ECE2210 Final given: Fall 13

1. (23 pts) a) Draw the asymptotic Bode plot (the straight-line approximation) of the transfer function below. Accurately draw it on the graph provided.

   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..

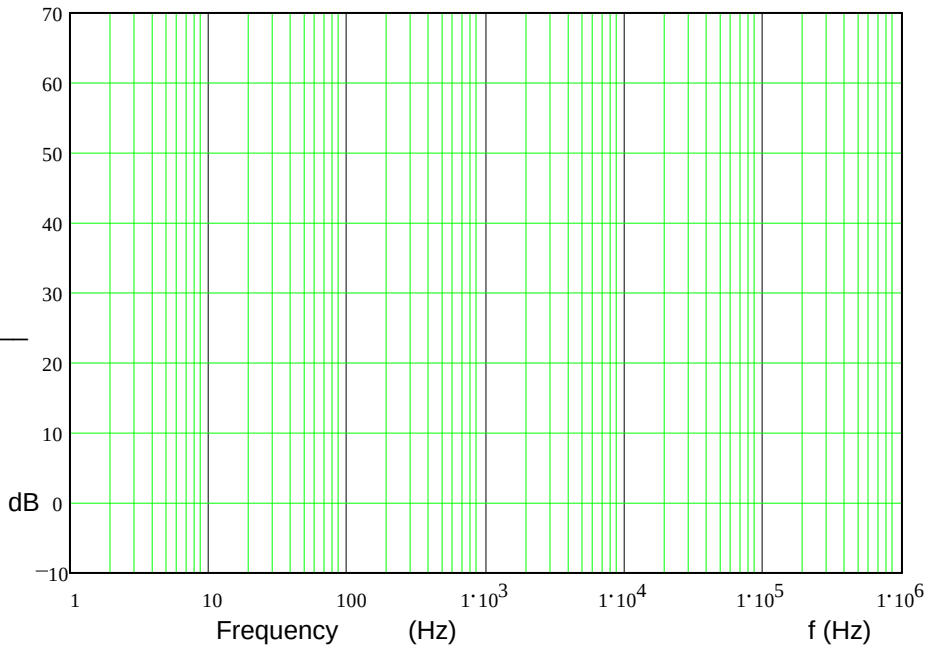
$$H(f) := \frac{5 \cdot j \cdot f \cdot \left(4 + \frac{j \cdot f}{10 \cdot kHz}\right)}{(100 \cdot Hz + 0.5 \cdot j \cdot f)}$$

Magnitude plot

$|H(f)|$

Straight-line approximation ____

Actual _ _ _ _



   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 arrow(s)) and write down the actual magnitude(s) at that (those) point(s).

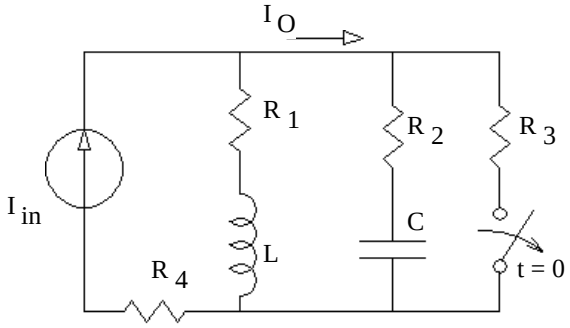
   c) If there are any corners in the Bode plot associated with **poles** in the transfer function, list that/those corner frequency(ies) here (f_p).

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

2. (14 pts) Find the s-type transfer function of the circuit shown after the switch opens. I_{in} is the input and I_O 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.

   H(s) = ?



3. (8 pts) A transfer function is found to be:

$$\mathbf{H}(s) = \frac{s \cdot (s - K_1)}{s^2 + \frac{1}{(R_2 + R_1) \cdot C} \cdot s + \frac{8}{L \cdot C}}$$

   a) Find the characteristic equation of the transfer function shown.

   b) The solutions to the characteristic equation are called the _____ of the transfer function.

   c) Does the transfer function have one or more zeros? If yes, express it (them) in terms of K_1, R_1, R_2, C, & L.

4. (24 pts) A single-phase, 240-V source is connected to two loads (in parallel). The source provides 2400W and 12A. Load 1 consumes 1500W at a power factor of 0.6, lagging. This power factor refers to load 1 ONLY.

