NECESSARY BUT POINT ME WHERE YOU

DID THAT.

- ***Your Equation sheet must be turned in with the Exam.***
- ***NO Cell PHONE or PROGRAMMABLE Calculators allowed. Other calculators ok.***
- **Closed books/closed lecture notes.**
- ***<u>Each Problem worth 15 points.</u>***
- THE PROGRAMMER'S BEER DRINKING SONG

  100 Little bugs in the code,100 bugs in the code, fix one bug, compile it again- 101 little bugs in the code. 101 little bugs in the code, 101 bugs in the code, take one down, pass it around......Repeat until BUGS = 0

Test 1--15 Feb 2018

EE315 Spring 2018—Dr. B

NAME Solution Key

DO ALL YOUR WORK ON THIS EXAM. USE THE BACK SIDES of EXAM PAPER IF NECESSARY BUT POINT ME WHERE YOU DID THAT.

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1. **Questions : Circle either true or false (2 points each):**

(a) (True False) Amplifier efficiency is defined as nu= Power delivered to the load/ power supplied by the d. c. sources.

(b) (True False) Another way to define Amplifier "power gain " is as how accurately the output VOLTAGE "follows" the output current. Nope

(c) (True False) The ideal operational amplifier has the following characteristics: infinite output resistance, infinite input resistance, finite gain, and finite bandwidth.
Nope Nope Nope

(d) (True False) The operational amplifier "d. c. rail voltages" provide "bias" power to the operational amplifier. Looks like Railroad tracks

(e) (True False) An ideal operational amplifier provides rejection of common mode signals like noise.

(f) (True False). Cascade amplifiers are used whenever a single amplifier stage has insufficient gain, by itself, to provide the overall amplification needed.

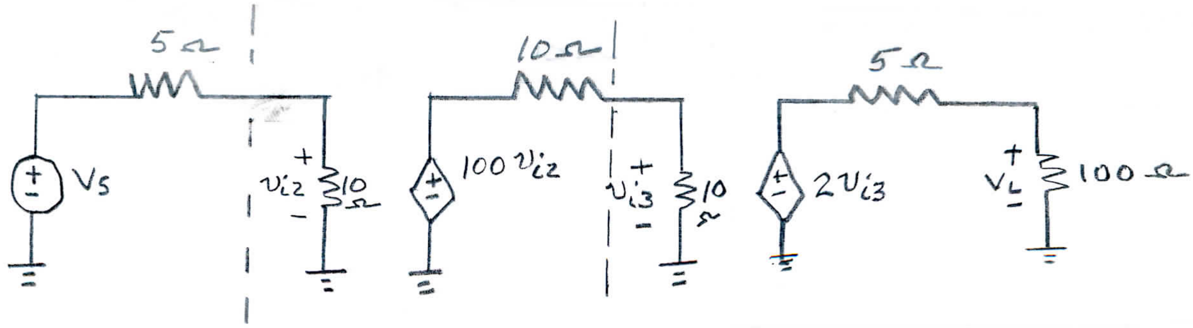
(g) (True False). The textbook discusses 4 different types of amplifiers; Voltage amps, current amps, trans-conductance amps, and efficient amps.
Nope

(h) (True False) Voltage gain in decibels is 20 ln (Vout/Vin).
Log

(i) (True False) The main claim to fame for a Voltage Follower is to integrate an input signal but with "unity" gain.
Nope

(j) (True False) Negative feedback is applied to an operational amplifier to control the amount of closed loop gain the amplifier will provide.

1. Problem – (Part Credit) Find VL/ Vs for the cascaded amplifier given below.



$$\frac{V_L}{v_{i3}} \times \frac{v_{i3}}{v_{i2}} \times \frac{v_{i2}}{V_s} = \frac{V_L}{V_s}$$

$$V_L = \left[\frac{100}{100+5}\right] 2\,v_{i3} = \frac{200}{105}\,v_{i3} \Rightarrow \frac{V_L}{V_{i3}} = 1.90$$

$$v_{i3} = \left(\frac{10}{10+10}\right) 100\,v_{i2} = \frac{1000}{20}\,v_{i2} \Rightarrow \frac{v_{i3}}{v_{i2}} = 50$$

$$v_{i2} = \left(\frac{10}{10+5}\right) V_s = \frac{10}{15}\,V_s \Rightarrow \frac{v_{i2}}{V_s} = .67$$

