NAME: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

(Don’t put Student ID Number or any other numbers on this page)

**ECE 111**

**FINAL EXAM**

**Fall 2012**

FOR GRADERS’ USE ONLY.

|  |  |  |
| --- | --- | --- |
| PROBLEM # | GRADE | POINTS |
| 1 |  | 10 |
| 2 |  | 32 |
| 3 |  | 6 |
| 4 |  | 18 |
| 5 |  | 34 |
| 6 |  | 44 |
| 7 |  | 32 |
| 8 |  | 24 |
| TOTAL |  | 200 |

1. (10 points total)

Given simple circuit elements with voltages across and currents through them as shown below, what power are they dissipating?

A. (3 points)

**A**

**+**

**-**

**9V**

**5 mA**

PA = \_\_\_\_+5mAx9V=45mW\_\_\_\_\_\_\_\_\_

B. (3 points)

**B**

**+**

**-**

**12 V**

**3 A**

PB = \_\_-3Ax12V=-36W\_\_\_\_\_\_\_\_\_\_\_\_\_

C. (3 points)

**C**

**-**

**+**

**-5 V**

**5 mA**

PC = \_\_+(5mA)x(-5V)=-25mW\_\_\_\_\_\_\_

1. (1 point) Circle the letter of all of the above elements that are supplying power to the circuit.

A B C

2.) (32 points total)

Given the circuit below:

10kΩ

5kΩ

5 V

10kΩ

10kΩ

Vo

-

+

+

-

3 mA

1

2

3

4

We are going to find the voltage across the 10kΩ resistor on the upper right.

A.) (4 points) The nodes are numbered as for Nodal Analysis. Are any Node Voltages fixed, and therefore do not need to be solved for, but are known? Which one(s)? Which one do you pick as the Reference Node?

**V1 is fixed at 5V. I pick Node 4 as Reference.**

B.) (3 points) What is the output voltage (Vo) in terms of the node voltages (V1, V2, V3, V4)?

V0=V2-V3

C) (15 points) Write the equations you’ll need to solve to find the node voltages.



D.) (10 points) Solve these equations to get the output voltage Vo.



3. (6 Points Total)

Given this circuit containing an Ideal Op-Amp:

25kΩ

Vin

**+**

**-**

**+**

**-**

**+**

**-**

100kΩ

20kΩ

**Vout**

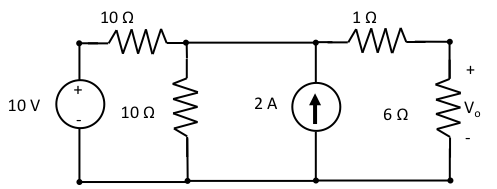
A. (2 points) Is this: Non-Inverting, **Inverting**, Comparator, Differential, or Buffer Configuration (CIRCLE ONE.)

B. (4 points) Given part A, what is the output in terms of Vin?



4. (18 points total)

Given the circuit below:



A.) (10 points) Use Source Transformations or other technique to find the Thevenin Equivalent of the

circuit, not including the 6 Ω load resistor.

10V & 10Ω becomes 1A // 10Ω.

Combine 1A and 2 A to get 3A. Combine 10Ω//10Ω to get 5Ω.

Convert 3A and 5Ω to get 15V and 5Ω.

Combine 5Ω and 1Ω to get 6Ω.

Final Result: 15V and 6Ω

B. (2 points) What is the voltage across the load resistor, Vo?



C. (4 points) What power is being delivered to the load resistor?



D. (2 points) If I put a load resistor with a different resistance on this circuit, is there any way to get more power delivered to the load?

No, you have already matched the load to the source resistance.

5. (34 points total)

Given the circuit below, in which the switch has been open for a long time and closes at t=0, answer the following questions:

**RS = 20 Ω**

**+**

**-**

12V

**t=0**

**-**

**+**

**v**

**1 µF**

**RL = 10 Ω**

A. (6 points) If I asked you for the TOTAL response of anything in this circuit (current through or voltage across ANY passive element) and I called it Y(t), what general form would it take?