   Hint: Remember that Q's add and subtract just like P's

   In order to find the following, you may have to make an assumption. If you do, be sure to clearly state your assumption in such a way that I can tell that you know what the other assumption might be.

   a) Find the complex power (both P and Q) consumed by load 2.

   $P_S := 2.4\cdot kW$ $I_S := 12\cdot A$ $P_{L1} := 1.5\cdot kW$ $pf_{L1} := 0.6$ $V_S := 240\cdot V$

   b) Load 2 can be modeled as 2 parts. Draw a model and find the values of the parts.

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

5. (27 pts) Assume that diodes D_1 and D_4 **DO** conduct.

   Assume thatdiodes D_2 and D_3 **DO NOT** conduct.

   a) Find I_{R2}, I_{D1}, V_{D2}, & V_{D3} based on these assumptions. Stick with these assumptions even if your answers come out absurd.

   I_{R1} = _____

   I_{D1} = _____

   V_{D2} = _____

   V_{D3} = _____

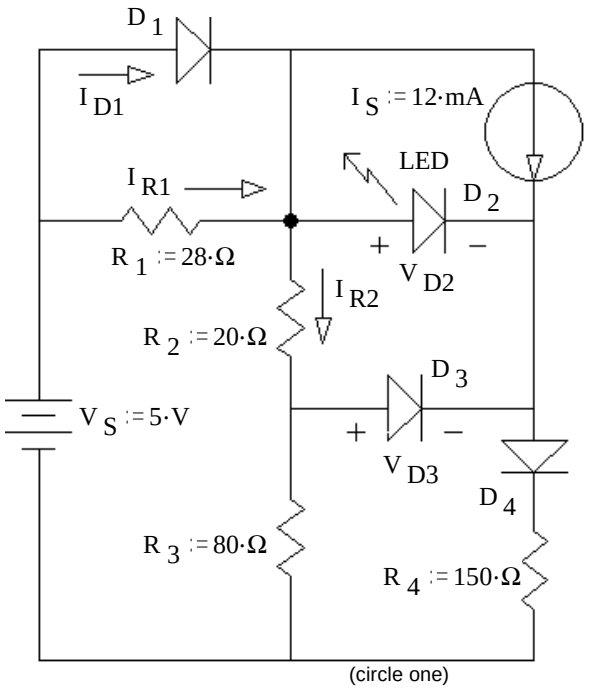
   b) Based on the numbers above, was the assumption about D_1 correct? yes no

   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
   How do you know? (Show a value & range.)

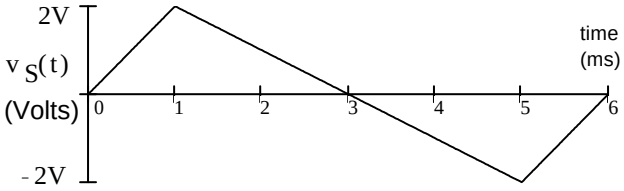
   d) Was the assumption about D_3 correct? yes no
   How do you know? (Show a value & range.)

   e) Was the assumption about D_4 correct? yes no
   How do you know? (Show a value & range.)

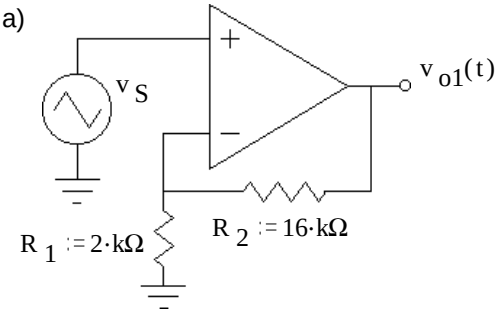


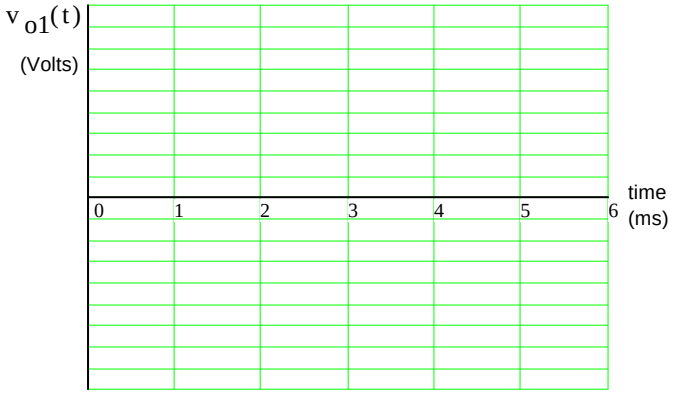
(circle one)

