ECE2210 Final given: Fall 18

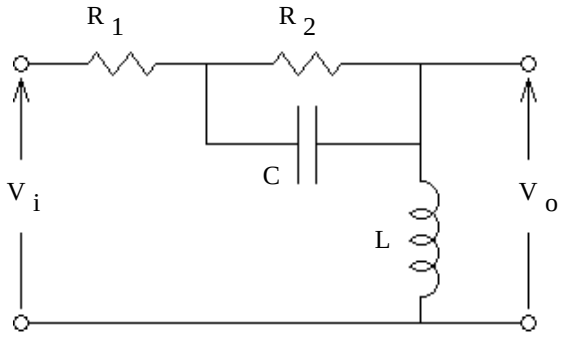
Closed Book, Closed notes except preprinted sheet, Calculators OK.

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

1. (19 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.

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



   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.

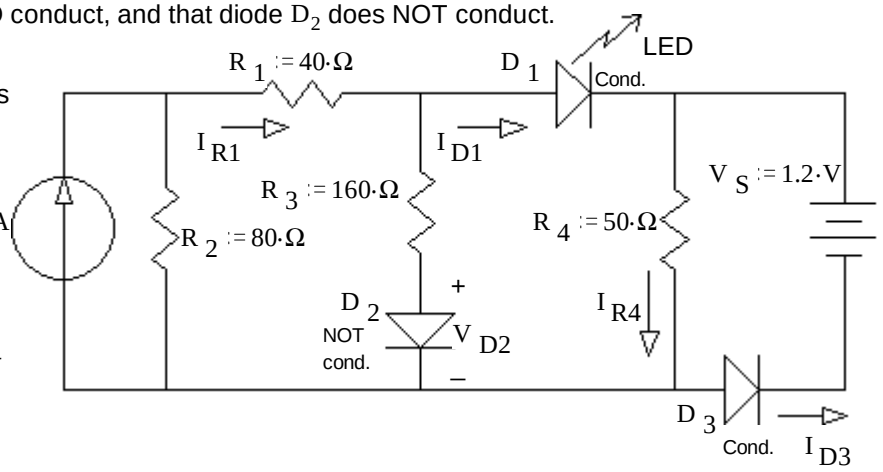
2. (26 pts) Assume that diodes D_1 and D_3 DO conduct, and that diode D_2 does NOT conduct.

   a) Find I_{R4}, V_{D2}, I_{R1}, I_{D1},& I_{D3} based on these assumptions. Stick with these assumptions even if your answers come out absurd.

   I_{R4}= ? V_{D2}= ? I_{R1}= ?

   I_{D1}= ? I_{D3}= ?

   Notes: The calculation of I_{R1} may be difficult unless you write a nodal equation or change the current source and R_2 into a Thevenin equivalent. Don't refer to nodal voltages unless you specify a ground.

