ECE 214 — Final Exam

Estimated time for completion: $\leq$ 2.0 hours
6 May 2014

Rules of the Exam

Rule 1: The examination period begins at 8:00am on Tuesday 6 May 2014 and ends at 10:00 on Tuesday 6 May 2014.

Rule 2: There are three problems and an optional extra credit problem worth an additional five points.

Rule 3: Circle your final answers and make sure to include the units along with the numerical answer.

Rule 4: Show all work.

Rule 5: The exam is closed book and closed notes but you may use your ECE 214 Laboratory Notebook and a calculator.

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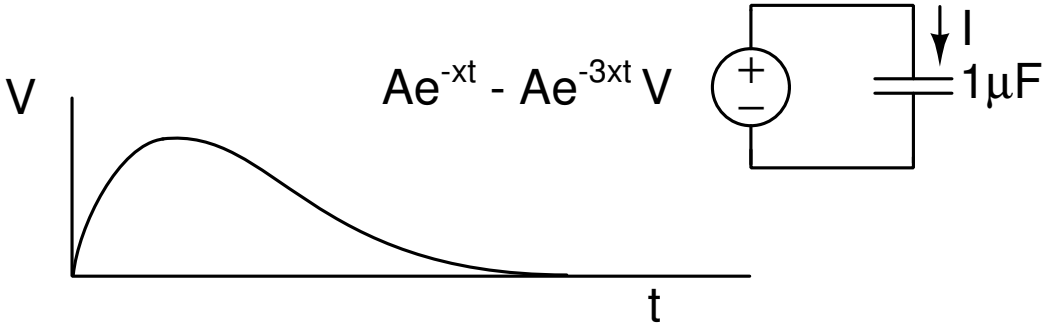
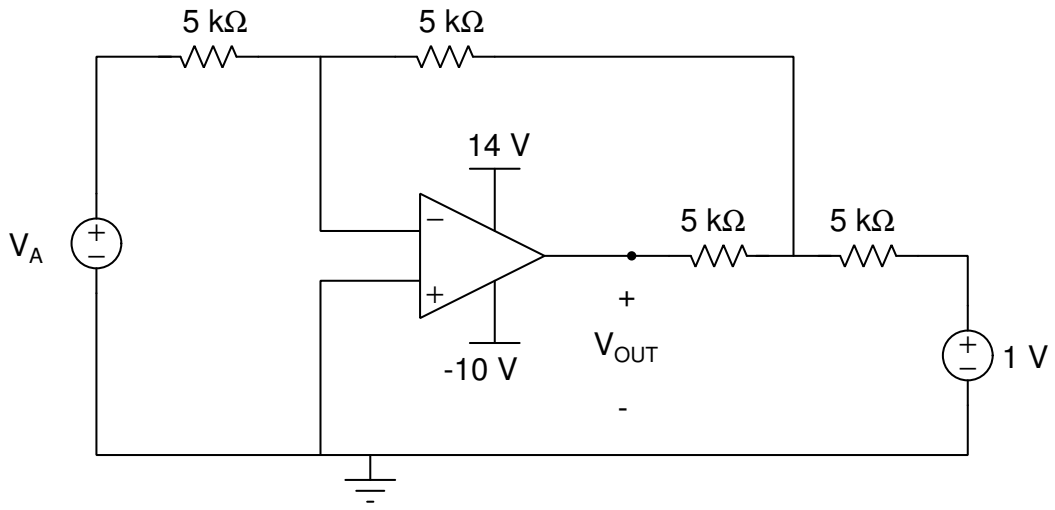
Name

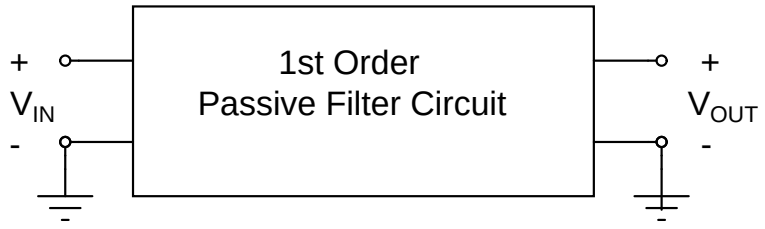
Problem 1. (6 pts.) The voltage pulse shown below is equal to zero for $T < 0$. At $t = 549.3\mu$s, the current I through the capacitor is zero. At some point in time the current I reaches a maximum negative value of 5 mA. What is the value of A?



