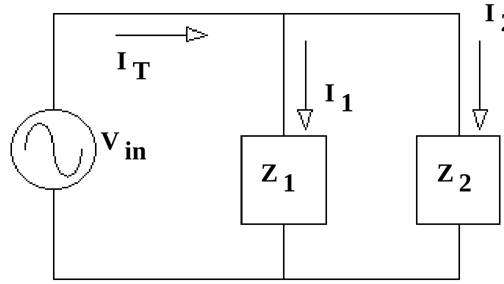
ECE2210 Final given: Fall 11

1. (20 pts)



$I_2 := 40 \cdot mA \ \underline{/0^o}$

$Z_2 := (90 + 120 \cdot j) \cdot \Omega$

$Z_1 := 50 \cdot \Omega \cdot e^{-j \cdot 30 \cdot deg} = 50\Omega \ \underline{/-30^o}$

a) Find V_{in} in polar form.

b) Find I_T.

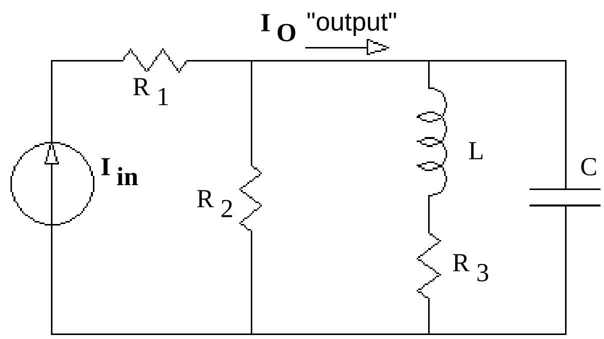
c) Circle 1:

i) The source current leads the source voltage

ii) The source voltage leads the source current

d) By how much? I.E. what is the phase angle between the voltage and current?

2. (15 pts) a) Find the s-type transfer function of the circuit shown. Consider I_{in} as the input and I_O as the "output".



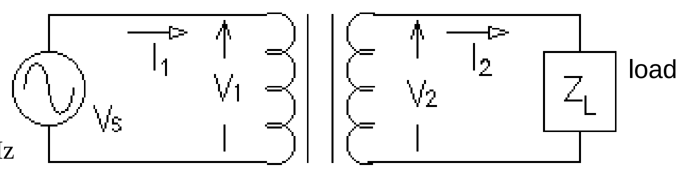
You MUST show work to get credit. Simplify your expression for H(s) so that the denominator is a simple polynomial with no coefficient before the highest-order s term in the denominator.

$H(s)$ = ?

b) How many zeroes does this transfer function have?

c) How many poles does this transfer function have?

3. (31 pts) A transformer is rated at 1000V / 200V, 1kVA. Assume the transformer is ideal and all voltages and currents are RMS.



$f := 60 \cdot Hz$

$V_S := 600 \cdot V \ \underline{/0^o}$

$|S_L| = 720 \cdot VA$

$pf := 82 \cdot \%$ leading

a) The primary has 250 turns of wire. How many turns does the secondary have?

b) The the source voltage, $V_S = 600 \cdot V$ How big is voltage across the load ($|V_2|$)?

c) The secondary load draws 720VA of apparent power at a power factor of 82%. Find the secondary load, Z_L (magnitude **and** **<u>angle</u>**).

d) Find the primary current, I_1 (magnitude **and** **<u>angle</u>**).

e) What is the load as seen by V_S? (magnitude **and** **<u>angle</u>**)

f) How much average power does the load dissipate?

g) How much average power does the power source (V_S) supply?

h) Is this transformer operating within its ratings?
How do you know? (Specifically show a values which are or are not within a correct range.)

Within range? yes no (circle one)

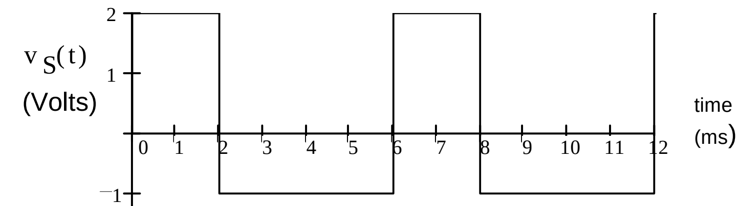
i) Using the given load voltage and power factor, what is the smallest load impedance magnitude that you could hook to this transformer and still operate within its ratings? $|Z_{Lmin}|$ = ?

j) Z_L is that found in part c). Add a component to the secondary side of the transformer so as to minimize the currents. Do not change the real power delivered to the load. Draw the part on the drawing and find its value.