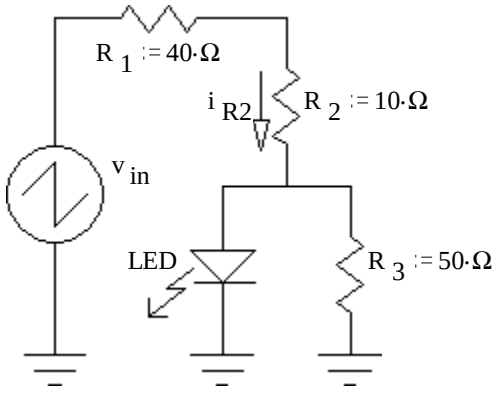


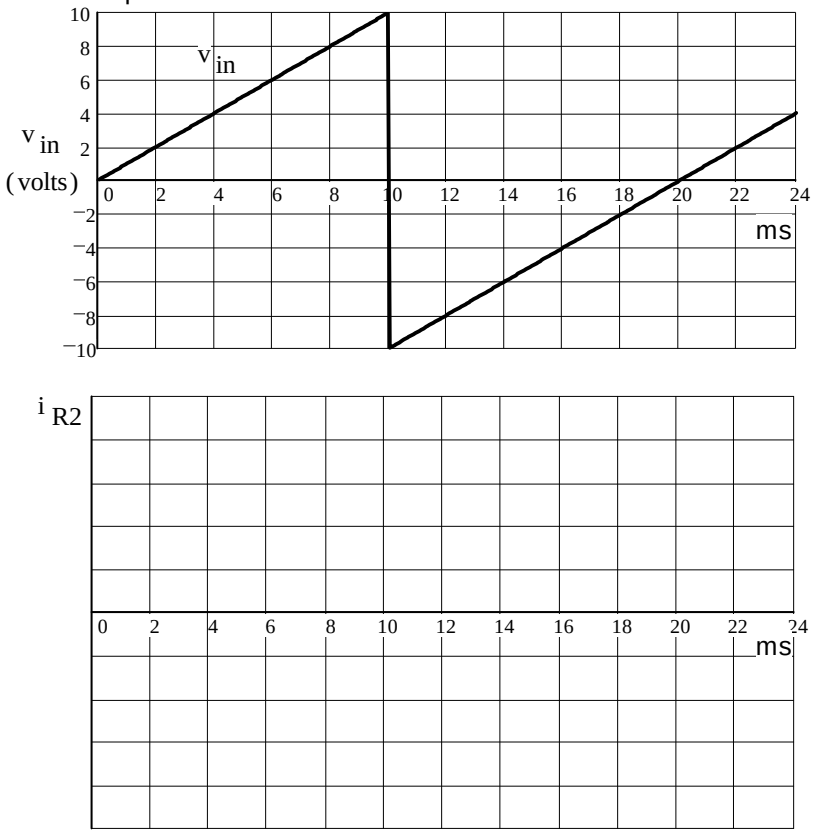
   b) Based on the numbers above, was the assumption about D_1 correct? yes no (circle one)
   How do you know? (Specifically show a value which is or is not within a correct range.)

   c) Was the assumption about D_2 correct? yes no (circle one) How do you know? (show value(s))

   d) Was the assumption about D_3 correct? yes no (circle one) How do you know?

3. (20 pts) A voltage waveform (top dark line) is applied to the circuit shown. Accurately draw the i_{R2} current waveform. Label important times **and** current levels.

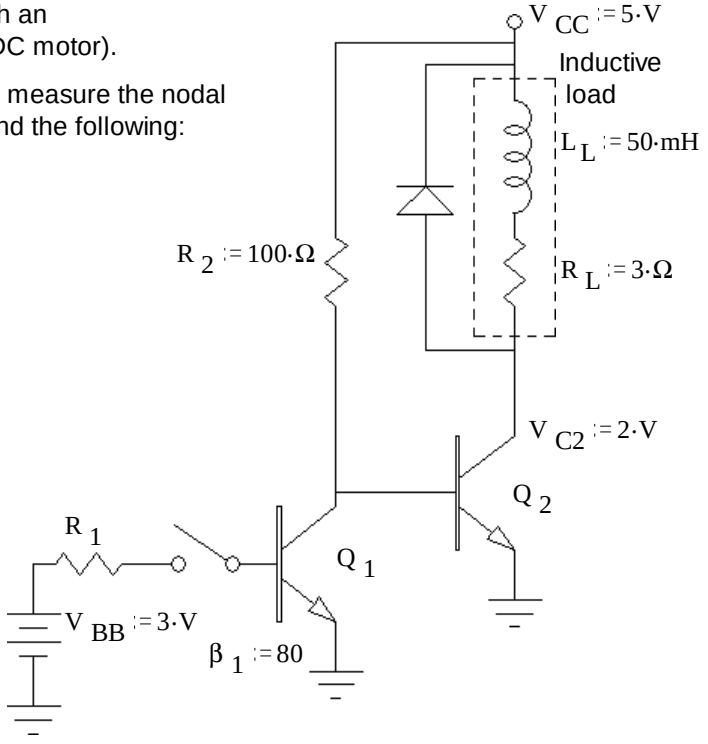




Show important times, values and units

4. (36 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 .
β_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 $\beta_2 := 50$ Use this β from now on. 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 at the collector of Q_2 ? V_{C2} = ?

