ECE 2210 Final given: Spring 15

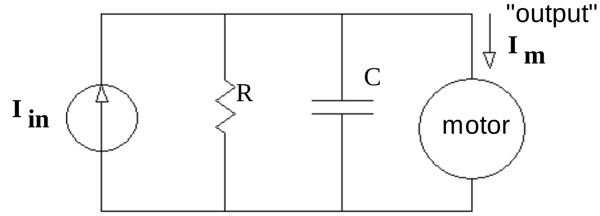
Closed Book, Closed notes except preprinted yellow sheet, Calculators OK.

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

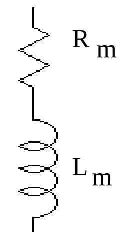
1. (15 pts) a) Find the s-type transfer function of the circuit shown. Consider the motor current ($\mathbf{I_m}$) as the "output".

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

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



The motor may be modeled as a resistor in series with an inductor, like this:



b) How many poles does this transfer function have?

c) How many zeroes does this transfer function have?

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

2. (17 pts) Find the values below. Show your work.

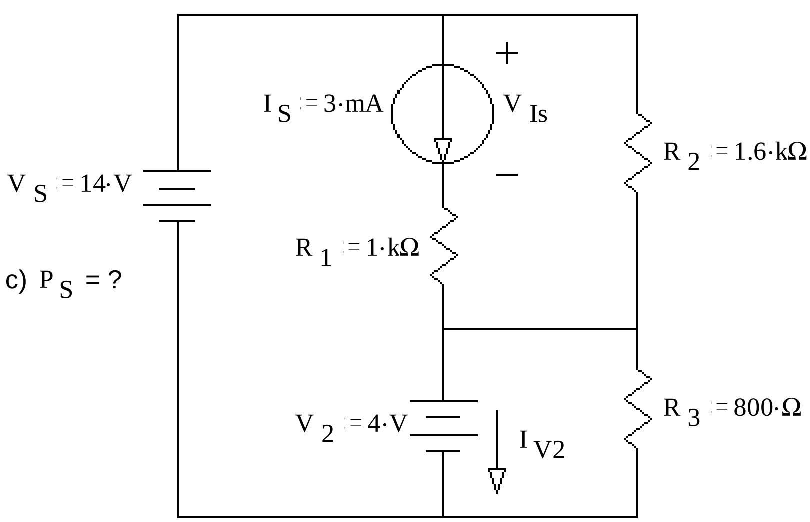
Note: feel free to show work & answers right on the schematic

a) V_{Is} = ?

b) I_{V2} = ?

c) P_S = ?

a) V_{Is} = ?



b) I_{V2} = ?

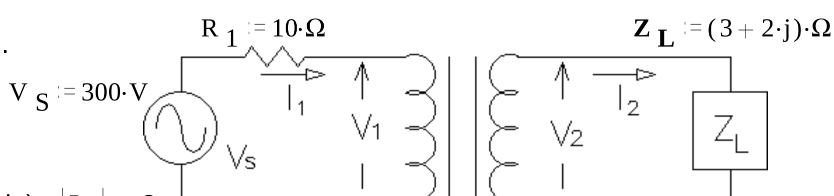
3. (20 pts) The transformer shown in the circuit below is ideal. It is rated at 600/120 V, 1.5 kVA, 60 Hz

Find the following:

All values are RMS unless specified otherwise.

a) The primary current (magnitude).

$|\mathbf{I_1}|$ = ?



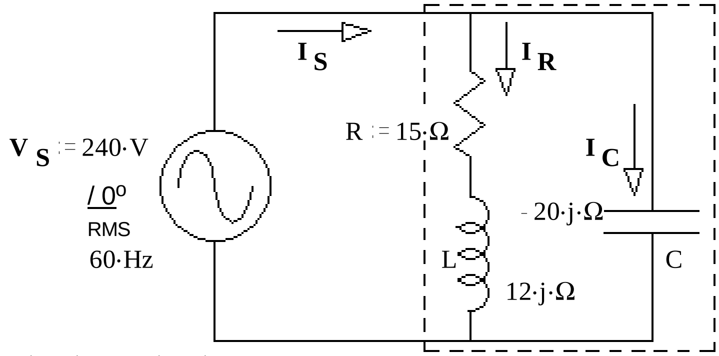
b) The secondary current (magnitude). $|\mathbf{I_2}|$ = ?