6. (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 ± 12 V power supplies.



a)





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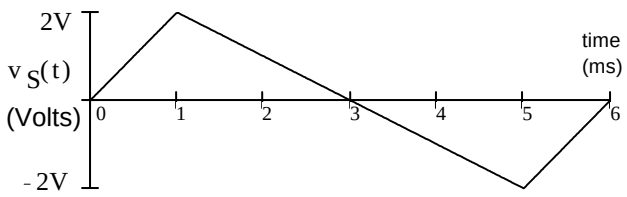
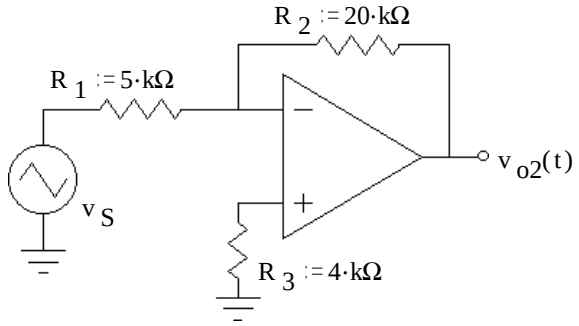
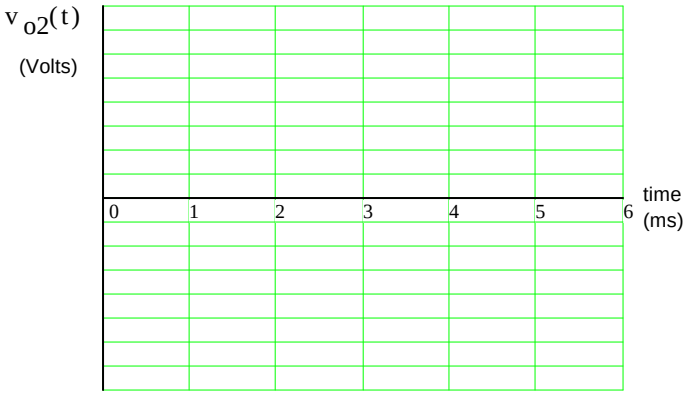
6, continued, the input is repeated at right.

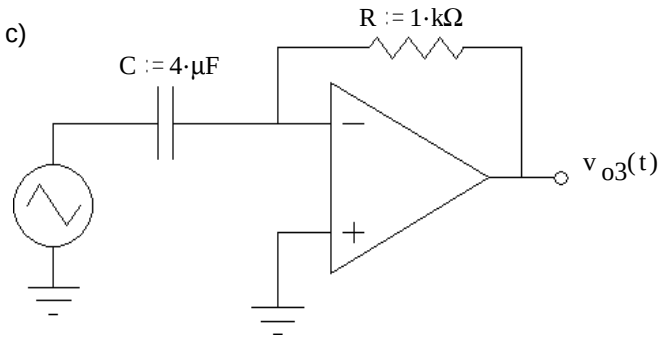


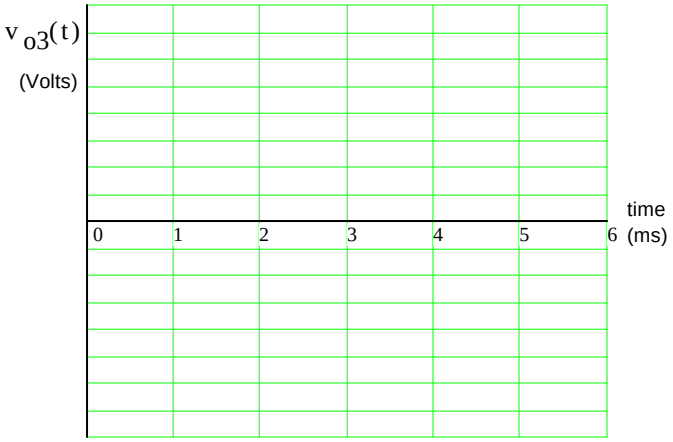
b)