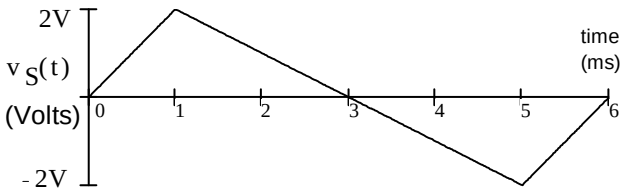
f) The diode in this circuit conducts a significant current: (circle one)

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

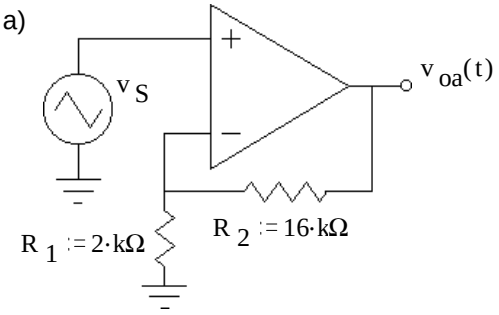
g) R_1, is that found in part d). The switch is opened and closed a few times.
What is the maximum diode current you expect. (Answer 0 if it never conducts.)

h) Transistor Q_1 goes 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} = ?

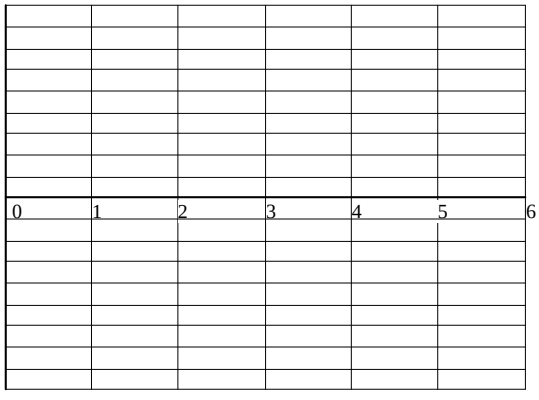
5. (30 pts) The same input signal (at right) is connected to several op-amp circuits below. Sketch the output waveform for each circuit. Clearly label important voltage levels on each output. If I can't easily make out what your peak values are, I'll assume you don't know. Don't forget to show inversions. All op-amps are powered by $\pm$ 12 V power supplies.



a)



$v_{oa}(t)$
(Volts)



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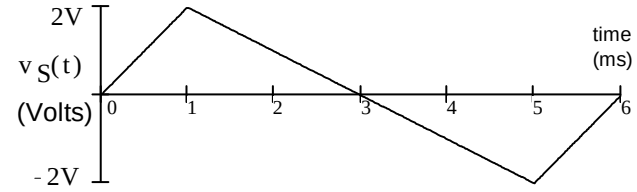
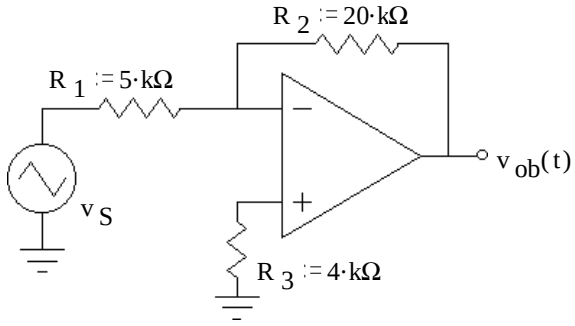
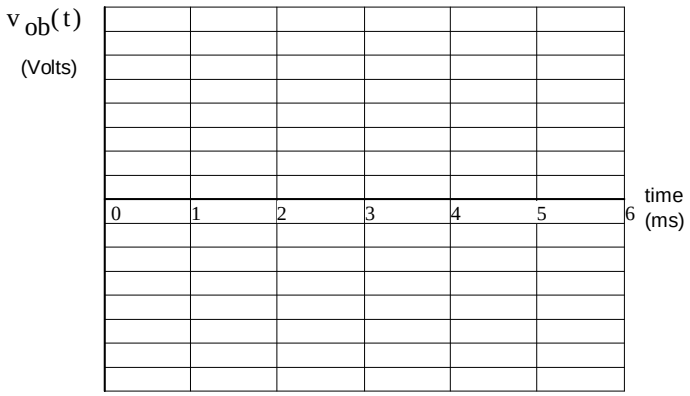
5, continued, the input is repeated at right.

