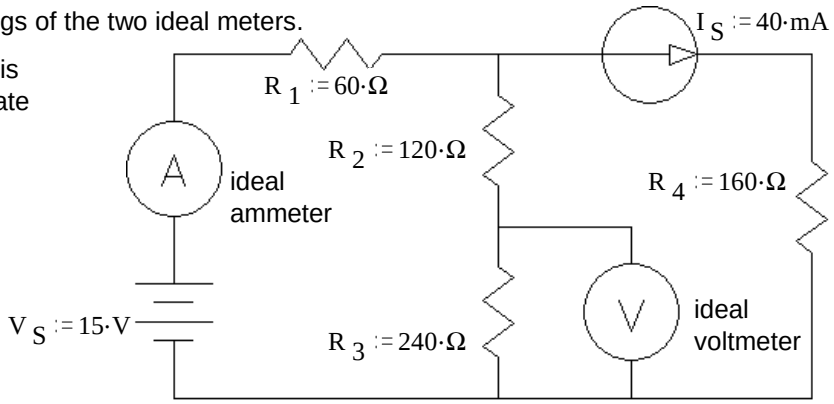
ECE2210 Final given: Spring 13

1. (20 pts) Use nodal analysis to find the readings of the two ideal meters.

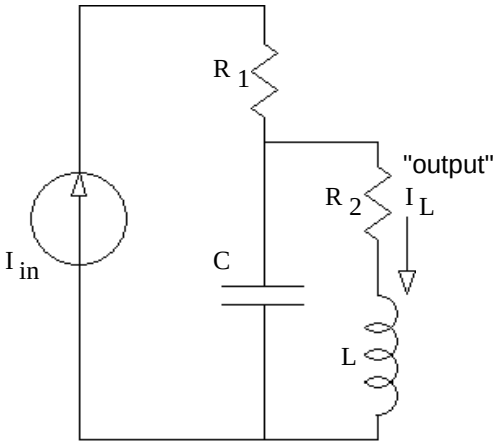
   You **MUST** show all the steps of nodal analysis work to get credit, including drawing appropriate symbols and labels on the circuit shown.



2. (14 pts) a) Find the s-type transfer function of the circuit shown. Consider I_L as the "output".

   You MUST show work to get credit. Simplify your expression for $H(s)$ so that the denominator is a simple polynomial.

$$\mathbf{H}(s) = \frac{\mathbf{I_L}(s)}{\mathbf{I_{in}}(s)} = ?$$



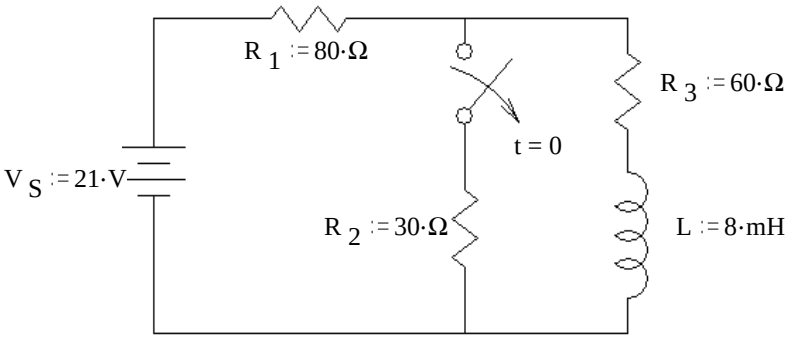
   b) How many zeroes does this transfer function have?

   c) How many poles does this transfer function have?

   If it has 1 or more, express them (probably in terms of R_1, R_2, L and C).

3. (28 pts) The switch has been closed for a long time and is opened (as shown) at time $t = 0$.

