General Feedback on Final Exam 2016

Units and the conversion between scientific notation and the prefixes used with units should be learned by heart.

Name	Unit
Resistance	Ω (Ohm)
Voltage	V (Volt)
Current	A (Ampere or Amp)

Prefix	Scientific notation
G (giga)	10^9
M (mega)	10^6
k (kilo)	10^3
m (milli)	10^{-3}
μ (micro)	10^{-6}
n (nano)	10^{-9}
p (pico)	10^{-12}

<u>Question 1</u>

In superposition, the number of independent sources in a circuit is equal to the number of circuits that should be analysed. In each of the circuits that are created when applying the theory of superposition, only one independent source should be left on and the rest of the independent sources should be turned off (i.e., the amplitude of an independent voltage source should be set to 0 V and the amplitude of an independent current source should be set to 0 A). The dependent sources should be left on in all circuits.

Remember: Each current source, no matter whether it is an independent and dependent source, has a voltage across its two terminals.

<u>Question 2</u>

The gain of an amplifier is the slope of the line between the two line segments that have a slope of 0. If the slope is positive, the amplifier is a non-inverting amplifier. If the slope is negative, the amplifier is an inverting amplifier.

The schematic for an inverting amplifier and a non-inverting amplifier should be learned by heart – these two amplifiers are used extremely frequently. Also, the differences between an ideal and nonideal operational amplifier should be learned – they are important (see Question 5a). A major difference is that the range of output voltages from a nonideal operational amplifier is limited to the range between the positive and negative power supplies used to make the operational amplifier active (V^+ and V^-). An ideal operational amplifier will output as much or as little voltage as is required to satisfy the gain equation.

<u>Question 3</u>

First – a Thévenin equivalent circuit is a Thévenin equivalent voltage source in series with a Thévenin (Norton) equivalent resistor and the load resistor. A Norton equivalent circuit is a Norton equivalent current source in parallel with a Norton (Thévenin) equivalent resistor and the load resistor. The

Thévenin equivalent resistor is almost always equal in value to the Norton equivalent resistor (and we don't worry about the cases where the two resistors aren't the same in this course). **The load resistor is never part of the equivalent resistor!**

There are a number of ways to determine the amplitude of the Thévenin and Norton equivalent sources and the Thévenin equivalent resistor. Applied properly, each approach will result in the same values for the amplitudes of the Thévenin voltage source, the Norton current source, and the resistance of the equivalent resistor. An equation to remember is $V_{\text{Thévenin}} = I_{Norton}R_{equivalent}$.

Note that voltage sources in series can be combined, taking into account the polarity of the voltages and current sources in parallel to one another can be combined, taking into account the direction of current flow. Components in series can switch places so that two voltage sources are then in series with one another before combining them. Components in parallel can switch places so that two current sources are then in series with one another before combining them.

If the Thévenin equivalent circuit and the Norton equivalent circuit have been derived properly, then the current flowing through the load resistor and the voltage across the load resistor will be the same in each circuit as well as in the original circuit.

Question 4

Because it can be assumed that no current flows into an operational amplifier input (one of the essential assumptions of an ideal operational amplifier), then the voltage at the noninverting input terminal of the operational amplifier can be calculated using voltage division. Note that the total voltage across the 4 kΩ and 2 kΩ is 6 V, not 4 V, because of the polarity of the 1 V source.

Since there is a voltage at the noninverting input terminal as well as at the inverting input terminal of the operational amplifier, the circuit is not an inverting amplifier nor is it a noninverting amplifier. The best approach to analyse an amplifier circuit is to apply nodal analysis. It is one of two critical analysis techniques where loop analysis (also known as mesh analysis) is the other. **Learn them!!!**