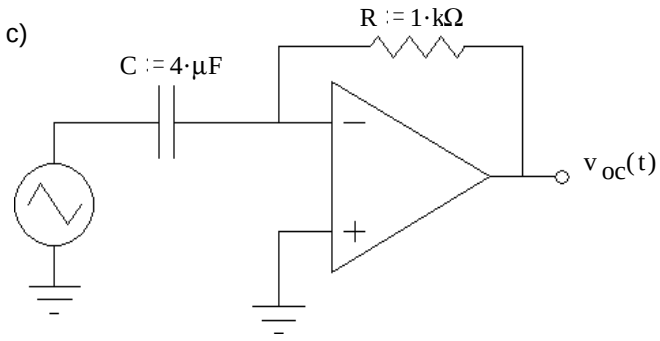


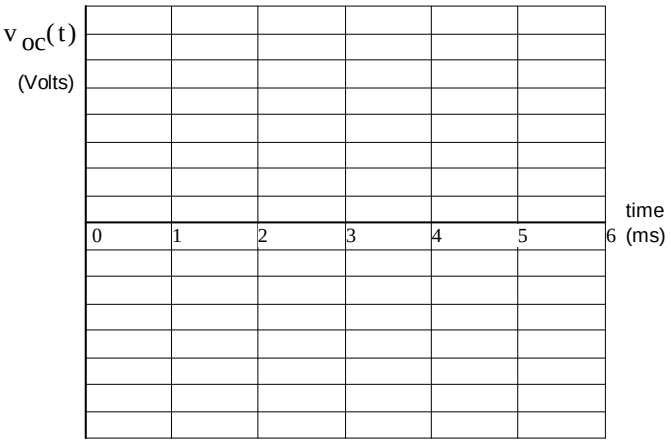
b)



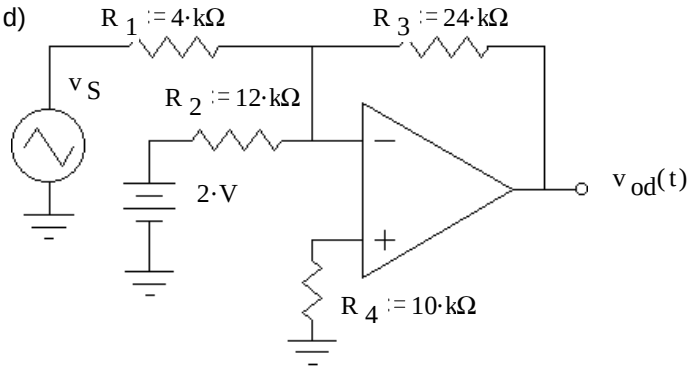


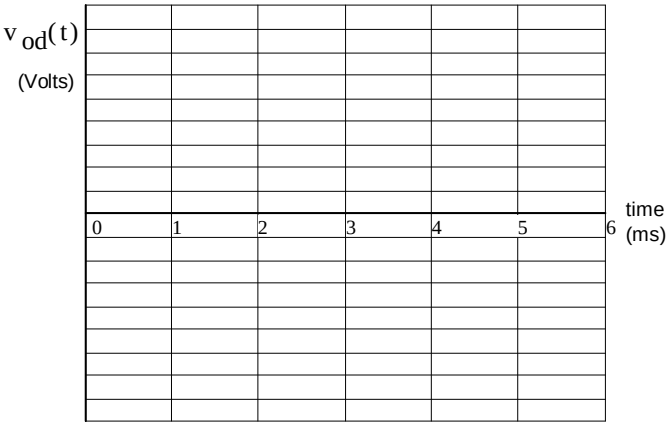
c)