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



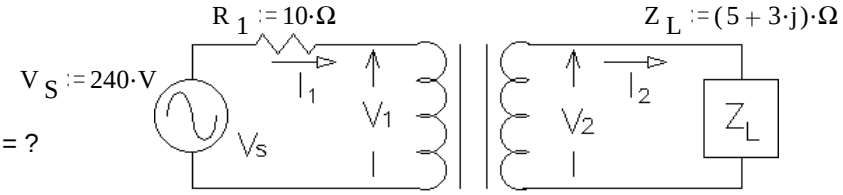
   b) Find i_L at time $t = 1.5\tau$. $i_L(1.5\cdot\tau) = ?$

   c) At time $t = 1.5\tau$ the switch is closed again. Find the complete expression for $i_L(t')$, where t' starts when the switch closes. Be sure to clearly show the time constant.

4. (20 pts) The transformer shown in the circuit below is ideal. It is rated at 360/120 V, 1.5 kVA, 60 Hz

   All values are RMS unless specified otherwise.

   Find the following:



   a) 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. $\mathbf{S_L} = ?$

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

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

5. (22 pts) Assume that diodes D_1 and D_2 **DO** conduct.

   Assume that diode D_3 does **NOT** conduct.

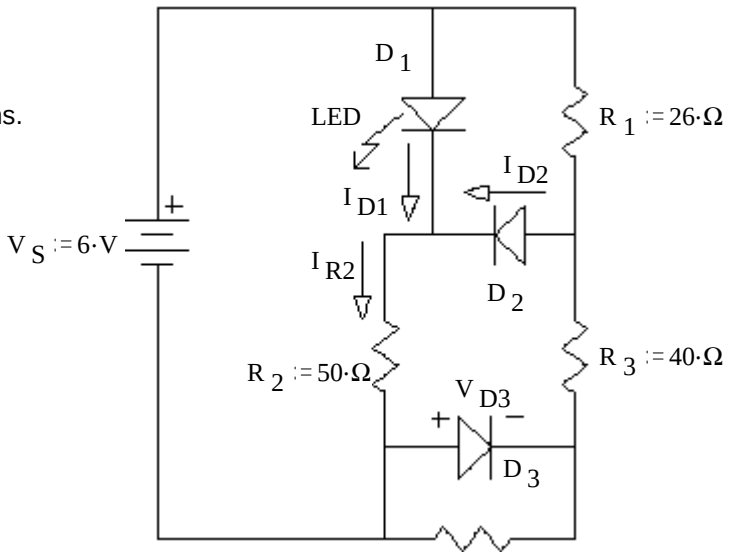
   a) Find I_{R2}, I_{D2}, I_{D1}, & V_{D3} based on these assumptions. Stick with these assumptions even if your answers come out absurd.

   I_{R2} = _____

   I_{D2} = _____

   I_{D1} = _____

   V_{D3} = _____



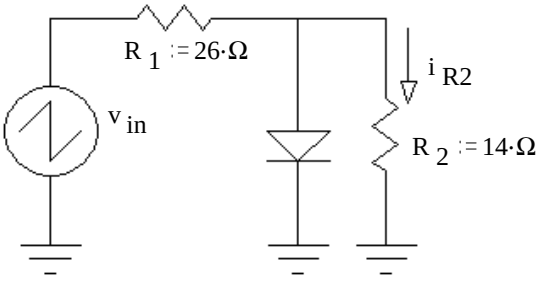
   b) Based on the numbers above, was the assumption about D_1 correct? yes no (circle one)

