EE 261 **Spring 2025** **Homework 7—Handwritten**

Due Sunday, Mar. 9, 2024 by 11:59 p.m.

NOTE: This is only the "handwritten" portion of Homework 7. There are also problems you must do online via the Mastering site. For this handwritten portion you must submit a PDF scan of your work at Canvas. Please ensure your work is contained in a single file and is legible.

Problems from Nilsson and Riedel:

1. 5.39 For part (a), assume the op-amp is not saturated (i.e., the output is somewhere between -9 V and 9 V. However, you should find that if the load resistance is too large (such as in part (c)), the output voltage needed to maintain a constant current exceeds that being supplied to the op-amp. For the "sketch" in part (d), you may sketch things by hand, but I encourage you to use a plotting package (once again, MATLAB can come in handy).

2. 5.42 Recall that if you know the voltages at the non-inverting terminals, you know the voltages at the inverting terminals. You thus know the voltages across the 2 kΩ and 4.7 kΩ resistors. Knowing these values, you can determine some current flows that will allow you to find one output voltage and then the other.

3. The current through a 15 mH inductor is

$$i(t) = \begin{cases} 10 \text{ A} & t < 0, \\ 10(t+1)e^{-2t} \text{ A} & 0 \leq t \leq 1 \text{ s}, \\ 20e^{-2} \text{ A} & 1 \text{ s} < t. \end{cases}$$

   What is the corresponding voltage? (Provide the mathematical description of the voltage, but optionally you may also provide a plot of the voltage.)

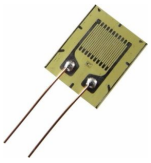
4. The current through a 100 μF capacitor that is initially uncharged is

$$i(t) = \begin{cases} 0 \text{ mA} & t < 0, \\ -0.5 \text{ mA} & 0 \leq t < 1 \text{ s}, \\ 0 \text{ mA} & 1 \text{ s} \leq t < 2 \text{ s}, \\ 0.5 \text{ mA} & 2 \text{ s} \leq t < 3 \text{ s}, \\ 0 \text{ mA} & 3 \text{ s} \leq t. \end{cases}$$

   What is the corresponding voltage? (Provide the mathematical description of the voltage, but optionally you may also provide a plot of the voltage.)

(Continued on next page.)

The following problems are courtesy of Prof. Brian Faulkner of the Milwaukee School of Engineering.

5.  Strain gauges change their resistance slightly when stretched or compressed and can be used as a force sensor. Strain gauges are configure to create the circuit shown on the next page. If the gauges were experiencing no stretching or compression, all four resistances on the left of the circuit would be $350\ \Omega$. However, as shown, owing to compression and stretching, the resistances have changed slightly from their default values. In general, the voltage between points A and B is proportional to strain, but is very small and needs amplification. What is the value of V_{out} at the current strain depicted in the circuit?