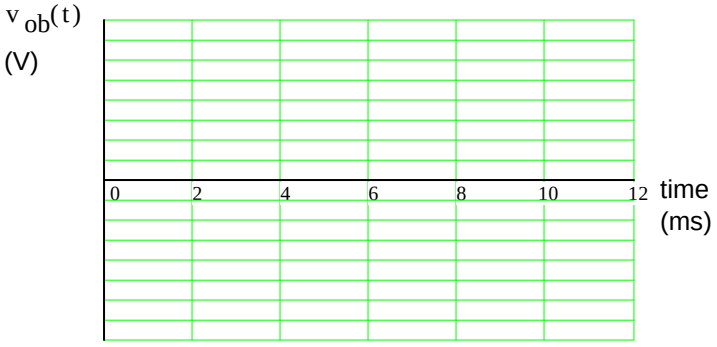
a)



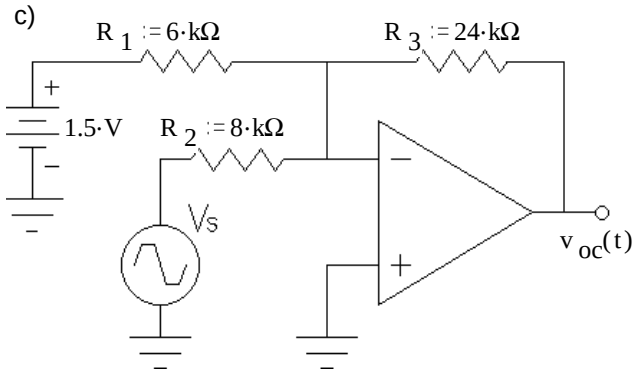


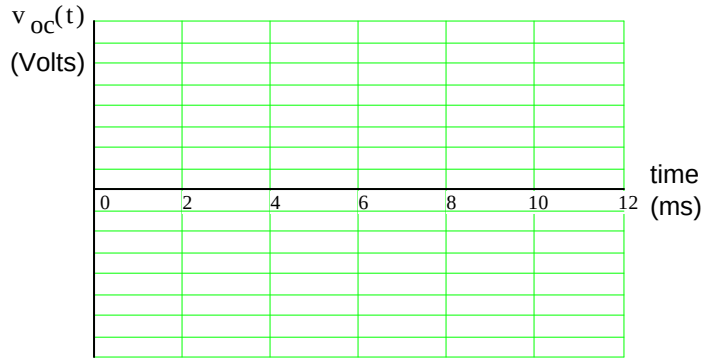
b)



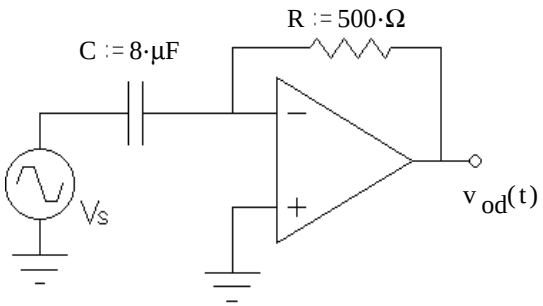


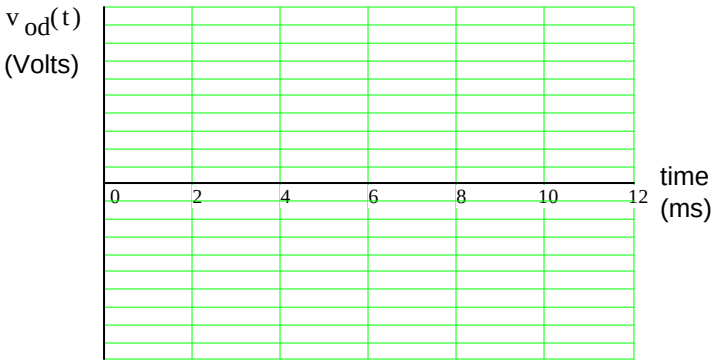
c)