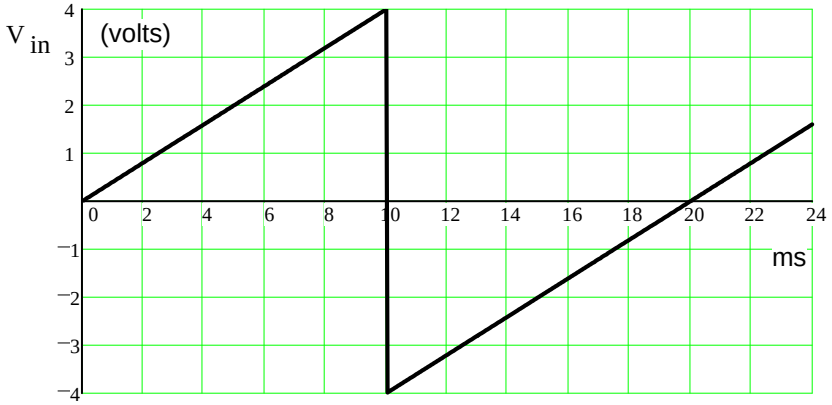
   How do you know? (Specifically show a value which is or is not within a correct range.)

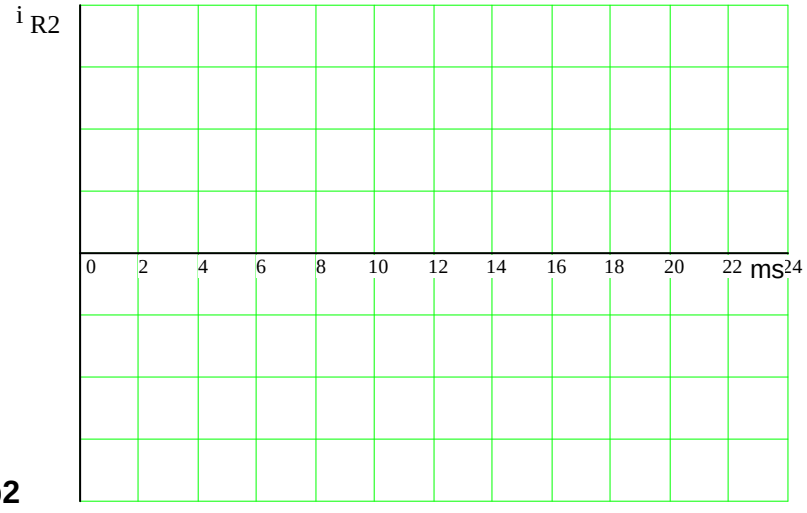
   c) Was the assumption about D_2 correct? yes no (circle one)
   How do you know? (Show a value & range.)

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

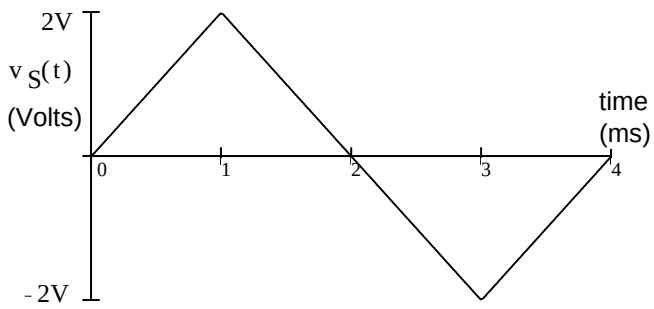
9. (18 pts) A voltage waveform is applied to the circuit shown. Accurately draw the R_2 current waveform (i_{R2}) that you expect to see. Label important times **and** current levels.



