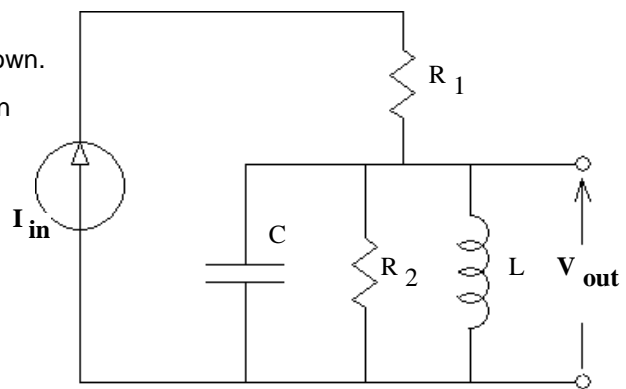# ECE2210 Final given: Fall 15

1. (12 pts) a) Find the s-type transfer function of the circuit shown.

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

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

   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
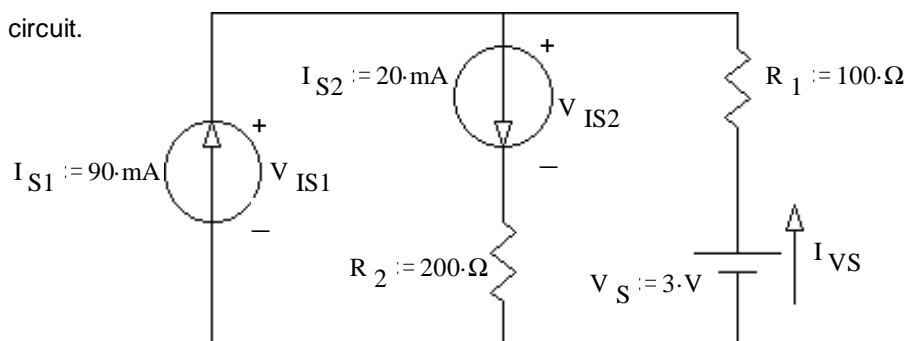   (probably in terms of R_1, R_2, L and C).

2. (18 pts) Find the values below. Show your work.

   Find: V_{IS1} V_{IS2} I_{VS} &

   P_{Vs} , The power V_S supplies to the circuit.

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

   $I_{S2} := 20 \cdot mA$ V_{IS2} $R_1 := 100 \cdot \Omega$

   $I_{S1} := 90 \cdot mA$ V_{IS1}

   $R_2 := 200 \cdot \Omega$ $V_S := 3 \cdot V$ I_{VS}

3. (18 pts) For partial credit, you must
   show work and/or intermediate results.

   a) Find $\mathbf{Z_2}$

   b) Find $\mathbf{V_S}$

   c) Circle 1:   i) $\mathbf{I_S}$ leads $\mathbf{V_2}$

   ii) $\mathbf{I_S}$ lags $\mathbf{V_2}$

   i) $\mathbf{I_S}$ leads $\mathbf{V_2}$

   Why? Show numbers:

   Or explain by other means:

   $\mathbf{I_S} := (12.49 + 10 \cdot j) \cdot mA$

   Z_1 $\mathbf{Z_1} := 100 \cdot j \cdot \Omega$

   $\mathbf{V_S}$

   Z_2 $\mathbf{V_2} := 3 \cdot V \cdot e^{-j \cdot 30 \cdot deg}$
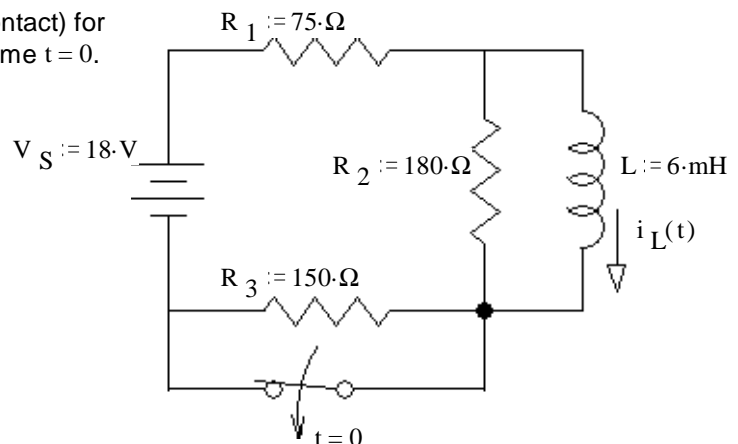
4. (22 pts) The switch has been open (not making contact) for
   a long time and is switched closed (as shown) at time $t = 0$.