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

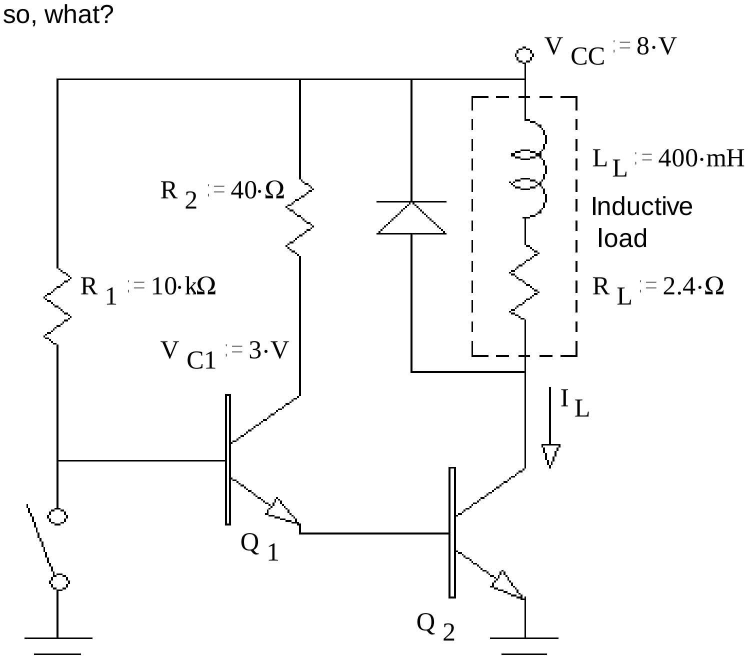
d) The complex power OR (P and Q) used by the load. $\mathbf{S_L}$ = ?

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

4. (25 pts) R, L, & C together are the load in the circuit shown.
   Find the following for the load (in dotted box):
   Be sure to show the correct units for each value.
   a) The real power. $P = ?$
   b) The reactive power. $Q = ?$
   c) The complex power. $\mathbf{S} = ?$
   d) The apparent power. $|\mathbf{S}| = ?$
   e) The power factor. $pf = ?$
   f) The power factor is: i) leading ii) lagging
   g) The magnitudes of the three currents. $|\mathbf{I}_S| = ?$ $|\mathbf{I}_R| = ?$ $|\mathbf{I}_C| = ?$
   h) Is there something weird about these currents? If so, what?

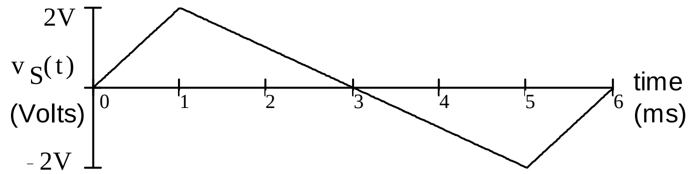


5. (30 pts) A couple of transistors are used to control the current flow through an inductive load.
   a) The switch has been open for a long time. You measure the voltage at the collector of Q_1 to be the value shown (referenced to ground). What is the minimum β_2 needed to insure that transistor Q_2 is in saturation? You may assume that the emitter current of Q_1 is approximately equal to the collector current of Q_1 . $\beta_{2min} = ?$