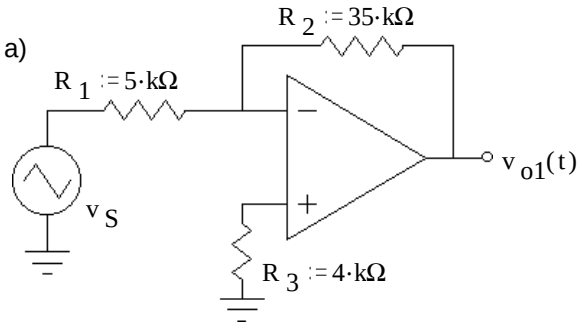


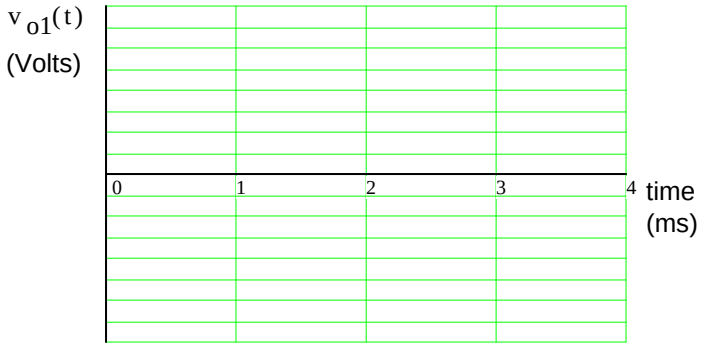


6. (28 pts) The same input signal (at right) is connected to several op-amp circuits below. Sketch the output waveform for each circuit. Clearly label important voltage levels on each output. If I can't easily make out what your peak values are, I'll assume you don't know. Don't forget to show inversions. All op-amps are powered by $\pm$ 12 V power supplies.

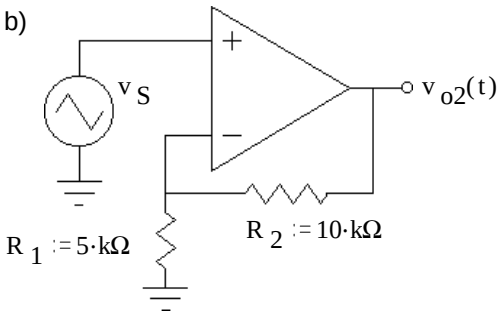


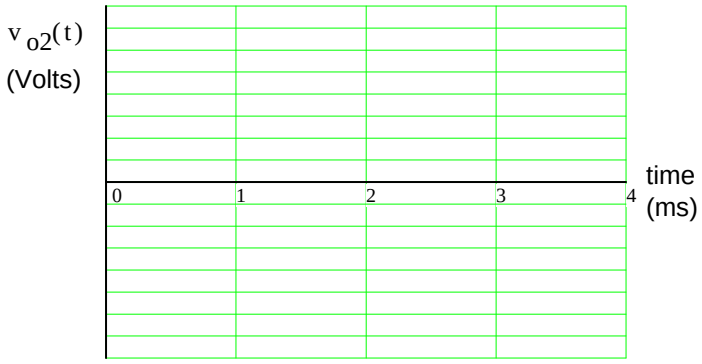
a)



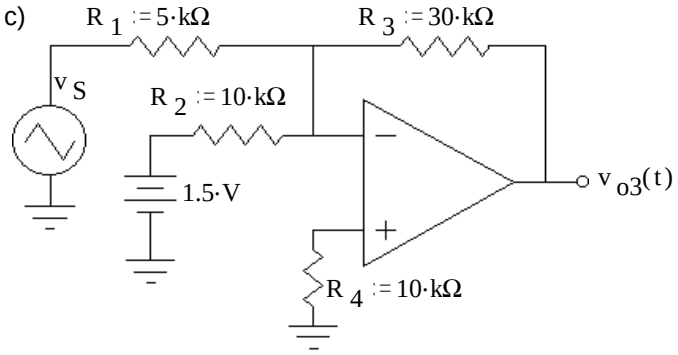


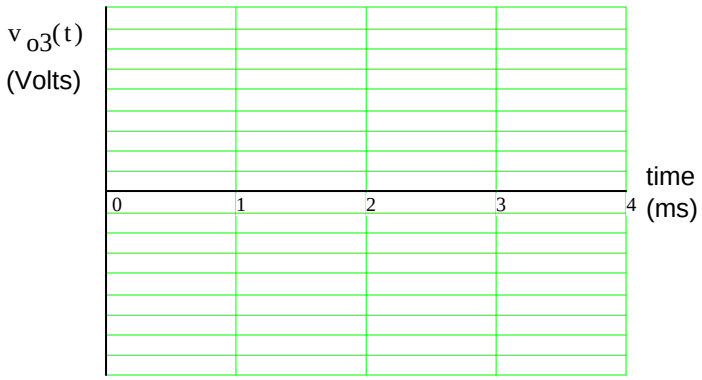
b)



