# Test 1

# EE315 Spring 2017—Dr. B

## NAME [redacted]

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

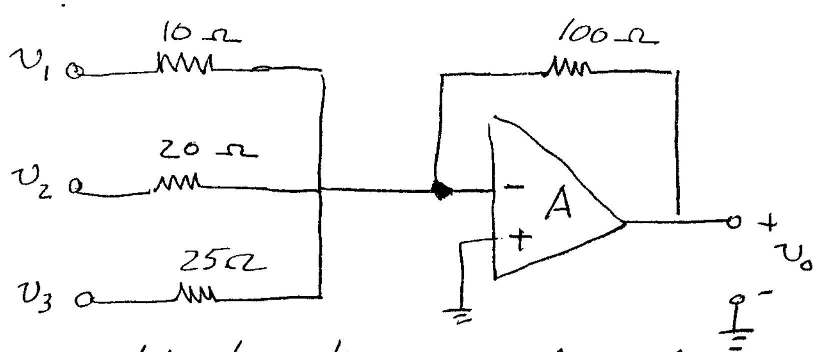
- ***Your Equation sheet must be turned in with the Exam.***
- ***NO Cell PHONE Calculators allowed. Other calculators ok.***
- ***Closed books/closed lecture notes.***
- ***<u>Each Problem worth 18 points.</u>***

"Engineers like to solve problems. If there are no problems handily available, they will create their own problems."
– <u>Scott Adams</u>

**Problem 1: Circle either true or false (1 point each):**

1. (True False) Amplifier power gain is 20 log Vout/Vin).
2. (True False) Amplifier "efficiency" is defined as how accurately the output signal "follows" the input signal.
3. (True False) The ideal operational amplifier has the following characteristics: infinite output resistance, zero input resistance, finite gain, and infinite bandwidth.
4. (True False) The operational amplifier "rail voltages" providing DC power to the amplifier provide saturation limits for the amplitudes of the amplifier's output voltage.
5. (True False) An ideal operational amplifier has zero common mode gain, or said another way, infinite common mode rejection.
6. (True False) A good example of a common mode signal is noise.
7. (True False) There are two types of input terminals for the operational amplifier; the inverting and the difference input.
8. (True False) Voltage gain in decibels is 10 log (Vout/Vin).
9. (True False) A Voltage Follower is a unity gain amplifier.
10. (True False) Negative feedback is applied to an operational amplifier to control the amount of gain the amplifier will provide.

2.




Given $A \to \infty$
$R_{IN} \to \infty$
$R_o \to 0$

Write the equation for $v_o$ as a function of $v_1$, $v_2$, $v_3$.

$$v_o = -\left[\frac{100}{10} v_1 + \frac{100}{20} v_2 + \frac{100}{25} v_3\right]$$

$$\boxed{v_o = -10 v_1 - 5 v_2 - 4 v_3}$$

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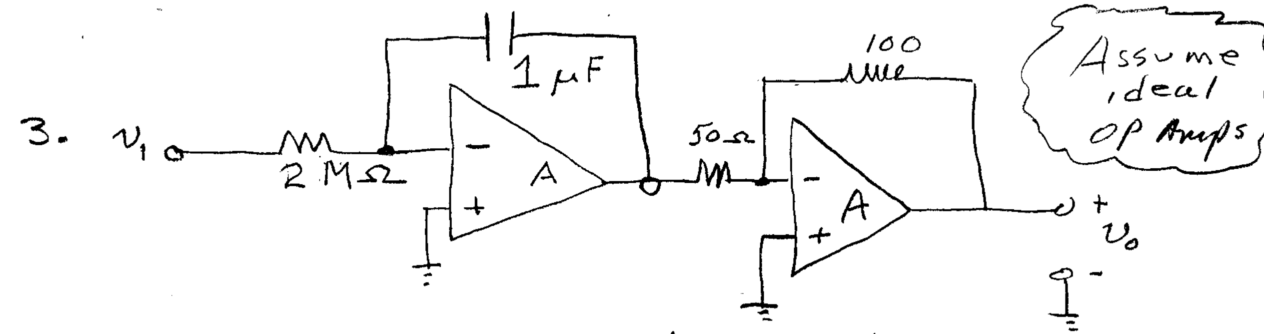
3.




Find Expression for $v_o(t)$.