Y(t) = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

B. (4 points) Which quantity, voltage across or current through which element in this circuit, MUST be continuous across the switch closing, and what is its initial value?

**Voltage across the capacitor must be continuous.**

NOW, I am going to ask you to find the voltage across the capacitor, v (t).

C. (6 points) What is the final value of v (i.e., v(∞))?



D. (2 points) What is v just after the switch closes (i.e., v(0+))?



E. (4 points) What is the decay constant, τ? (NOTE: This is for time t≥0.)



F. (6 points) Evaluate the constant(s) and give the formula for v(t) for t>0:

v(t) = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

G. (2 points) How long would I have to wait to make sure all transients from the switch have died away?



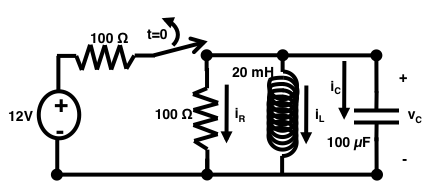
H. (4 points) Sketch v(t):

**V**

**t**

6. (44 points total)

Given the circuit below, in which the switch has been closed for a long time and opens at t=0:



We are going to analyze the circuit to find the voltage across the RLC, vC(t).

A. (6 points) What are the values of the state variables before the switch opens (i.e., at t=0-)? Then what are their values just after the switch opens (i.e., at t= 0+)?

L is a short, and C is an open ckt, so 



C. (2 points) What is the final value of vC  (i.e., vC(∞))?

L is again a short, so 

D. (12 points) What is the initial value of the derivative, dvC/dt (0+)?



so we need iC



E. (6 points) What are the natural frequency (ω0) and the damping coefficient (α)?

ω0 = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

α = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

F. (2 points) So, will the circuit be:

CIRCLE ONE: Over-damped, Critically-damped, or Under-damped ?

G. (4 points) Therefore, what will the FORM of vC(t) be?

vC(t) = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

where 

H. (4 points) At this point, without going any further on the math, sketch what you EXPECT the voltage to look like as a function of time. (Use the initial and final values, the initial value of the derivative, and whether it is under-, critically-, or over-damped. Don’t worry about exact values, just the general shape.)

**vc**

**t**

I. (8 points) Evaluate the constants and write an expression for the voltage:

We know that 

From  we get , so we have



vC(t) = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

7. (32 points total)

Given this circuit in the time domain:

**20Ω**

IS=5cos(100t)A

**400µF**

**-**

**+**

**V**

**200mH**

A. (6 points) On the drawing below, label each component with the corresponding frequency (j) domain quantity:

**\_\_\_\_\_\_Ω**

**\_\_\_\_\_\_Ω**

**-**

**+**

**V**

**\_\_\_\_\_\_\_Ω**

**\_\_\_\_\_\_<\_\_\_\_\_\_A**

**\_\_\_\_\_\_\_\_\_**

B. (12 points) If you replace the impedances with a single equivalent impedance, Zeq as in the diagram below, what will that equivalent be?

**-**

**+**

**V**

**\_\_\_\_\_\_<\_\_\_\_\_\_A**

**\_\_\_\_\_\_\_\_\_**

**Zeq**

(Room for calculations on next page.)



C. (2 points) Is this circuit overall inductive or capacitive at this frequency?

CIRCLE ONE: **INDUCTIVE** CAPACITIVE

D. (8 points) Derive an expression for the phasor voltage across the circuit.



**V = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

E. (4 points) Now write v in the time domain:

v(t) = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

8. (24 Points)

Given the circuit below:



We are going to find the voltage across the resistor  as a function of the input .

First,

1. (6 points) Label the diagram in the frequency domain:





B.) (10 points) Find an expression for the output phasor voltage as a multiple of the input phasor voltage (HINT: You might try Voltage Division.)





C.) (4 points) Using the values R = 240Ω, L = 10mH, C = 0.1µF, for what (natural, or radian) frequency are the current and voltage source in phase? What is that frequency in Hz (cycles/second)?





D.) (4 points) What is the output at low frequency () and at high frequency ()? How would you describe this output (High Pass, Low Pass, Band Pass)?

For both low and high frequencies, VR=0, so this is a Bandpass filter.