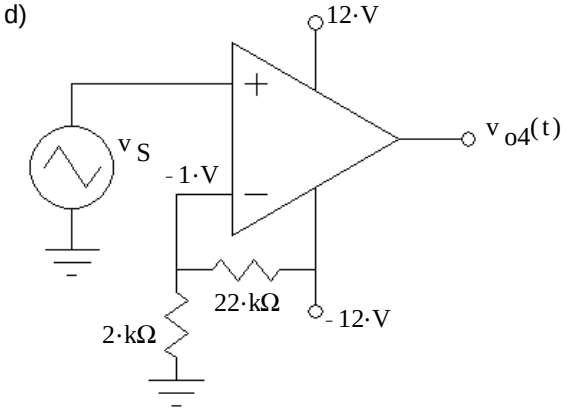


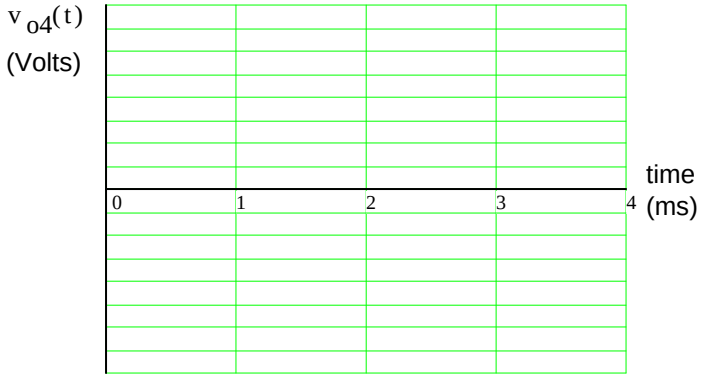
c)





d)





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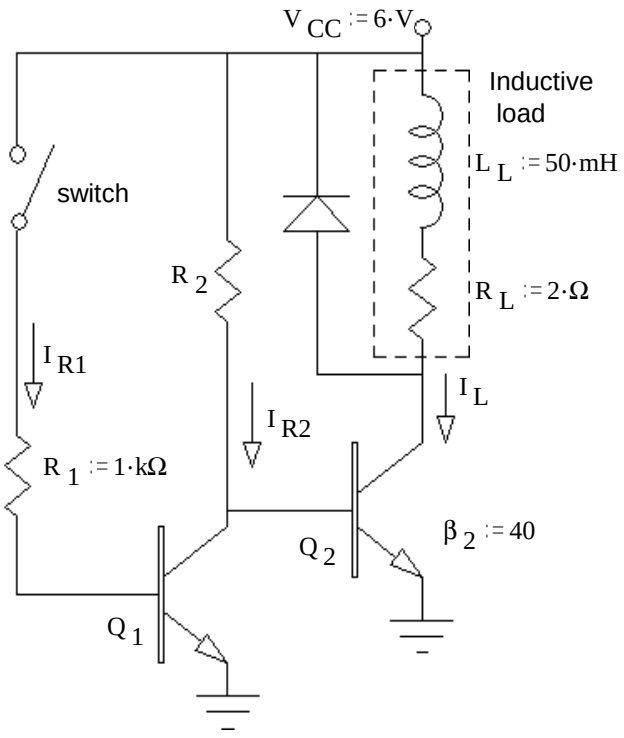
7. (30 pts) A transistor is used to control the current flow through an inductive load (in the dotted box, it could be a relay coil or a DC motor).



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 and transistor Q_2 is saturated. Find the power dissipated by transistor Q_2 (neglect base current and V_{BE}).

P_{Q2} = ?

c) Assume β_2 is as shown. Find the maximum value of R_2, so that Q_2 will be in saturation. R_2 = ?