Problem 2. (7 pts.) What are the minimum and maximum values of V_A that will prevent the output of the OpAmp (V_{OUT}) from saturating. The OpAmp is ideal.



Problem 3. (7 pts.) Consider the 1st order ideal passive filter circuit shown below:



For the questions below circle the most correct answer:

1. V_{IN} is a sine wave with a frequency of 50 kHz and a peak-to-peak voltage of 5 V. V_{OUT} is a sinusoidal waveform with a frequency of 150 kHz. What type of filter could be used to generate V_{OUT}?

   (a) low pass filter
   (b) band pass filter
   (c) band reject filter
   (d) high pass filter
   (e) none of the above

2. V_{IN} is a square wave with a 50% duty cycle, a frequency of 50 kHz, and a peak-to-peak voltage of 5 V. V_{OUT} is a sinusoidal waveform with a single frequency of 25 kHz. What type of filter could be used to generate V_{OUT}?

   (a) low pass filter
   (b) band pass filter
   (c) band reject filter
   (d) high pass filter
   (e) none of the above

3. V_{IN} is a square wave with a 50% duty cycle, a frequency of 50 kHz, and a peak-to-peak voltage of 5 V. V_{OUT} that is a sinusoidal waveform with a single frequency of 100 kHz? What type of filter could be used to generate V_{OUT}?

   (a) low pass filter
   (b) band pass filter
   (c) band reject filter
   (d) high pass filter
   (e) none of the above

4. V_{IN} is a square wave with a 50% duty cycle, a frequency of 50 kHz, and a peak-to-peak voltage of 5 V. The filter is a low pass filter with a cutoff frequency of 25 kHz. What is the relative amplitude of the 5th harmonic to the fundamental at the output of the filter?

   (a) -3.00 dB
   (b) -9.54 dB
   (c) -13.98 dB
   (d) -19.08 dB
   (e) -27.96 dB
   (f) -41.94 dB

5. V_{IN} is a triangular wave with a 50% duty cycle, a frequency of 50 kHz, and a peak-to-peak voltage of 5 V. The filter is a low pass filter with a cutoff frequency of 25 kHz. What is the relative amplitude of the 5th harmonic to the fundamental at the output of the filter?

   (a) -3.00 dB
   (b) -9.54 dB
   (c) -13.98 dB
   (d) -19.08 dB
   (e) -27.96 dB
   (f) -41.94 dB

6. V_{IN} is a triangular wave with a 50% duty cycle, a frequency of 50 kHz, and a peak-to-peak voltage of 10 V. The filter is a high pass filter with a cutoff frequency of 50 kHz. What is the relative amplitude of the 5th harmonic to the fundamental at the output of the filter?

   (a) -3.00 dB
   (b) -6.54 dB
   (c) -9.54 dB
   (d) -16.08 dB
   (e) -21.94 dB
   (f) -24.96 dB

7. V_{IN} is a triangular wave with a 50% duty cycle, a frequency of 50 kHz, and a peak-to-peak voltage of 10 V. The filter is a high pass filter with a cutoff frequency of 100 kHz. What is the relative amplitude of the 5th harmonic to the fundamental at the output of the filter?

   (a) -3.00 dB
   (b) -6.54 dB
   (c) -9.54 dB
   (d) -16.08 dB
   (e) -21.94 dB
   (f) -24.96 dB

Extra Credit Problem. (5 pts.) In the circuit below, the 5 mA source delivers no power and absorbs no power, the circuit dissipates a total of 100 mW of power, and stores 10 nJ of energy. Determine the values of R_1, R_2, and L_1.