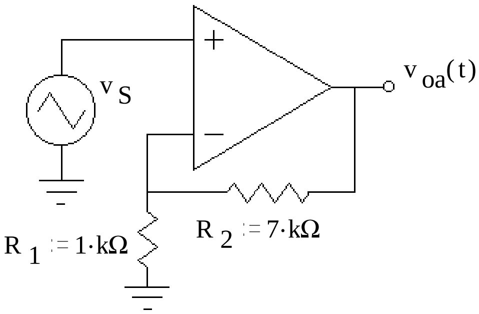


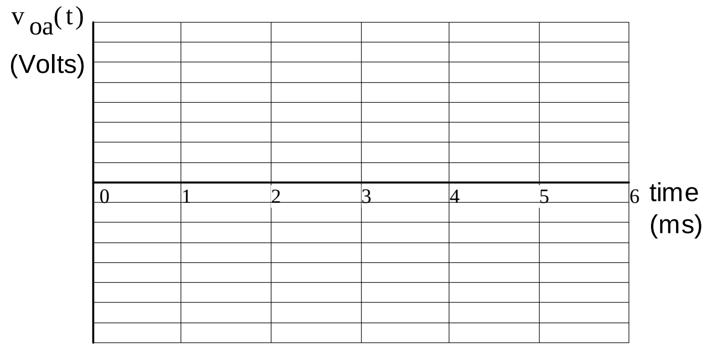
   b) Find the power dissipated in transistor Q_2 with this β. $P_{Q2} = ?$
   c) Find the β of Q_1. $\beta_1 = ?$
   d) Is this a minimum / maximum / actual value of β_1? (circle one)
   e) Find the power dissipated in transistor Q_2 if $\beta_2 := 20$ $P_{Q2} = ?$
   f) Find the power dissipated in transistor Q_2 if $\beta_2 := 20$ and the switch is closed. $P_{Q2} = ?$
   g) The diode in this circuit conducts a significant current: (circle one)
      A) never.
      B) when the switch first closes.
      C) whenever the switch is closed.
      D) always.
      E) when the switch first opens.
      F) whenever the switch is open.
   h) What is the maximum diode current you expect when the switch is cycled. (Answer 0 if it never conducts.)
      Assume the β_2 of part a).

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 $\pm$ 12 V power supplies.

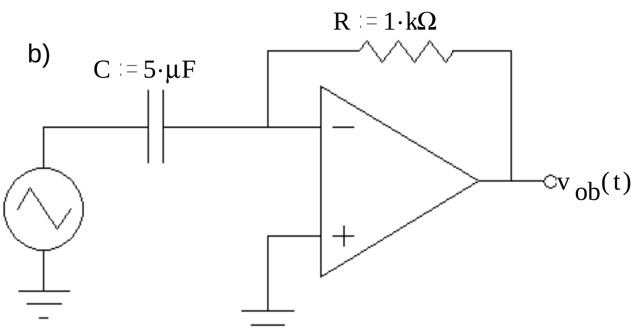


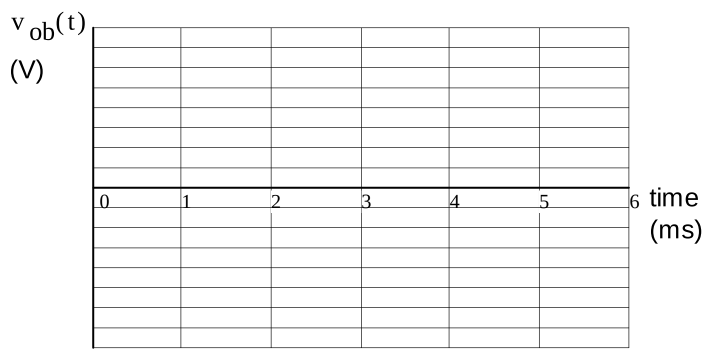
a)



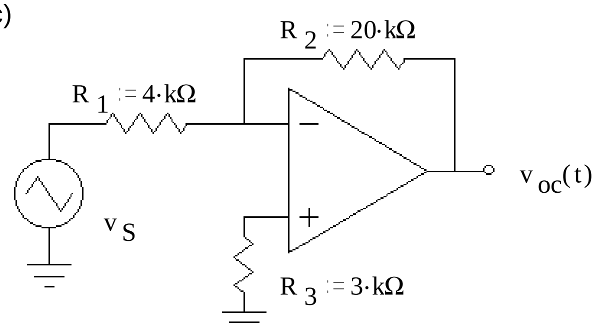


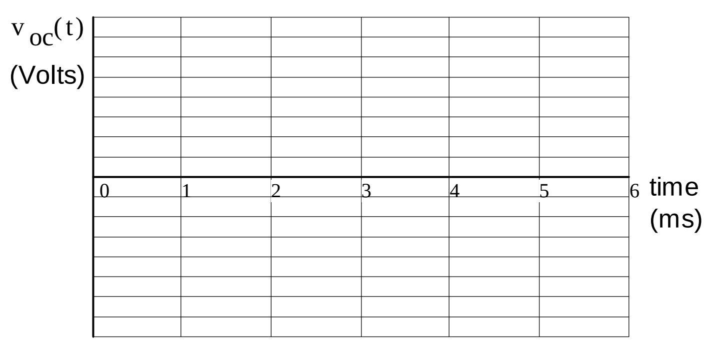
b)