Use this value of R_2 for the remainder of the problem

d) If β_2 were actually half the value shown shown, how much power would be dissipated by transistor Q_2 (neglect base current and V_{BE})? P_{Q2} = ?

Use the value of β_2 shown for the remainder of the problem. (not the half-value)

e) When the switch is changed from the position you circled in part a), the load current should go to zero. What is the minimum value of β_1 needed to saturate Q_1?

f) EXTRA CREDIT (8 pts). If β_1 were actually half the value you found above, what would I_L be?

8. 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

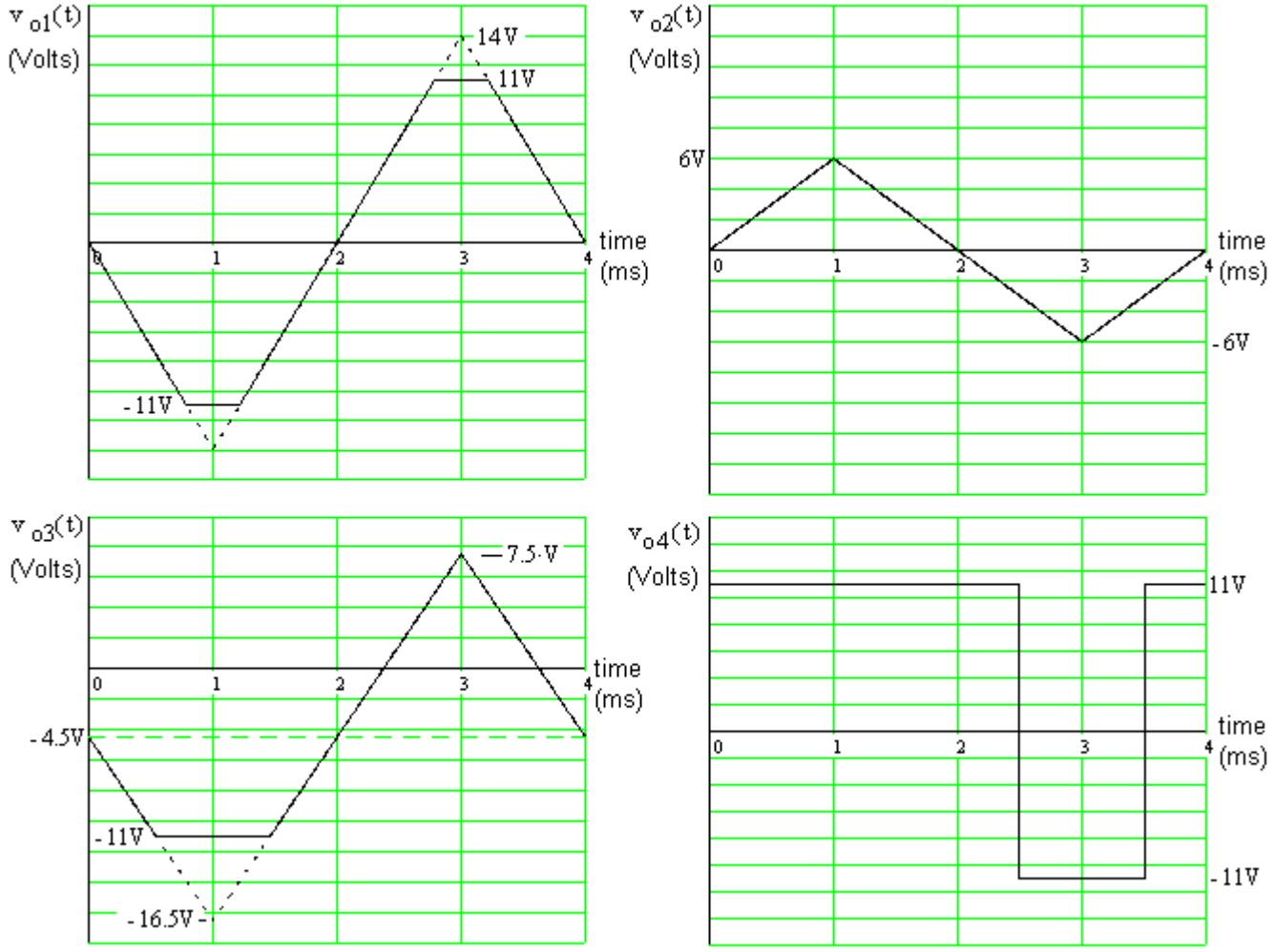
1. $7.2 \cdot V$ $70 \cdot mA$ 2. a) $\dfrac{\frac{1}{L \cdot C}}{s^2 + \frac{R_2}{L} \cdot s + \frac{1}{L \cdot C}}$ b) 0 c) 2 $\dfrac{-\frac{R_2}{L} \pm \sqrt{\left(\frac{R_2}{L}\right)^2 - \frac{4}{L \cdot C}}}{2}$