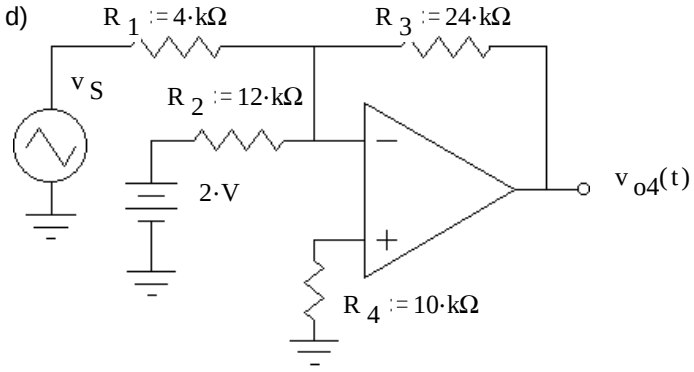


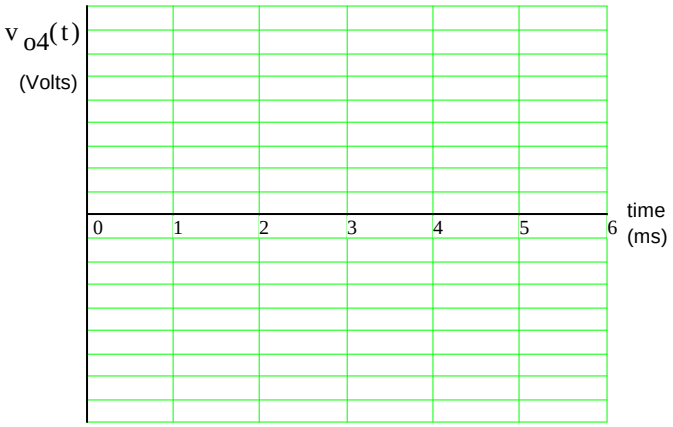
c)





d)





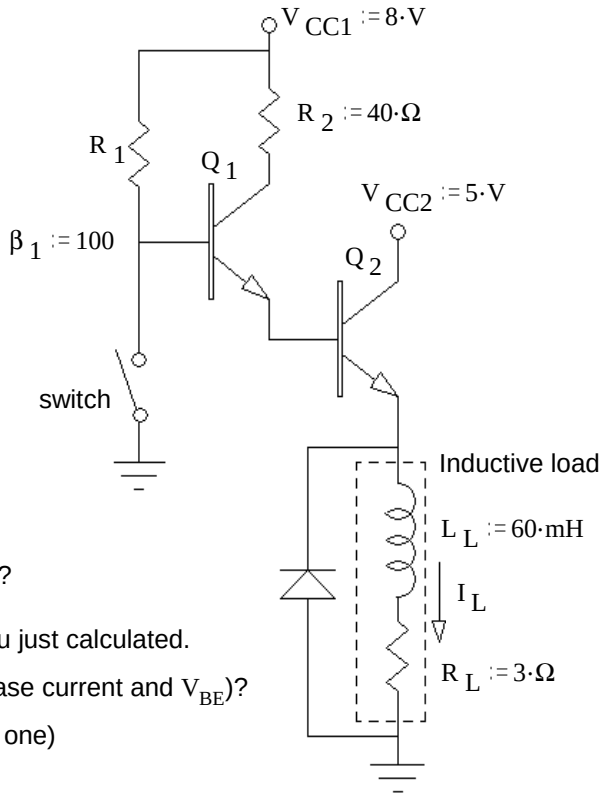
7. (34 pts) A transistor is used to control the current flow through an inductive load (in the dotted box, it could be a relay coil or a DC motor).
   a) In order for current to flow in through the load, the switch should be:

      i) closed or ii) open (Circle one)

   b) Assume the switch has been in the position you circled above for a long time. I_L is 1.3A. Find the power dissipated by transistor Q_2 (neglect base current and V_{BE}).

      $I_L := 1.3 \cdot A$ $P_{Q2} = ?$

   c) This is an unacceptable power loss, so you would like to determine the minimum β_2 needed so that Q_2 will be in saturation. Assume Q_1 is also in saturation. You may assume $I_E = I_C$ for both traistors.



$\beta_{2min} = ?$

You replace Q_2 with a new transistor that has a β greater than what you just calculated.

