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

**ECE 111**

**EXAM 2**

**Fall 2013**

FOR GRADERS’ USE ONLY.

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| --- | --- | --- |
| PROBLEM # | GRADE | POINTS |
| 1 |  | 8 |
| 2 |  | 24 |
| 3 |  | 16 |
| 4 |  | 54 |
| TOTAL |  | 102 |

1. (2 points each, 8 points total) Match the letter of the Configuration with the appropriate circuit diagram:

A) Inverting Configuration

B) True Differential Configuration

C) Non-inverting Configuration

D) Buffer Configuration

Configuration: \_\_\_**\_C\_**\_\_\_ Configuration: \_\_\_**\_D\_**\_\_\_

Configuration: \_\_\_A**\_\_**\_\_\_ Configuration: \_\_\_**\_B\_**\_\_\_

2. (24 Points Total)

Given this circuit:



A.) (8 points) What Thevenin Equivalent Circuit is seen by the load resistor RL?

**BY SOURCE CONVERSIONS:**

**Convert 20V & 5Ω to I src: 4A & 5Ω, combine 5Ω and 50Ω in parallel, Rth=4.545Ω.**

**Convert 4A & 4.545Ω to V src: 18.18V & 4.545Ω.**

**OR, Remove RL and find Voc by voltage division: Voc=((50Ω)/(5Ω+50Ω))\*20V=18.18V. Turn off 20V and fine Req seen by RL: Req= 5Ω//50Ω = 4.545Ω**

B.) (4 points)? What value of load resistor would result in the maximum power being delivered to the load resistor RL?

**Max power when RL=Rth=4.545Ω**

C.) (8 points) Under those conditions, how much power would be dissipated by the load resistor?

**PL=(Voc2)/(4RL)=(18.18)2 / (4\*4.545)=18.18 W (No that is not a typo, it is 18.18 W, same as the voltage)**

D.) (4 points) Under those conditions, how much power is being DISSIPATED by the voltage source?

**PS=-(VOC2)/(2RL)=-2\*PL=36.36 W (half the power supplied by the source is dissipated in the Load, half in the Internal Resistor.)**

3.) (16 points total)

Given this circuit containing an Ideal Op-Amp, capable of Rail-to-Rail operation (that is, the output is able to go all the way to the supply voltage):



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

B. (6 points) Given part A, what is the output Vout in terms of the input VS?

**Vout=-(9kΩ/1kΩ)VS=-9VS**

C. (4 points) If Vin is 0.3V, what will the output be?

**Vout= -9(0.3V)=-2.7V**

D. (4 points) If Vin is 2V, what will the output be?

**Will try for Vout= -9(2V)=-18V, but that exceeds the supply, so Vout= -12V**

4. (54 points total)

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



A. (6 points) Which quantity, voltage across or current through which element in this circuit, MUST be continuous across the switch opening? Label it on the diagram above.

**Current through inductor must be continuous. Draw iL going DOWN through the inductor.**

NOW, I am going to ask you to find the current down through the 100 Ω resistor, iR(t).

B. (8 points) Label this current on the diagram above. Just before the switch opens, sketch the relevant equivalent circuit, and find both the current through the inductor (i.e., find iL(0-)) and the current through the 100Ω resistor (i.e., find iR(0-)).

**Entire circuit, with L replaced by a short circuit. This shorts out the 100Ω resistor, so iL(0-)=12V/10Ω=1.2A**

C. (6 points) What is the current down through the 100Ω resistor just after the switch opens, iR(0+)? (HINT: Apply KCL at the top node of the resistor.)

**KCL shows that iR(0+)=-iL(0+)=-iL(0-)=-1.2A.**

D. (4 points) After the switch opens, what resistance is seen by the inductor, and what is the decay constant, τ? (NOTE: This is for time t≥0.)

**After the switch opens the voltage source is removed, leaving only the 10 mH inductor and the 100Ω resistor. So τ=L/R=(10mH)/(100Ω)=0.1 ms.**

E. (12 points) A long time after the switch opens, sketch the relevant equivalent circuit and find iR()?

**A long time later we have just the 100Ω resistor and the inductor, which has become a short circuit. This is source-free so iR()=0.**

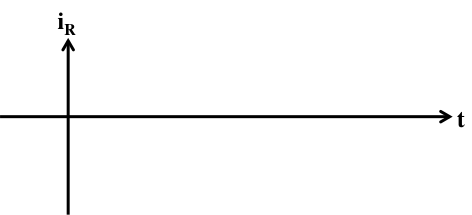
F. (12 points) Evaluate the constant(s) and give the formula for iR(t):



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

**5τ=0.5 ms**

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



**Zero, then jumps down to -1.2A, then decays to zero.**