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

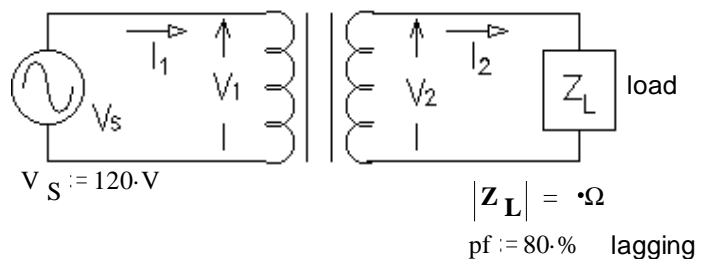   b) Find i_L at time $t = 1.2\tau$.

   c) At time $t = 1.2\tau$ the switch is opened again.
      Will the time constant be different now?
      If yes, find the new time constant. JUST the
      time constant.

   $R_1 := 75 \cdot \Omega$

   $V_S := 18 \cdot V$ $R_2 := 180 \cdot \Omega$ $L := 6 \cdot mH$

   $i_L(t)$

   $R_3 := 150 \cdot \Omega$

   $t = 0$

ECE2210 Final   given: Fall 15   p1

5. (7 pts) A transformer is rated at $240V/120V$, $1.2kVA$.
   Assume the transformer is ideal and all voltages and
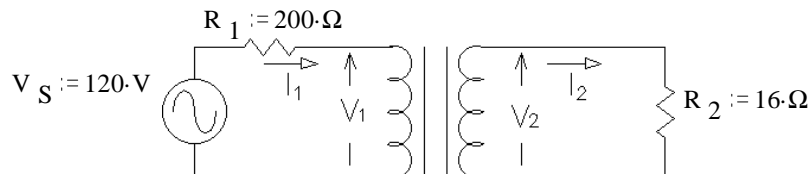   currents are RMS.

   How much power does the load consume?

$V_S := 120 \cdot V$

$\left|Z_L\right| = \cdot \Omega$

$pf := 80 \cdot \%$ lagging

6. (16 pts) The transformer shown in the circuit below is ideal. It is rated at $240/48$ V, 20 VA, 60 Hz
   Find the following: All values are RMS unless specified otherwise.

   a) $I_1 = ?$

   b) $V_2 = ?$

   c) $I_2 = ?$

$R_1 := 200 \cdot \Omega$

$V_S := 120 \cdot V$

$R_2 := 16 \cdot \Omega$

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

7. (18 pts)   Assume that diode D_1 does conduct.   Assume that diode D_2 does NOT conduct.

   a) Find I_{R1}, I_{R2}, I_{R3}, & I_{D1} based on these assumptions. Stick with
      these assumptions even if your answers come out absurd.

   I_{R1} = _____

   I_{R2} = _____

   I_{R3} = _____

   I_{D1} = _____

   (circle one)