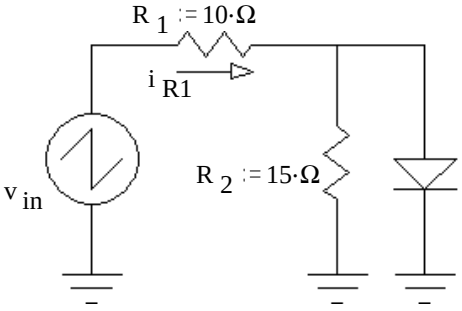
   d) How much power is dissipated by the new transistor Q_2 (neglect base current and V_{BE})?

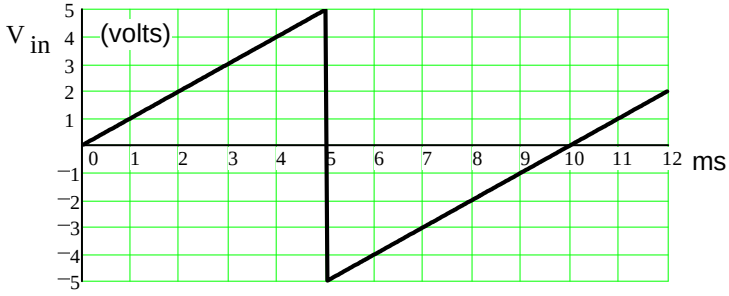
   e) What is the maximum value of R_1 needed to saturate Q_1? (circle one)

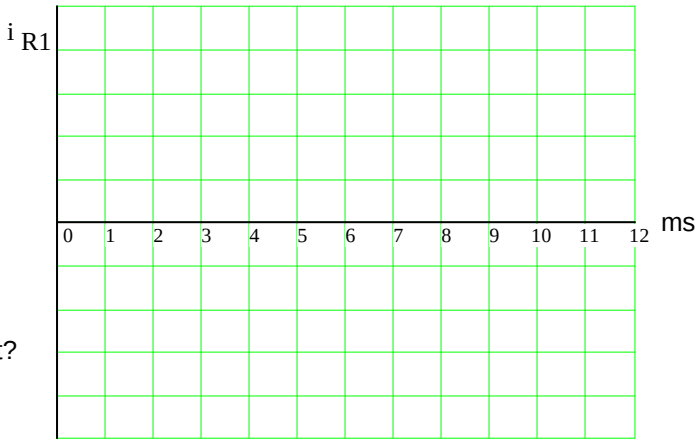
   f) The diode in this circuit conducts a significant current:
      A) never. B) when the switch closes. C) whenever the switch is closed.
      D) always. E) when the switch opens. F) whenever the switch is open.

   g) What is the maximum diode current you expect when the switch is cycled. (Answer 0 if it never conducts.)

8. (20 pts) A voltage waveform is applied to the circuit shown. Accurately draw the R_1 current waveform (i_{R1}) that you expect to see. Label important times **and** current levels.







9. Do you want your grade and scores posted on the Internet? If your answer is yes, then provide some sort of alias:

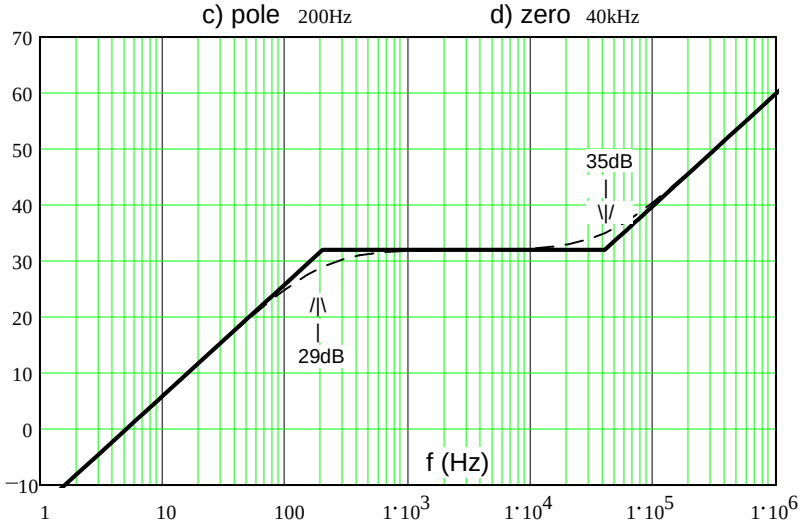
_____

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 or your folder number. The pdf will show the homework, lab, and exam scores of everyone who answers here.