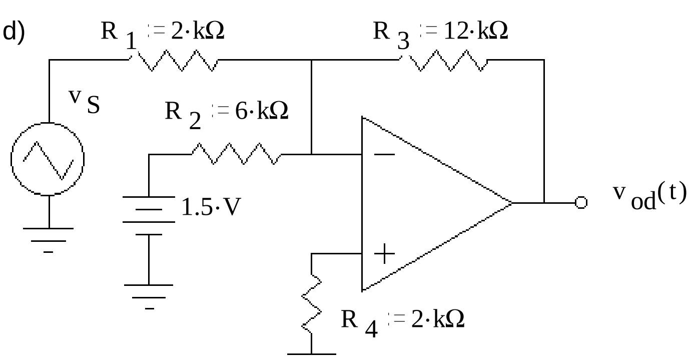


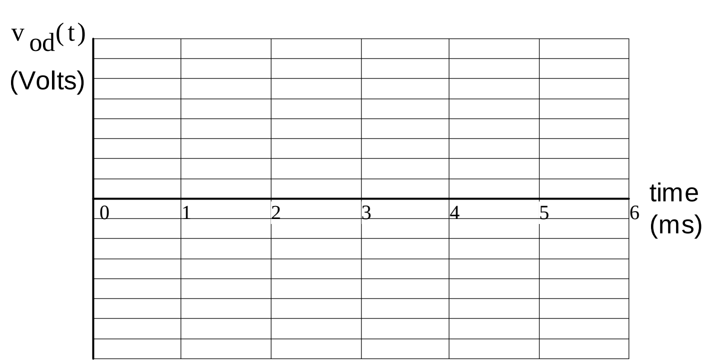
c)





d)





7. (25 pts) Assume that diodes D_1 and D_2 **DO** conduct.

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

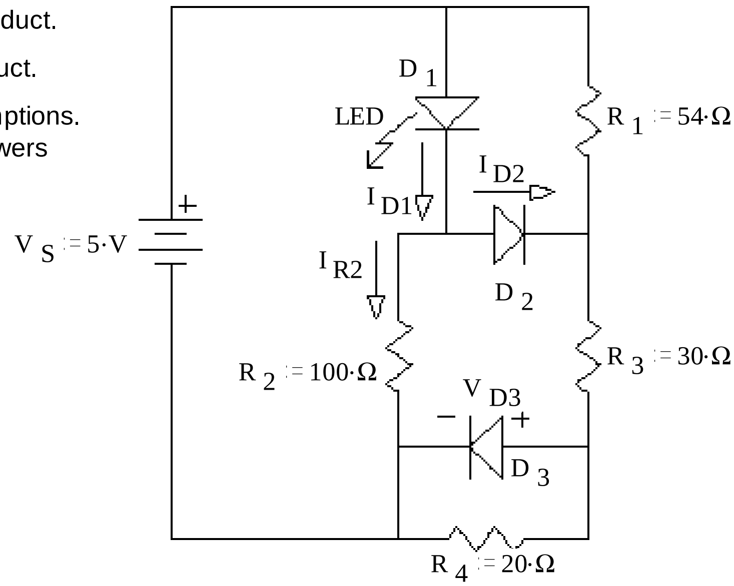
a) Find I_{R2}, I_{D2}, I_{D1}, & V_{D3} based on these assumptions. Stick with these assumptions even if your answers come out absurd.

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.)

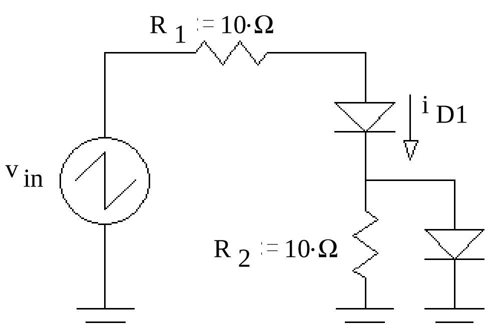
e) Based on your answers to parts b), c) & e), Circle one:
You do not need to justify your answer.