   b) Was the assumption about D_1 correct?   yes   no
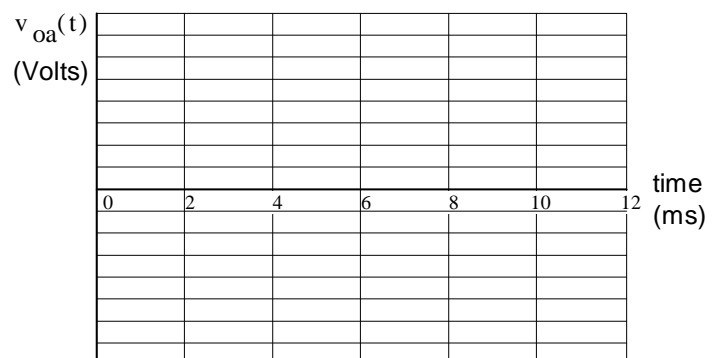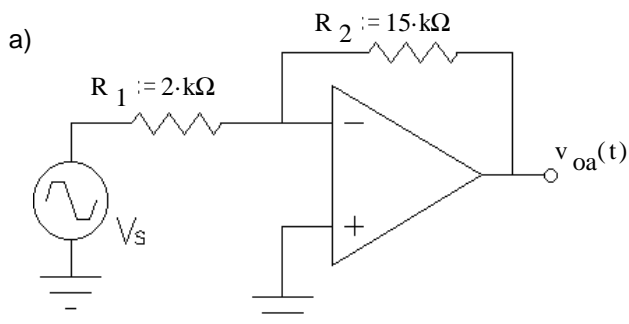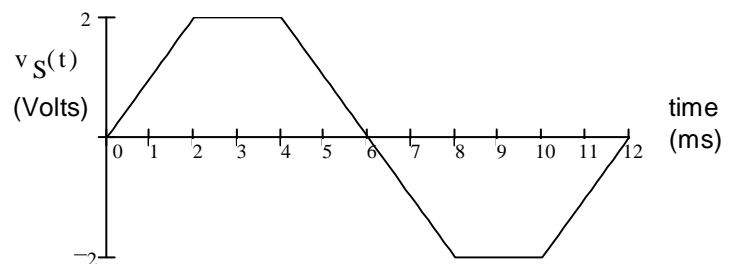
      How do you know? (Specifically show a value
      which is or is not within a correct range.)

   c) Was the assumption about D_2 correct?   yes   no
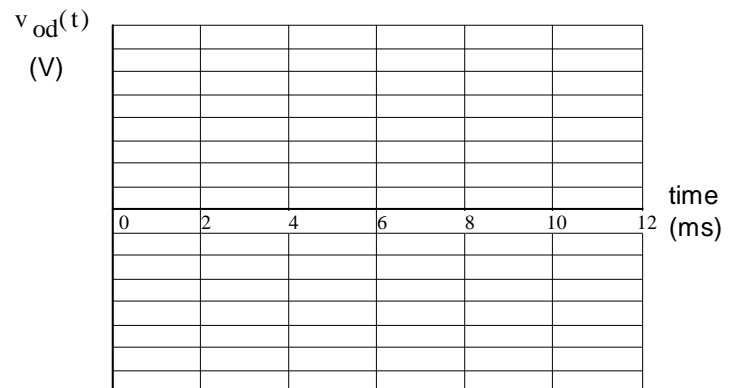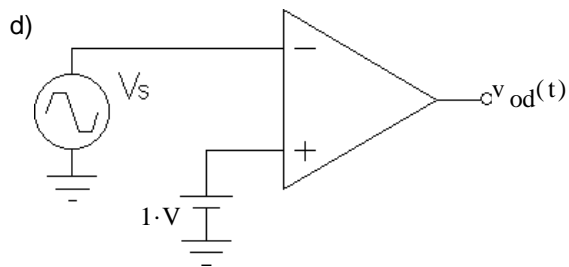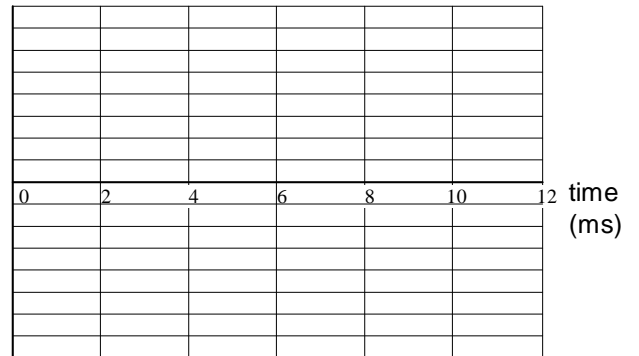
      How do you know?