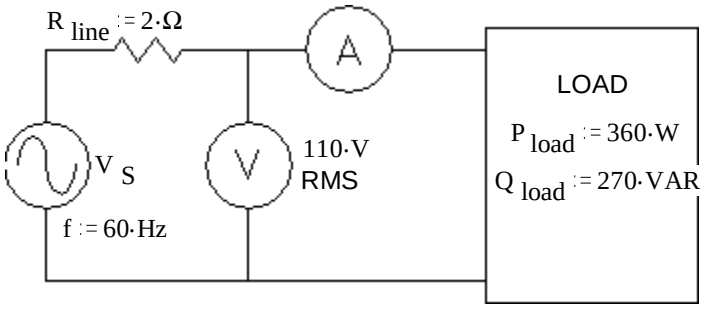
d)





All values are RMS unless specified otherwise.

6. (25 pts) The AC load uses 360W and 270VAR.
   The voltmeter measures 110 V.
   a) Find the apparent power. $|\mathbf{S}|$ = ?
      Give with correct units



b) What does the ammeter measure? Hint: $|\mathbf{S}| = |\mathbf{V}| \cdot |\mathbf{I}|$

c) Find the power factor of the load. pf = ?

d) The power factor is: i) leading ii) lagging (circle one) i) lagging, because the Q_{load} is positive

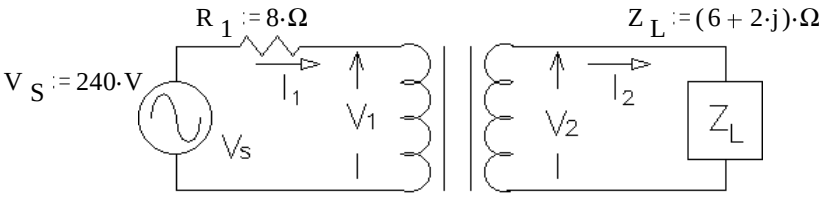
e) The load consists of two parts in parallel. Draw the parts in the box above and find the values.

f) How much power does R_{line} waste? P_{Rline} = ?

g) Find the complex power provided by the source. $\mathbf{S}_S = P_S + j \cdot Q_S$ = ?

h) What is the source voltage (magnitude)? $|\mathbf{V}_S|$ = ? Remember, you can't add magnitudes of complex numbers.

7. (22 pts) The transformer shown in the circuit below is ideal.
   a) is rated at 300/100 V, 1.0 kVA, 60 Hz. Find:
   The primary current (magnitude).
   $|\mathbf{I_1}|$ = ?



   b) The secondary current (magnitude). $|\mathbf{I_2}|$ = ?

   c) The secondary voltage (magnitude). $|\mathbf{V_2}|$ = ?

   d) The complex power (P and Q) used by the load. $\mathbf{S_L}$ = ?
   Be sure to show the correct units.

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

Do you want your grade and scores posted on the Internet? If yes, then provide some sort of alias: _____ Total _____/ 180
otherwise, leave blank

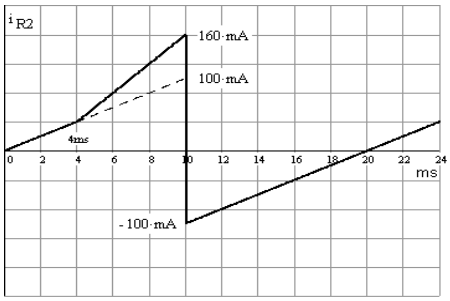
The grades will be posted on line in pdf form in alphabetical order under the alias that you provide here. I **will not** post grades under your real name or an alias that looks like a real name or u-number. The pdf spreadsheet will show the homework, lab, and exam scores of everyone who answers here.