$$v_o = -\frac{100}{50}\left[-\frac{1}{(2M)(1\mu F)}\int v_1\,dt\right]$$

$$= \frac{2}{2}\int v_1\,dt = \boxed{\int v_1\,dt = v_o}$$

4. Given $v(t) = 10 \sin \omega t$ volts

$i(t) = 40 \sin \omega t$ Amps

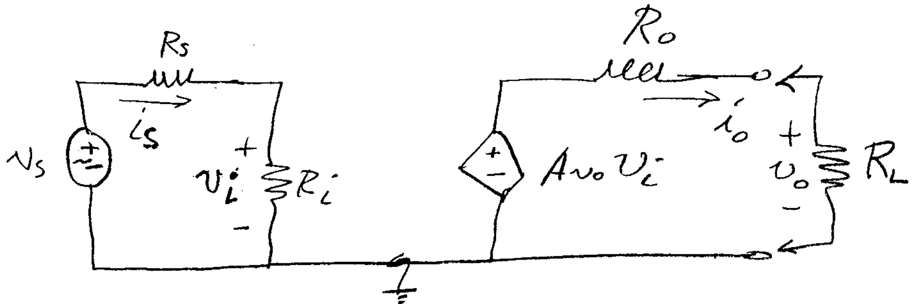
(a) Express $v(t)$ in RMS value

(b) Express $i(t)$ in RMS value

(a) $.707(10) = 7.07$ volts

(b) $.707(40) = 28.28$ Amps

5. Given




Find Equations for $A_v = \frac{v_o}{v_s}$ And $A_i = \frac{i_o}{i_s}$

Given $A_{vo} = 100$ V/V

$$v_o = \left(\frac{R_L}{R_o + R_L}\right) A_{vo} v_i \qquad v_i = \left(\frac{R_i}{R_s + R_i}\right) v_s$$

$$v_o = \left(\frac{R_L}{R_o + R_L}\right) A_{vo} \left(\frac{R_i}{R_s + R_i}\right) v_s$$

$$\boxed{\frac{v_o}{v_s} = \frac{(R_L R_i)\, A_{vo}}{(R_o + R_L)\,(R_s + R_i)} = \frac{100\, R_L R_i}{(R_o + R_L)(R_s + R_i)}}$$

$$i_o = \left(\frac{A_{vo} v_i}{R_o + R_L}\right) = \frac{100\, v_i}{R_o + R_L} \text{ and } v_i = i_s R_i$$

$$i_o = \left(\frac{100}{R_o + R_L}\right)(R_i)\, i_s$$

$$\boxed{\frac{i_o}{i_s} = \frac{100\, R_i}{R_o + R_L}}$$

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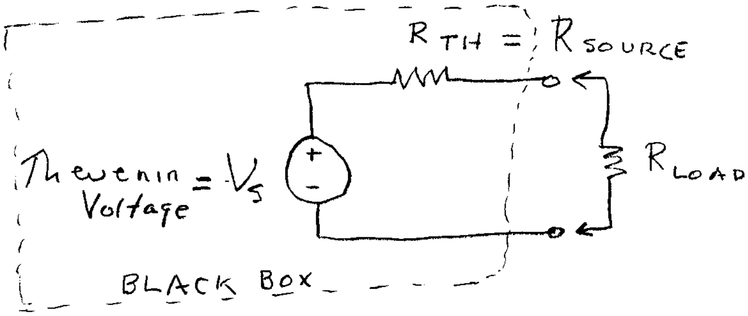
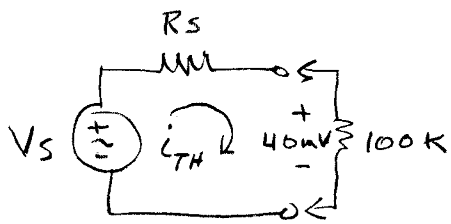
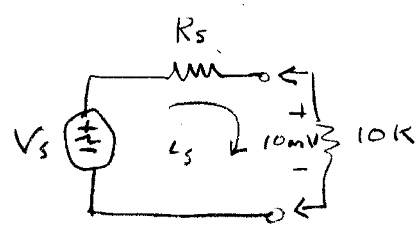
6. An unknown signal source produces a voltage across a 100 K ohm load resistor of 40 millivolts (data point 1) and 10 millivolts across a load resistor of 10 K ohm(data point 2) .

Your task: from the experimental data above, what is the Thevenin voltage, the Norton current, and the internal resistance of the signal source?




$$V_o = \left(\frac{100K}{R_S + 100K}\right) V_S = 40\text{ mV} \qquad V_o = \left(\frac{10K}{R_S + 10K}\right) V_S = 10\text{ mV}$$

$$\text{OR } V_S = \frac{(40\text{ mV})(R_S + 100K)}{100K} \qquad V_S = \frac{10\text{ mV}\ (R_S + 10K)}{10K}$$

$$\text{Then} \quad \frac{40\text{ mV}\ (R_S + 100K)}{100K} = \frac{10\text{ mV}\ (R_S + 10K)}{10K}$$

$$1000\ (R_S + 10K) = 400\ (R_S + 100K)$$

$$1000 R_S + 1 \times 10^7 = 400 R_S + 4 \times 10^7$$

$$600 R_S = 3 \times 10^7$$

$$\boxed{R_S = 50 \times 10^4 = 50\text{ K}\Omega = R_{TH}}$$

$$\text{Then } V_S = V_{TH} \Rightarrow \frac{40\text{ mV}\ (50 \times 10^3 + 100 \times 10^3)}{100K} = .06 \text{ volts}$$

$$\boxed{V_{TH} = 60\text{ mV}}$$

$$\boxed{I_{SC} = \frac{V_{TH}}{R_{TH}} = \frac{60\text{ mV}}{50K} = 1.2\ \mu A}$$