D_1

$R_2 := 60 \cdot \Omega$

I_{D1}

I_{R2}

$R_1 := 35 \cdot \Omega$

D_2

I_{R1}

$R_3 := 66 \cdot \Omega$

$V_1 := 4 \cdot V$
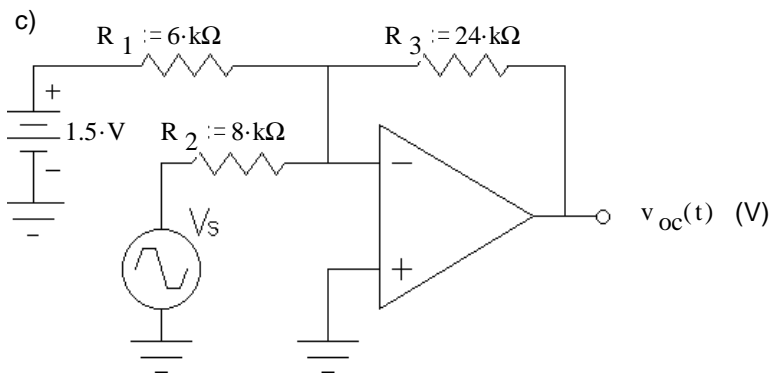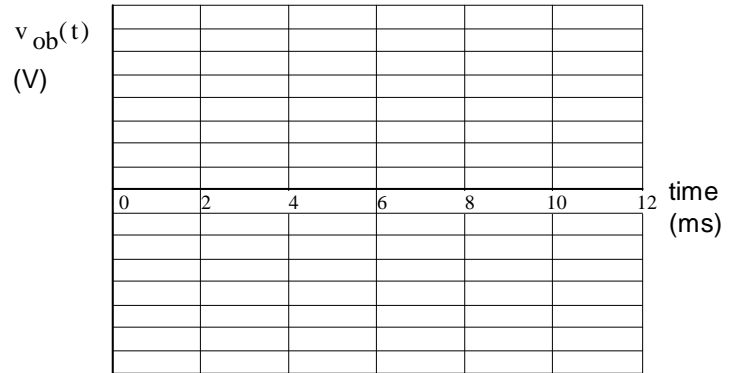
I_{R3}

$V_2 := 3 \cdot V$

8. (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. The op-amp
   is connected to $+12V$ & $-12V$ power supplies.

   a)

$R_2 := 15 \cdot k\Omega$

$R_1 := 2 \cdot k\Omega$

$v_{oa}(t)$

V_S

$v_S(t)$

(Volts)

time
(ms)

$v_{oa}(t)$

(Volts)

time
(ms)

8. continued, the input is repeated at right. The op-amp
   is connected to +12V & -12V power supplies.

$v_S(t)$
(Volts)

time
(ms)

b)

$v_{ob}(t)$

$R_2 := 6 \cdot k\Omega$

$R_1 := 2 \cdot k\Omega$

$v_{ob}(t)$
(V)

time
(ms)

c)

$R_1 := 6 \cdot k\Omega$ $R_3 := 24 \cdot k\Omega$

$1.5 \cdot V$ $R_2 := 8 \cdot k\Omega$

V_S

$v_{oc}(t)$ (V)

time
(ms)

d)

V_S

$v_{od}(t)$

$1 \cdot V$

$v_{od}(t)$
(V)

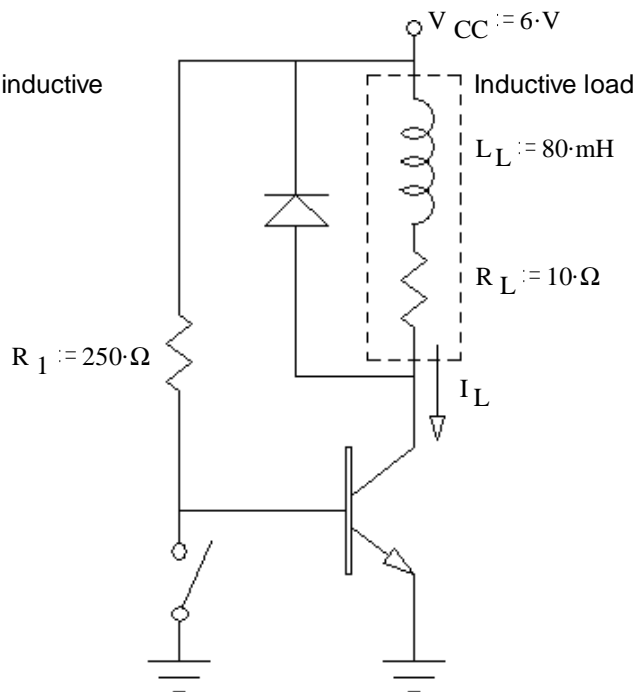time
(ms)

$V_{CC} := 6 \cdot V$

9. (24 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).