So $\frac{V_L}{V_s} = (1.90)(50)(.67) = \boxed{63.65\ V/V}$

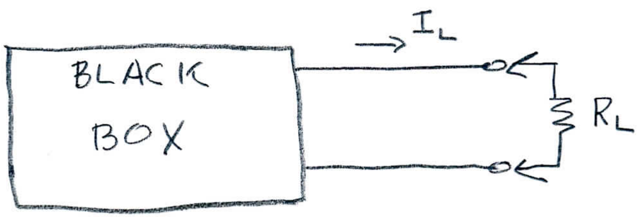
Slightly Modified Example 1.3, page 26, text.
Discussed in Class Lectures and Problem Sessions

Problem 2. (Part Credit) Given the Black Box below which is a box that you cannot see into to determine what electronics is inside. You conduct two experiments using only the output terminals of the Black Box.

(a) In Experiment 1 you find a 20 ohm load resistor, RL causes an 2 amp current to flow in the load resistor.

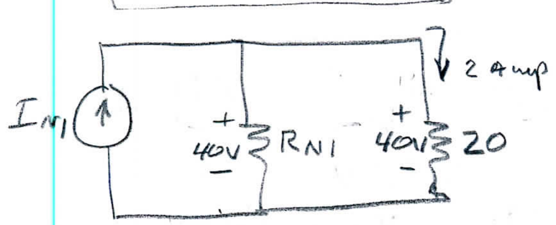
(b) In Experiment 2 you find a 50 ohm load resistor RL has 1 amp through it.
Question: What is the NORTON Equivalent Circuit for the electronics inside the Black Box?

Slightly Modified HW Problem 1.24, page 48.

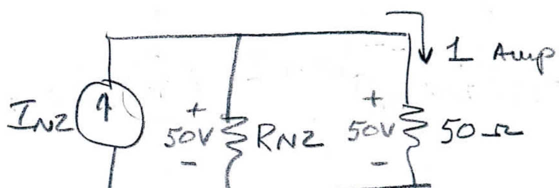


Solution

Experiment ①



Experiment 2



$I_{N1} = I_{N2}$

$R_{N1} = R_{N2}$

$$\frac{40}{R_{N1}} + 2 = \frac{50}{R_{N2}} + 1 \Rightarrow \frac{40}{R_N} + 2 = \frac{50}{R_N} + 1$$

