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

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

$$H(s) = ?$$

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: $V_{IS1}$, $V_{IS2}$, $I_{VS}$ and $P_{VS}$, The power $V_S$ supplies to the circuit.

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

a) Find $Z_2$

b) Find $V_S$

c) Circle 1: i) $I_S$ leads $V_2$

ii) $I_S$ lags $V_2$

iii) $I_S$ leads $V_2$

Why? Show numbers:

Or explain by other means:

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.
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?

\[
V_S := 120\text{V} \\
|Z_L| = 8\Omega \\
pf := 80\% \text{ lagging}
\]

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) \(I_2 = ?\)

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.

\[I_{R1} = \ldots\]
\[I_{R2} = \ldots\]
\[I_{R3} = \ldots\]
\[I_{D1} = \ldots\]

(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?

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

b) \( v_{\text{ob}}(t) \) 

\[ V_S \]

\[ R_1 := 2 \cdot \text{k}\Omega \]

\[ R_2 := 6 \cdot \text{k}\Omega \]

c) \( v_{\text{oc}}(t) \) 

\[ V_S \]

\[ R_1 := 6 \cdot \text{k}\Omega \]

\[ R_2 := 8 \cdot \text{k}\Omega \]

\[ R_3 := 24 \cdot \text{k}\Omega \]

d) \( v_{\text{od}}(t) \)

\[ V_S \]

\[ 1 \cdot \text{V} \]
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).

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 $P_Q$.

$I_L = ?$

$V_{CE} = ?$

$P_Q = ?$

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 $\beta$ would be required to achieve saturation?

d) You can't change the $\beta$. 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.
Answers

1. a) \( \frac{1}{C}s \) 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-mA - 160-mA e\( ^{-\frac{t}{0.113\text{ms}}} \) b) 192-mA c) 60-µs

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

6. a) 20-mA 5-mA 50-mA 35-mA
   b) yes 35-mA > 0 c) yes \( V_{D2} = 0.3 \cdot V < 0.7V \)

7. 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

8. a) 9.3\ V
   b) 7-V
   c) -12\ V
   d) 11V
   e) -11V
   f) 11V

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

10. a) 11V
    b) 7-V
    c) -12\ V
    d) 11V
    e) -11V