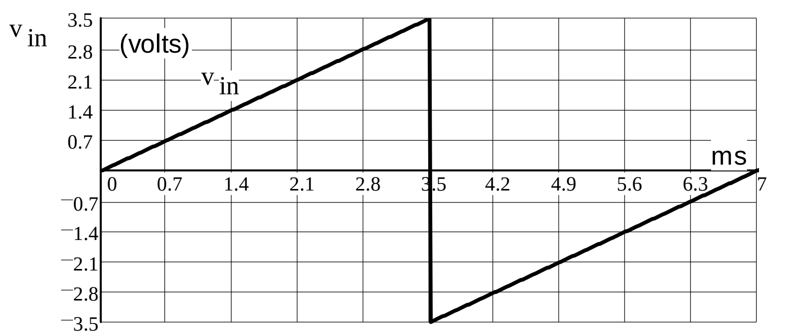
i) The ***real*** $I_{R2} < I_{R2}$ calculated in part a.

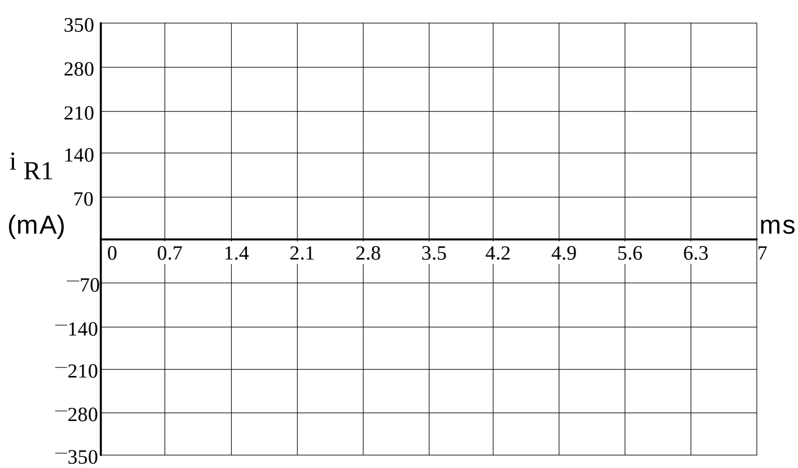
ii) The ***real*** $I_{R2} = I_{R2}$ calculated in part a.

iii) The ***real*** $I_{R2} > I_{R2}$ calculated in part a.

8. (18 pts) The voltage waveform shown is applied to the circuit. <u>Accurately</u> draw the diode current (i_{D1}) 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 an alias that looks like a real name or u-number. It will show the homework, lab, and exam scores of everyone who answers here.