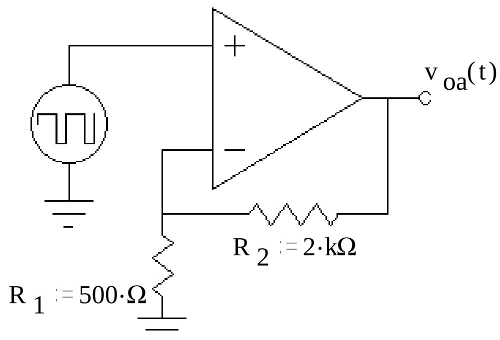
k) Is this transformer operating within its ratings with this new part?
How do you know? (Specifically show a values which are or are not within a correct range.)

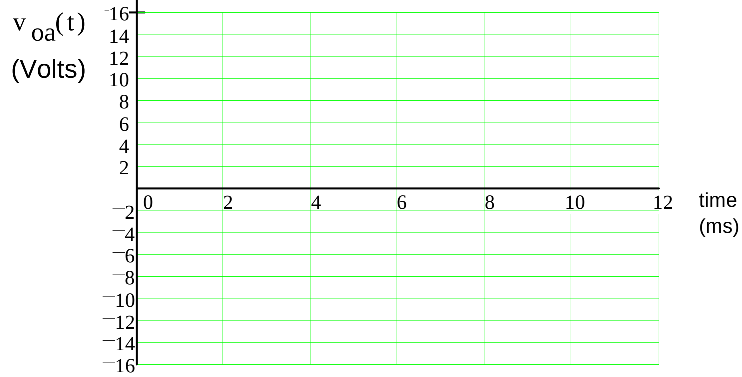
Within range? yes no (circle one)

4. (31 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.

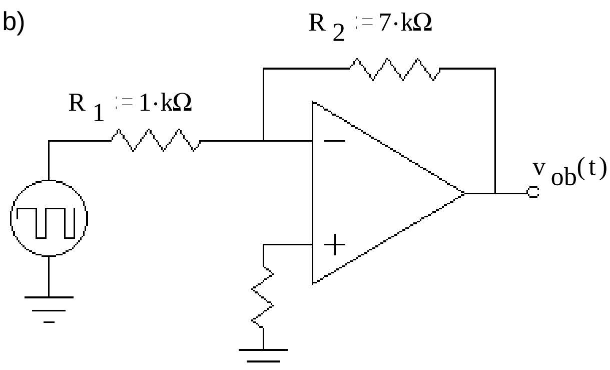


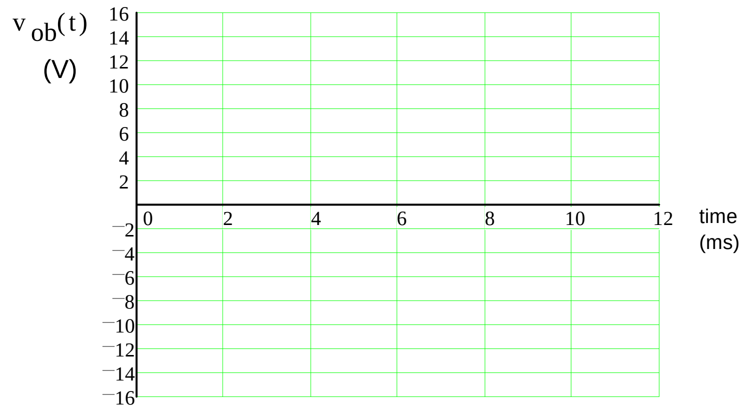
a)