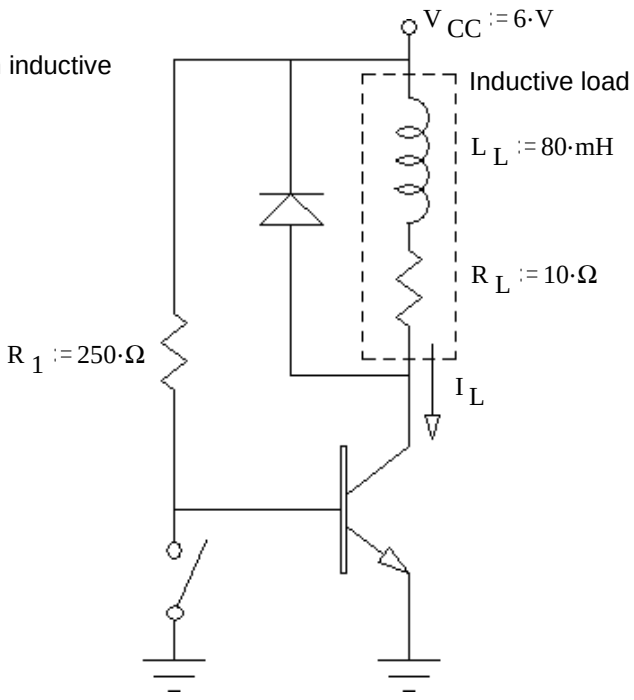


d)





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) $\beta := 20$ Assume the switch has been open for a long time and the transistor is in the active region, find I_L, and V_{CE} and P_Q.

I_L = ?

V_{CE} = ?

P_Q = ?

b) Was the transistor actually operating in the active region? yes no circle one yes

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

c) What minimum β would be required to achieve saturation?

d) You can't change the β. Find the maximum value of R_1, so that the transistor will be in saturation. $\beta = 20$

e) 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. (circle one)

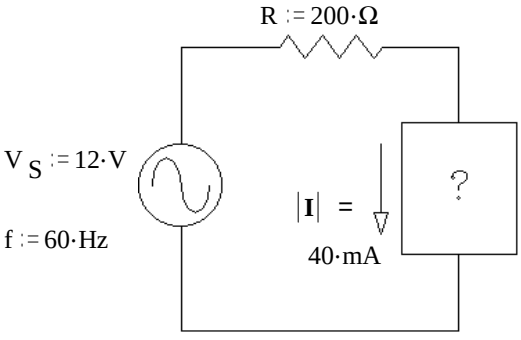
E) whenever the switch is closed.

F) always.

f) 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.)

9. (17 pts) The magnitude of the steady-state, sinusoidal source voltage and the magnitude of the current are shown.



a) If the box contained a resistor, what would be its value?

b) If the box contained an inductor, what would be its value? L = ?

c) If the box contained a capacitor, what would be its value? C = ?

d) If the current is leading the voltage, which component is it?

R L C (circle one)

e) By how many degrees does the current lead?

10. 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. It will show the homework, lab, and exam scores of everyone who answers here.

Answers

1. a) 7·V 20·mA 100·mA
   b) -80·mW

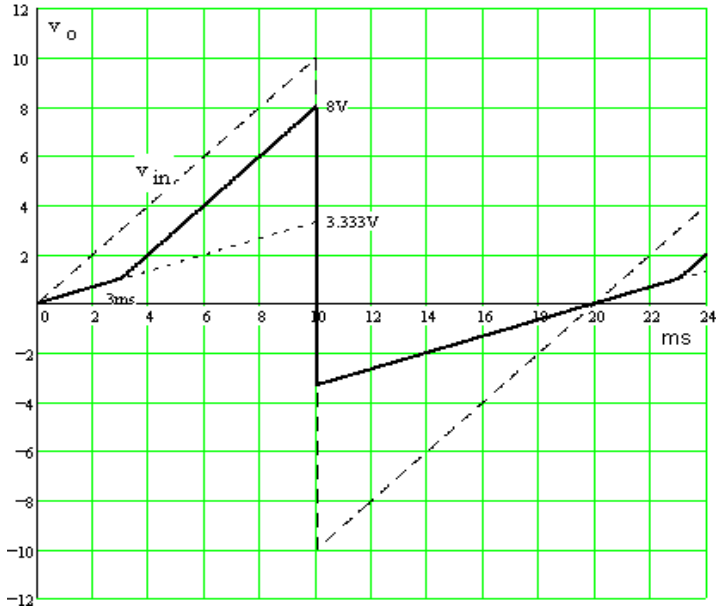
2. a) $\dfrac{\frac{1}{C}\cdot s}{s^2+\frac{1}{C\cdot R_2}\cdot s+\frac{1}{C\cdot L}}$ b) 2 c) yes, s = 0