Answers

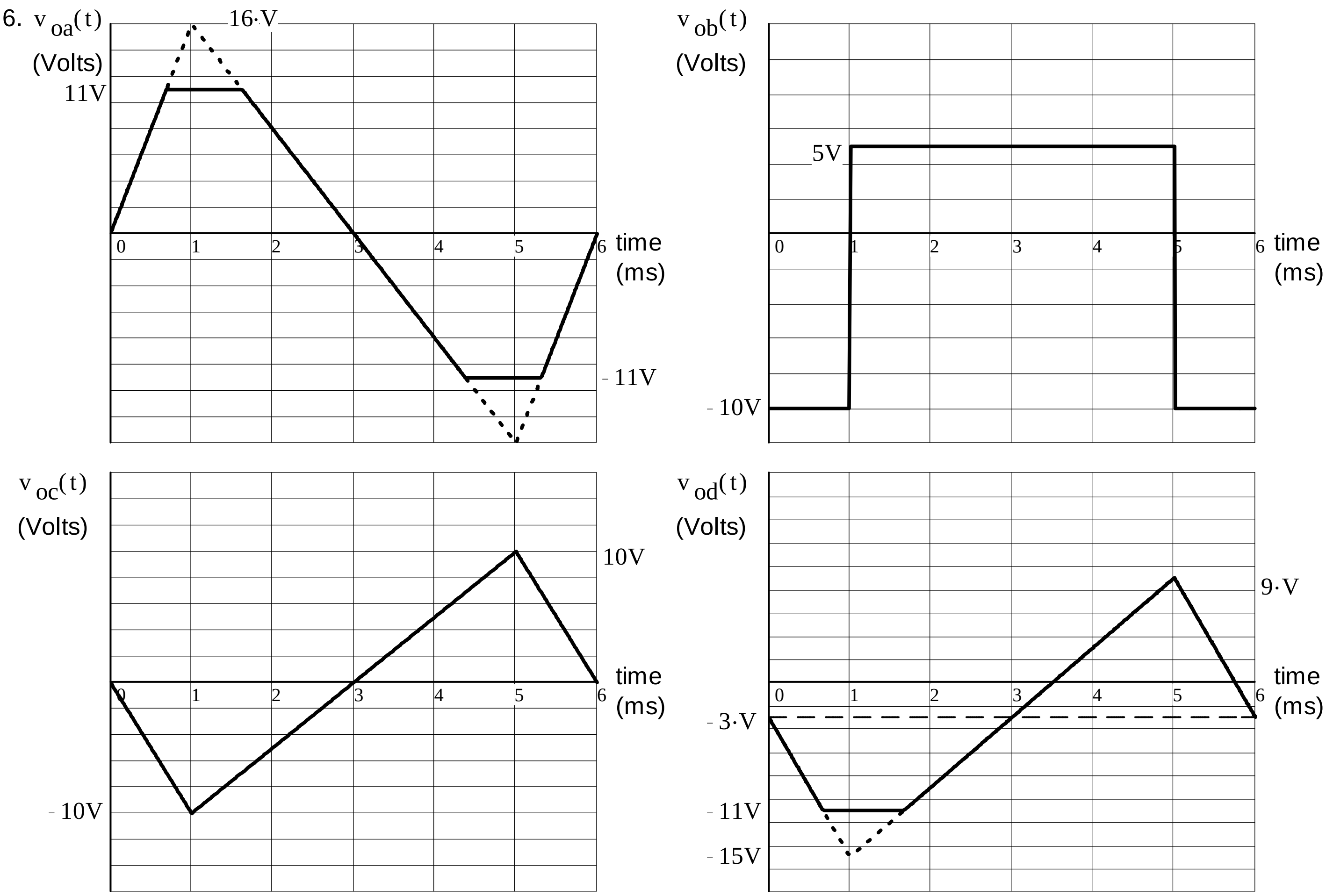
1. a) $\dfrac{\dfrac{1}{L_m \cdot C}}{s^2 + \left(\dfrac{R_m}{L_m} + \dfrac{1}{R \cdot C}\right) \cdot s + \dfrac{1}{L_m \cdot C} \cdot \left(1 + \dfrac{R_m}{R}\right)}$ b) 2 c) 0

2. a) $7 \cdot V$ b) $4.25 \cdot mA$ c) $129.5 \cdot mW$

3. a) $3.04 \cdot A$ b) $15.2 \cdot A$ c) $54.8 \cdot V$ d) $(694 + 463 \cdot j) \cdot VA$
e) NO $3.04 \cdot A > 2.5 \cdot A$

4. a) $2.34 \cdot kW$ b) $-1.01 \cdot kVAR$ c) $2.34 - 1.01 \cdot j\ kVA$ d) $2.55 \cdot kVA$ e) 0.919 f) i)
g) $10.6 \cdot A$ $12.5 \cdot A$ $12 \cdot A$ h) $|\mathbf{I}_S|$ is the smallest of the three because $\mathbf{I}_R$ and $\mathbf{I}_C$ are badly out of phase

5. a) 26 b) $0.65 \cdot W$ c) 189 d) actual e) $5 \cdot W$ f) $0 \cdot W$ g) B) h) $3.25 \cdot A$

6.


7. a) $30 \cdot mA$ $-4 \cdot mA$ $26 \cdot mA$ $0.92 \cdot V$
b) yes $26 \cdot mA > 0$
c) no $-4 \cdot mA < 0$
d) no $0.92 \cdot V > 0.7V$ e) ii)

8.