$$1 = \frac{10}{R_N} \Rightarrow \boxed{R_N = 10\Omega}$$

I_N by Current Div Exp ①

$$\frac{10}{20+10}(I_N) = 2$$

$$\frac{1}{3} I_N = 2$$

$$\boxed{I_N = 6 \text{ Amp}}$$

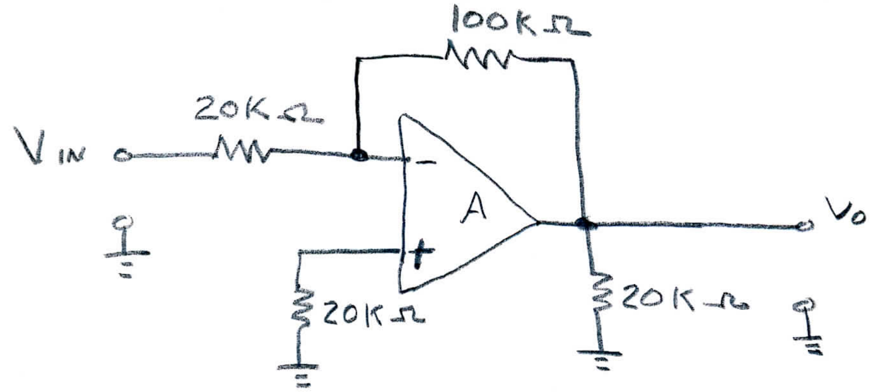
check

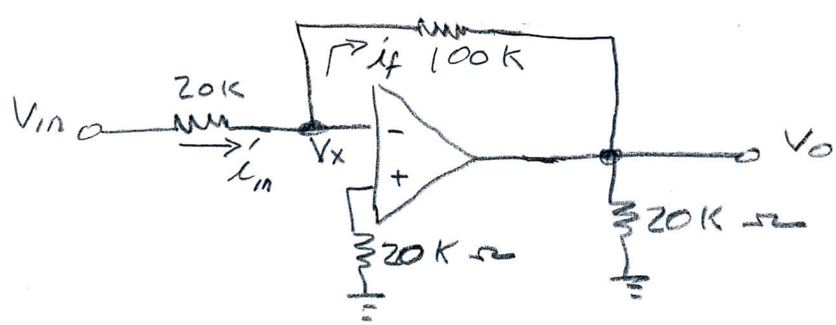
$$\frac{10}{50+10}(I_N) = 1$$

$$\frac{1}{6}(I_N = 1)$$

$$I_N = 6 \text{ Amps}$$

Problem 3. (PART CREDIT) Given the circuit below and assuming the op amp is IDEAL. Find the voltage gain, Vout/Vin.





KCL @ Node Vx: $\dfrac{V_{in} - V_x}{20K} = \dfrac{V_x - V_o}{100K}$

$A V_x = -V_o$

$V_x = -\dfrac{V_o}{A} \Rightarrow 0$ since $A \to \infty$

KCL becomes: $\dfrac{V_{IN}}{20K} = -\dfrac{V_o}{100K}$

So $\boxed{\dfrac{V_o}{V_{in}} = -\dfrac{100K}{20K} = -5\ \dfrac{V}{V}}$

Slightly Modified HW Problem 2.8, p. 117 parts (b) and (d) combined

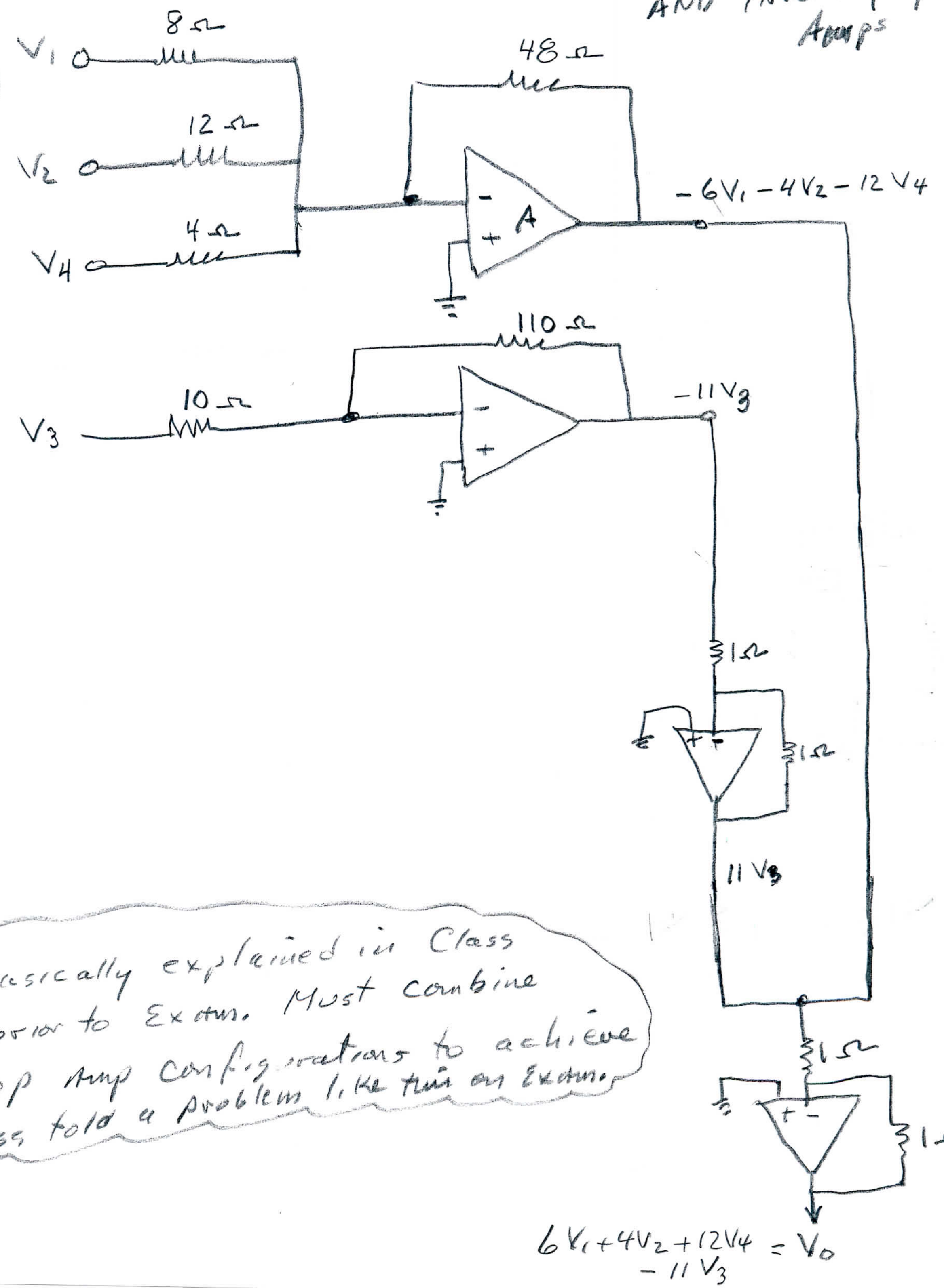
Problem 4. (~~NO~~ PART CREDIT) Using appropriate op amp circuitry, design a machine to solve equation below:

Vout= 6 V1 + 4V2 -11V3+12V4

(WATCH YOUR SIGNS AND GET THEM CORRECT FOR Vout)

Use Weighted Summer AND inverting op Amps

MANY possible Answers

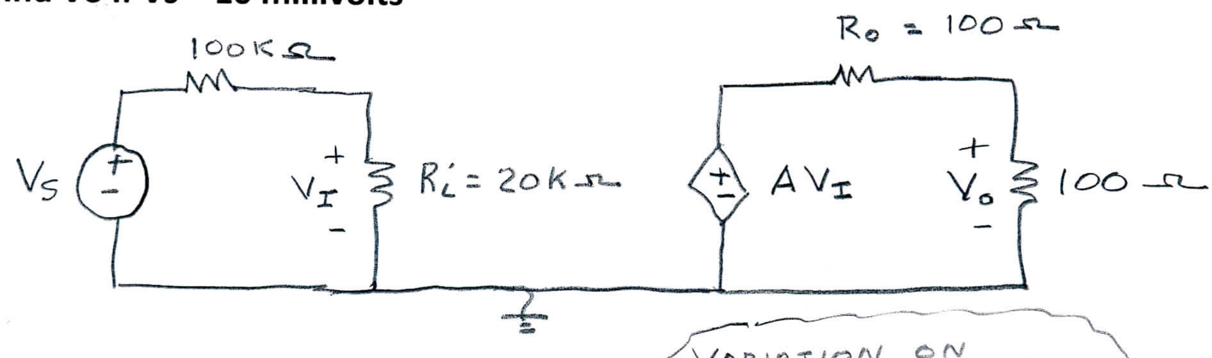


Approach Basically explained in Class one day prior to Exam. Must combine several op amp configurations to achieve result. Class told a problem like this on Exam.

Problem 5. (NO PART CREDIT) For the circuit below, given A = 1000 volts/volt

(10) **(a) find Vo/Vs**

(5) **(b) find Vo if Vs = 10 millivolts**



VARIATION ON HW PROBLEM 1.43, PAGE 50, Textbook AND Problem Sessions

(a) $$\underbrace{\frac{V_o}{V_I}} \times \frac{V_I}{V_s} = \frac{V_o}{V_s}$$

$$\left[\frac{100}{100+100}\right] AV_I = V_o$$ by Voltage division

$$V_o = \left(\frac{100}{200}\right) 1000\ V_I \Rightarrow \frac{V_o}{V_I} = 500$$

$$\left[\frac{V_o}{V_I} = 500\right]$$

By Voltage division: $\left(\frac{20K}{100K+20K}\right) V_s = V_I$

$$\left[\frac{V_I}{V_s} = .167\right.$$

So $\boxed{\frac{V_o}{V_s} = (500)(.167) = 83.5}$

(b) $\boxed{V_o = 83.5\,(.010) = 0.83 \text{ volts}}$

Problem 6. (Part Credit) Using op amp circuitry discussed in class and problem sessions, design a machine to solve the differential equation below:

$$\dddot{y} - 6\ddot{y} + 4\dot{y} + 10y = 10 \text{ volts}$$

all initial conditions are zero!

SOLUTION

$$\dddot{y} = 6\ddot{y} - 4\dot{y} - 10y + 10$$

Technique discussed in class AND Problem Session. As I recall, the class was not well attended that day so I decided to give an exam problem.