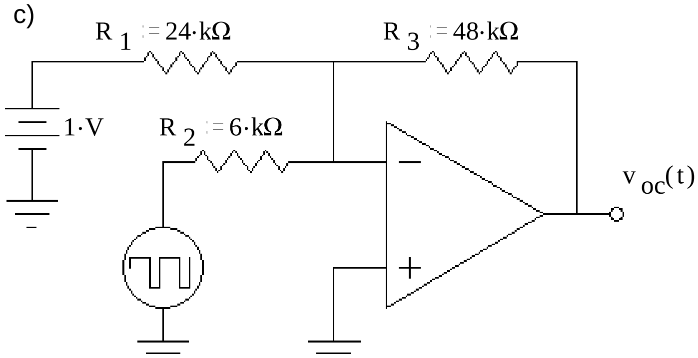


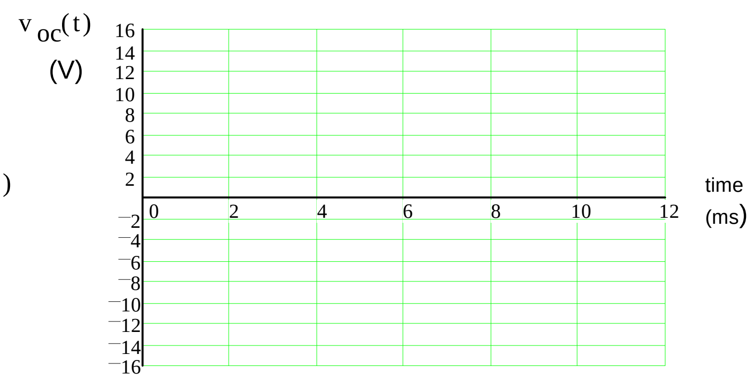
b)



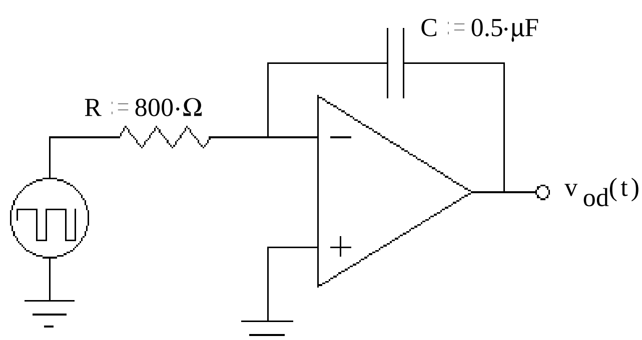


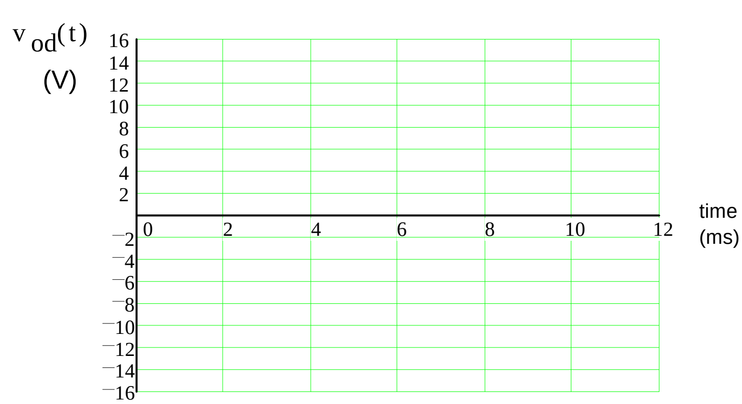
c)



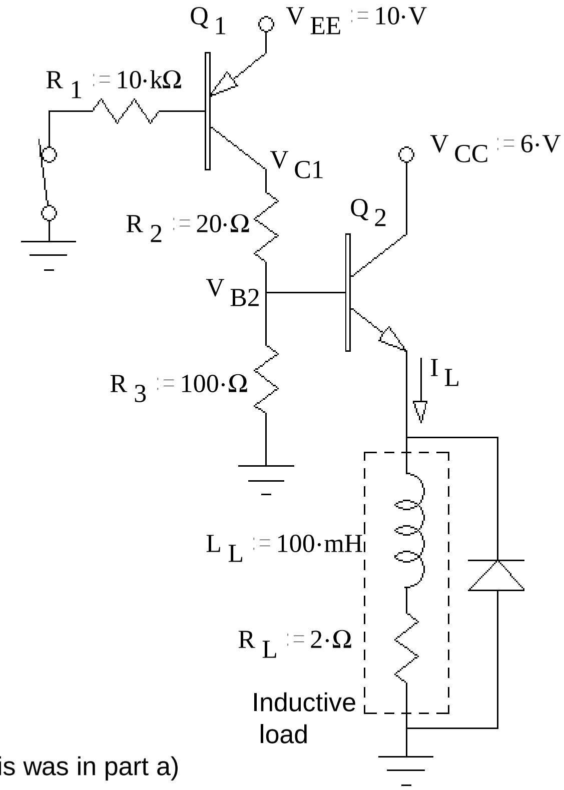


d)