Answers

1. a)



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

3. a) $0 = s^2+\frac{1}{(R_2+R_1)\cdot C}\cdot s+\frac{8}{L\cdot C}$

   b) poles

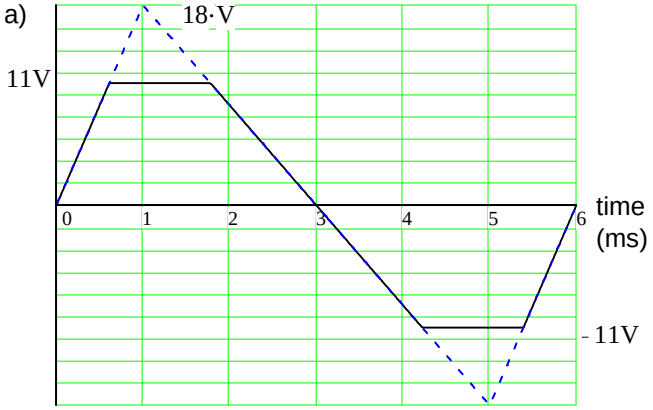
   c) Yes $s = 0$ $s = K_1$

4. a) $(900 - 408\cdot j)\cdot VA$

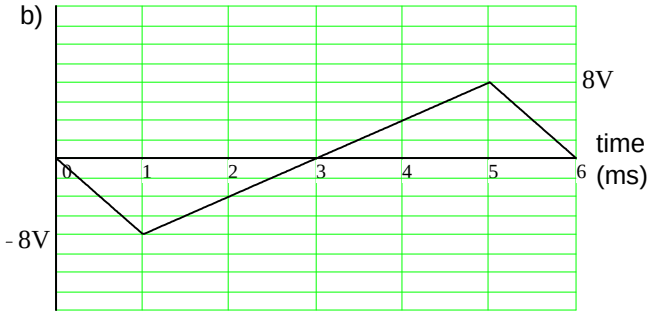
   b) parallel $64\cdot\Omega$ $18.8\cdot\mu F$
   series $53.1\cdot\Omega$ $110\cdot\mu F$

5. a) $25\cdot mA$ $30\cdot mA$ $1.8\cdot V$ $0.94\cdot V$ b) yes $30\cdot mA > 0$ c) yes $1.8\cdot V < 2V$ d) no $0.94\cdot V > 0.7V$ e) yes $12\cdot mA > 0$

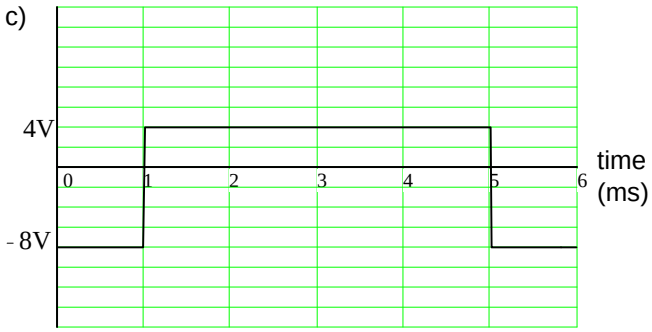
6. a)



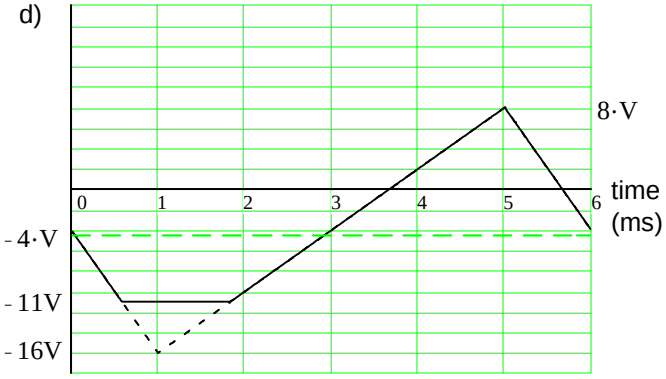
b)



c)



d)



7. a) ii) b) $1.43\cdot W$ c) close enough 27.8
   better 26.6
   d) $320\cdot mW$ e) $3.13\cdot k\Omega$ f) B) g) $1.6\cdot A$

8.