3. a) $300\cdot mA\cdot e^{\frac{-t}{45\cdot \mu s}}$ b) 90.4·mA c) $300\cdot mA - 209.64\cdot mA\cdot e^{\frac{-t'}{30\cdot \mu s}}$

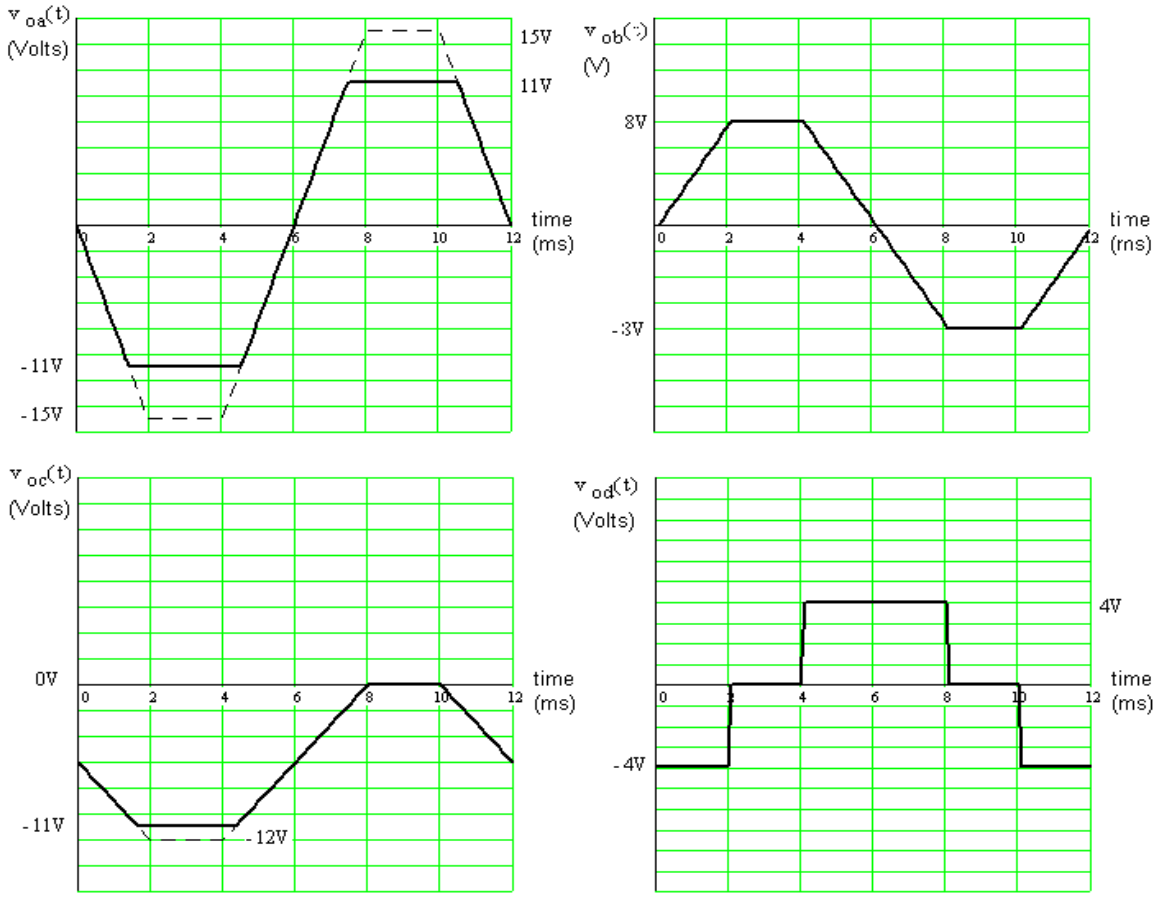
4. a) 2.08·A b) 8.33·A c) 400
   d) 320·V e) 10·A $\angle -41.4^o$
   f) 2.5·A $\angle -41.4^o$ g)&h) 600·W
   i) $128\cdot\Omega \angle 41.4^o$ k) No 8.33·A < 10·A

5. a) 5·mA 17·mA 10·mA -12·mA
   b) yes 17·mA > 0
   c) yes 0.3·V < 0.7V
   d) no -12·mA < 0

6.



7.



8. a) 424·mA 1.76·V 0.746·W b) yes 1.76·V > 0.2·V c) 27.4 d) 183·Ω e) D f) 580·mA

9. a) 100·Ω b) 593·mH c) 11.9·µF d) C e) 48.2·deg