Answers

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

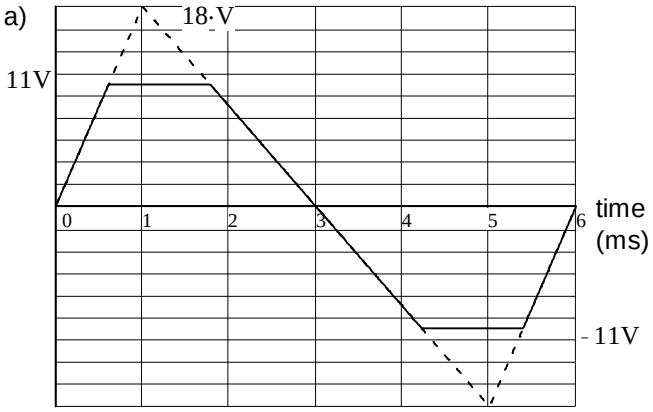
2. a) 10·mA 2.5·V 12.5·mA 12.5·mA -2.5·mA b) yes I_{D1} = 12.5·mA > 0
   c) no V_{D2} = 2.5·V > 0.7V
   d) no I_{D3} = -2.5·mA < 0

3.

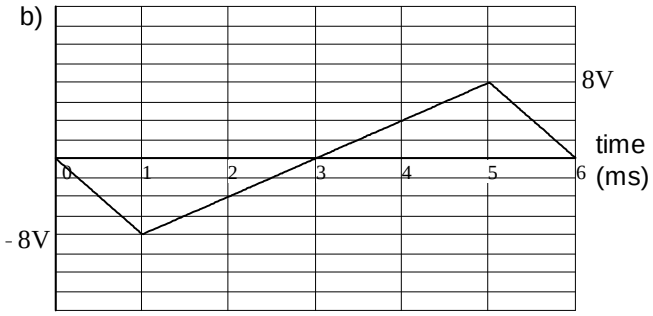


4. a) 2·W 23.3 b) 37.2 c) 0.32·W
   d) 3.8·kΩ e) 5·V f) D) g) 1.6·A h) 19·mA

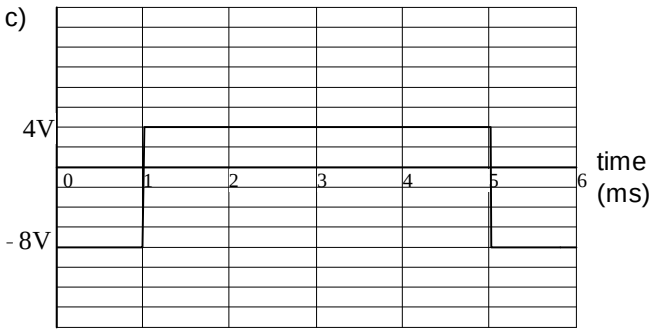
5. a)



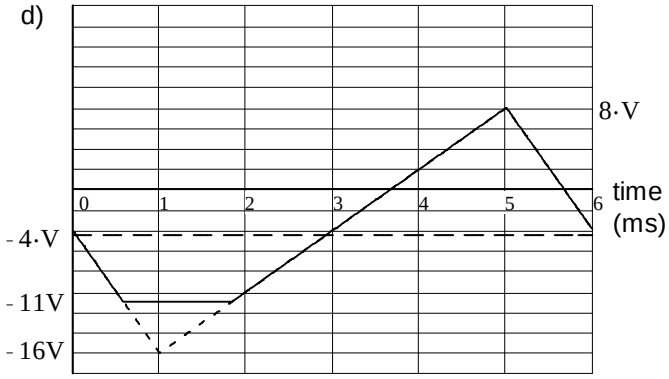
b)



c)



d)



6. a) 450·VA b) 4.09·A c) 0.8 d) ii) e) 33.6·Ω 119·mH f) 33.5·W g) 393.5 + 270·jVA h) 116.6·V

7. a) 3.72·A b) 11.15·V c) 70.5·V d) 746 + 249·j VA
   e) NO 11.1·A > 10·A