5. (34 pts) A couple of transistors are used to control the current flow through an inductive load. The switch has been closed, as shown, for a long time.



a) Assume both transistors are in saturation. Find the minimum β for transistor Q_2. $\beta_2 = ?$

Hint: You will need to find the voltage at the base of Q_2.

You may assume that $I_E \simeq I_C$ for both transistors.

b) Find the minimum β for transistor Q_1 to be in saturation. $\beta_{1min} = ?$

c) Something is wrong. Transistor Q_2 is getting too hot. You measure the voltage across the load and find that $V_L := 4\cdot V$.

How much power is being dissipated in transistor Q_2?

d) Next you measure the voltage at the collector of Q_1 and find that $V_{C1} := 8\cdot V$ with respect to ground.

Find the actual βs of both transistors and tell me what's wrong.

You replace the faulty component and everything is back to the way is was in part a)

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

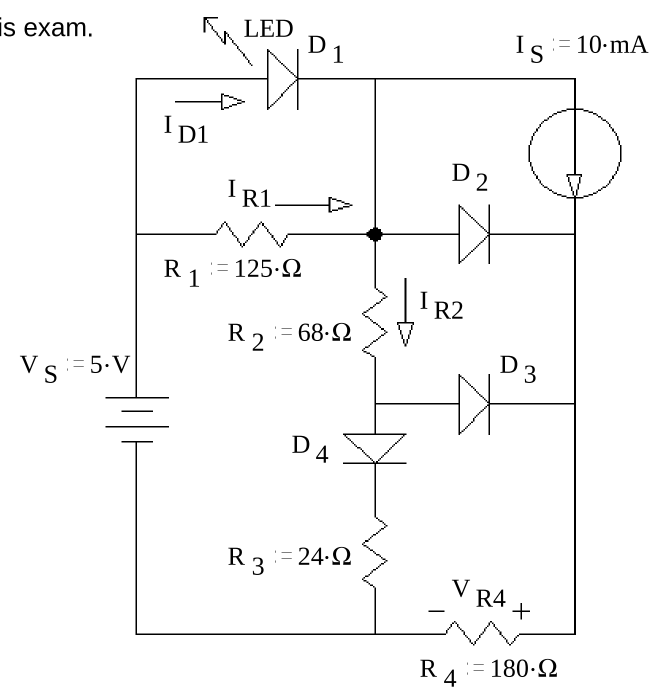
A) never. D) always.
B) when the switch closes. E) when the switch opens.
C) whenever the switch is closed. F) whenever the switch is open.

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

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

6. (32 pts) Assume that diodes D_1 and D_4 **DO conduct.**

Assume that diodes D_2 and D_3 do **NOT** conduct.



a) Stick with these assumptions even if your answers come out absurd. Find the following and anything else you need in order to check the assumptions:

I_{R1} = ________ I_{R2} = ________

I_{D1} = ________ V_{R4} = ________

b) Was the assumption about D_1 correct? yes no
How do you know? (Show a value & range.) (circle one)

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.)

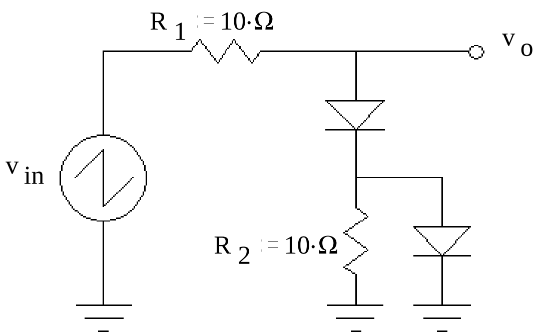
f) Based on your answers to parts b), c), d) & e), Circle one:

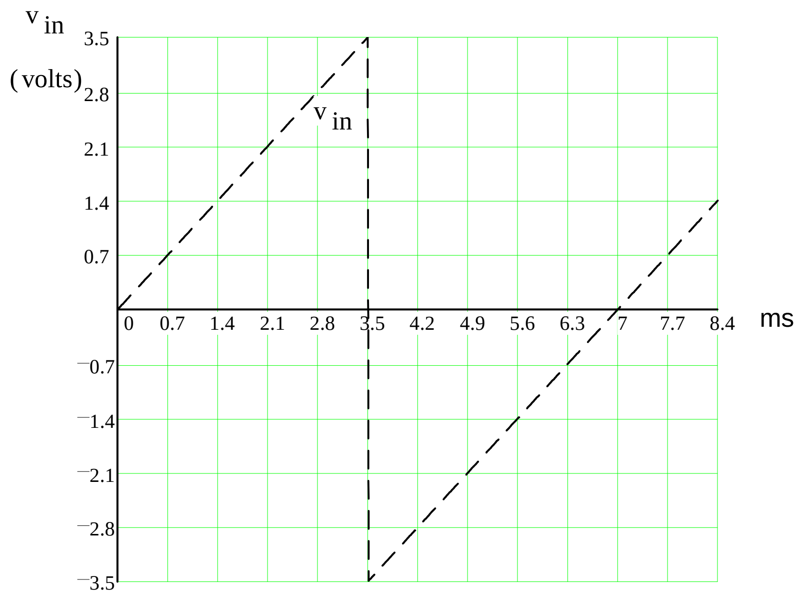
i) The ***real*** $I_{D1} < I_{D1}$ calculated in part a. Justify your answer.

ii) The ***real*** $I_{D1} = I_{D1}$ calculated in part a.

iii) The ***real*** $I_{D1} > I_{D1}$ calculated in part a.

7. (17 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.





If you're not specific about your times and voltages, I'll assume you don't know !

<u>Answers</u>

1. a) 6V <u>/53.13</u>° b) 131mA <u>/65.5</u>° c) i) d) $12.35\cdot deg$

2. $$\frac{s^2 + \frac{R_3}{L}\cdot s + \frac{1}{L\cdot C}}{s^2 + \left(\frac{1}{R_2\cdot C} + \frac{R_3}{L}\right)\cdot s + \frac{1}{L\cdot C}\cdot\left(\frac{R_3}{R_2} + 1\right)}$$ b) 2 c) 2

3. a) 50 b) $120\cdot V$ c) 20Ω <u>/-34.9</u>° d) 1.2A <u>/34.9</u>°

   e) 500Ω <u>/-34.9</u>° f) & g) $590.4\cdot W$ h) No $6\cdot A > 5\cdot A$

   i) $24\cdot\Omega$ j) Add a 92.7-mH inductor in parallel with the load k) YES

4. a) 10V to 2ms, then drops to -5V, stays there to 6ms, repeats.

   b) -11V to 2ms, then rises to 7V, stays there to 6ms, repeats.

   c) -11V to 2ms, then rises to 6V, stays there to 6ms, repeats.

   d) 0V at 0ms, ramps down to -10V at 2ms, then ramps up to 0V at 6ms, repeats.

5. a) 28 or 29 acceptable ans b) 177 c) $4\cdot W$

   d) 177 and 15.95 or 16.95 acceptable ans β_2 is too low e) E f) $2.9\cdot A$

6. a) $16\cdot mA$ $25\cdot mA$ $19\cdot mA$ $1.8\cdot V$ b) yes $I_{D1} = 19\cdot mA > 0$ c) no $V_{D2} = 1.2\cdot V > 0.7V$

   d) yes $V_{D3} = -0.5\cdot V < 0.7V$ e) yes $I_{D4} = 25\cdot mA > 0$

   f) iii D_2 will conduct current, all of which will have to come through D_1

7. Starts at 0V, ramps up to 0.7V at 0.7ms, ramps up to 1.4V at 2.1ms, flat at 1.4V to 3.5ms, drops instantly to -3.5V , ramps up to 0.7V at 7.7ms, Finally it ramps toward 1.4V at 9.1ms.