3. a) $150\cdot mA - 80\cdot mA\cdot e^{\frac{-t}{57.1\cdot \mu s}}$ b) $132\cdot mA$ c) $70\cdot mA + 62.2\cdot mA\cdot e^{\frac{-t}{97.8\cdot \mu s}}$

4. a) $3.92\cdot A$ b) $11.75\cdot A$ c) $68.5\cdot V$ d) $690\cdot 5 + j\cdot 414.3\ VA$ e) YES $I_{1max} = 4.17\cdot A > 3.92\cdot A = I_1$

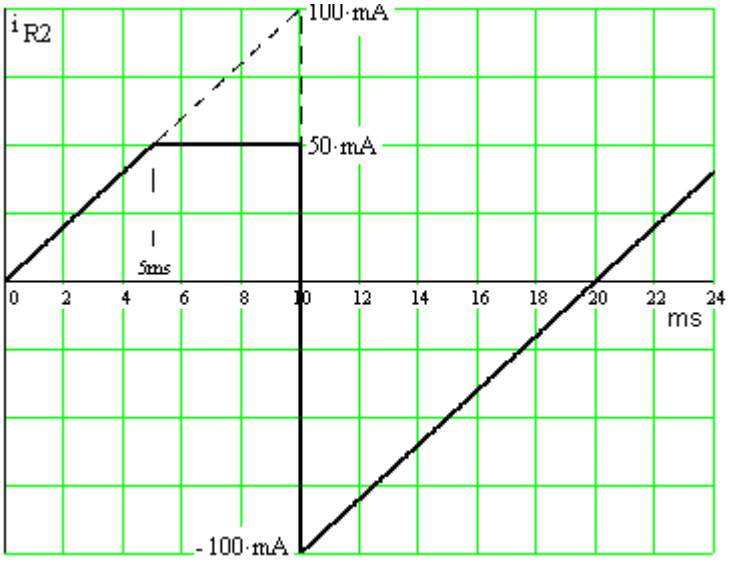
5. a) $80\cdot mA$ $-44\cdot mA$ $124\cdot mA$ $-0.94\cdot V$ b) yes $I_{D1} = 124\cdot mA > 0$ c) no $I_{D2} = -44\cdot mA < 0$
   d) yes $V_{D3} = -0.94\cdot V < 0.7V$

6.



7. a) open b) $580\cdot mW$ c) $73.1\cdot \Omega$ d) $4.5\cdot W$ e) 15 f) $1.31\cdot A$

9.



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Name _____

Scores:

prob 1	_____	/ 20 pts
prob 2	_____	/ 14 pts
prob 3	_____	/ 28 pts
prob 4	_____	/ 20 pts
prob 5	_____	/ 22 pts
prob 6	_____	/ 28 pt
prob 7	_____	/ 30 pts
prob 9	_____	/ 18 pts

Total _____ / 180 pts