Inductive load

$L_L := 80 \cdot mH$

a) $\beta := 20$ Assume the switch has been open for a long time and the transistor is in the active region, find I_L, and V_{CE} and P_Q.

$I_L = ?$

$V_{CE} = ?$

$R_L := 10 \cdot \Omega$

$P_Q = ?$

$R_1 := 250 \cdot \Omega$

I_L

b) Was the transistor actually operating in the active region?
   yes   no   circle one

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

c) What minimum β would be required to achieve saturation?

d) You can't change the β. Find the maximum value of R_1, so that the transistor will be in saturation. $\beta = 20$

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

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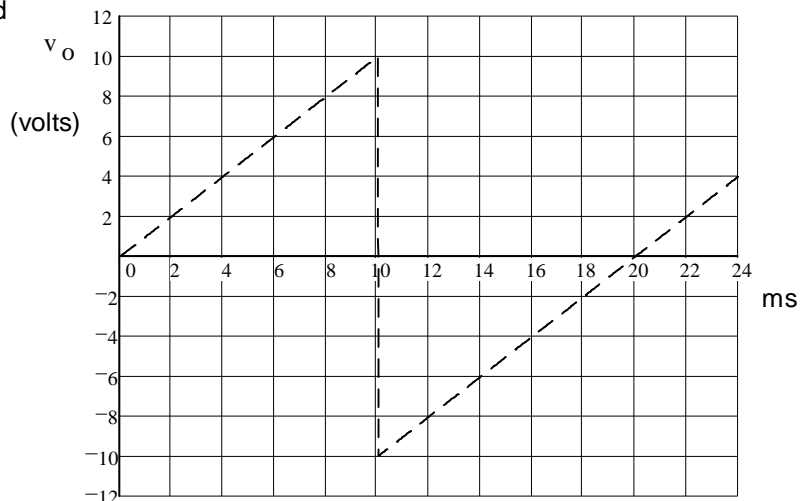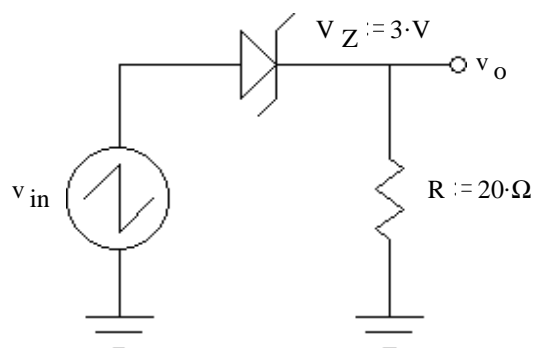
10. Do you want your grade and scores posted on the Internet?
    If your answer is yes, then provide some sort of alias: _____

    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. The pdf spreadsheet will show the homework, lab, and exam scores of everyone who answers here.

11. (17 pts) A voltage waveform (dotted line) is applied to the circuit shown. Accurately draw the output waveform (v_o) you expect to see. Label important times **and** voltage levels.

$V_Z := 3 \cdot V$

v_o

v_{in}

$R := 20 \cdot \Omega$

Answers

1. a) $\dfrac{\dfrac{1}{C}\cdot s}{s^2 + \dfrac{1}{C\cdot R_2}\cdot s + \dfrac{1}{C\cdot L}}$ b) 2   c) 1   s = 0

2. 10·V   6·V   - 70·mA   - 210·mW

3. a) 187.5Ω /-68.78°   b) 1.62V /-8.93°

   c) i) ±38.6° < ___-30°

4. a) $240\cdot mA - 160\cdot mA\cdot e^{-\frac{t}{0.113\cdot ms}}$ b) 192·mA   c) 60·µs

5. 360·W   6. a) 200·mA   b) 16·V   c) 1·A

7. a) 20·mA   5·mA   50·mA   35·mA

   b) yes   35·mA > 0   c) yes $V_{D2} = 0.3\cdot V < 0.7V$

9. a) 424·mA   1.76·V   0.746·W

   b) yes   1.76·V > 0.2·V

   c) 27.4   d) 183·Ω   e) D)   f)580·mA

11. v_o

(V)

8.