ECE 214 — Final Exam

Estimated time for completion: \leq 2 hour 10 May 2018

Rules of the Exam

- Rule 1: The examination period begins at 10:30 am on Thursday, 10 May 2018, and ends at 12:30 pm on Thursday, 10 May 2018.
- Rule 2: The exam is worth 20 points.
- **Rule 3:** There are three problems each worth seven points, plus one optional extra credit problem worth three points.
- **Rule 4:** The exam is closed book and closed notes. You may use your ECE 214 Laboratory Notebook, a ruler, and a calculator.
- Rule 5: To receive credit for an answer include the units along with the numerical answer.
- Rule 6: <u>Show all work</u> answers without supporting work will not receive credit.
- Rule 7: Do not leave the room until you have completed the exam.

Name

Problem 1: Consider the circuit below:



Draw the Thèvenin Equivalent Circuit with respect to terminals A and B.

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Assume the OpAmp is ideal with $V_{dd} = 9$ V.



- 1. What is the function of this circuit?
 - (a) inverting amplifier with DC offset
 - (b) non-inverting amplifier with DC offset
 - (c) comparator
 - (d) Schmitt trigger
 - (e) inverting integrator
 - (f) inverting integrator with DC offset
- 2. V_{IN} is a triangular waveform with 1 V peak–to–peak voltage and 4.5 V DC offset. What type of waveform is V_{OUT} ?
 - (a) sinusoidal waveform
 - (b) triangular waveform
 - (c) triangular waveform with a DC offset
 - (d) square waveform
 - (e) square waveform with a DC offset
 - (f) DC output equal to 0 V
- 3. $V_{IN} = 0$ V. What is V_{OUT} ?_____
- 4. $V_{IN} = -3$ V. What is V_{OUT} ?_____
- 5. $V_{IN} = 3$ V. What is V_{OUT} ?_____

Assume the OpAmp is ideal with $V_{dd} = 9$ V.



- 6. What is the function of this circuit?
 - (a) inverting amplifier with DC offset
 - (b) non–inverting amplifier with DC offset
 - (c) comparator
 - (d) Schmitt trigger
 - (e) inverting integrator
 - (f) inverting integrator with DC offset
- 7. $V_{\rm IN}$ is a triangular waveform with 1 V peak–to–peak voltage and 0 V DC offset. What type of waveform is $V_{\rm OUT}?$
 - (a) sinusoidal waveform
 - (b) triangular waveform
 - (c) triangular waveform with a DC offset
 - (d) square waveform
 - (e) square waveform with a DC offset
 - (f) DC output equal to 0 V
- 8. When $V_{IN} = 0$ V, what is V_{OUT} ?_____
- 9. When $V_{IN} = 4.5 \text{ V}$, what is V_{OUT} ?_____
- 10. When $V_{IN} = 9 V$, what is V_{OUT} ?_____

Problem 3: Consider the 1st order ideal passive filter circuit shown below:



For the questions below circle the <u>most correct</u> answer:

- 1. V_{IN} is a sine wave with a frequency of 150 kHz and a peak-to-peak voltage of 5 V. V_{OUT} is a sinusoidal waveform with a frequency of 150 kHz and a peak-to-peak voltage of 2 V. What type of filter could be used to generate V_{OUT} ?
 - (a) low pass filter
 - (b) high pass filter
 - (c) band reject filter
 - (d) all of the above
 - (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} that is a sinusoidal waveform with a frequency of 200 kHz and peak-to-peak voltage of 1 V? 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 10 V. The filter is a low pass filter with a cutoff frequency of 100 kHz. What is the relative amplitude of the 7th harmonic to the fundamental at the output of the filter?
 - (a) -3.0 dB
 - (b) -8.0 dB
 - (c) -10.9 dB
 - (d) -13.9 dB
 - (e) -16.9 dB
 - (f) -19.9 dB
 - (g) -22.8 dB
 - (h) -27.8 dB
 - (i) -30.8 dB
- 4. V_{IN} is a square wave with a 50% duty cycle, a frequency of 50 kHz, and a peak-to-peak voltage of 10 V. The filter is a low pass filter with a cutoff frequency of 50 kHz. What is the relative amplitude of the 7th harmonic to the fundamental at the output of the filter?
 - (a) -3.0 dB
 - (b) -8.0 dB
 - (c) -10.9 dB
 - (d) -13.9 dB
 - (e) -16.9 dB
 - (f) -19.9 dB
 - (g) -22.8 dB
 - (h) -27.8 dB
 - (i) -30.8 dB
- 5. V_{IN} is a square 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 7th harmonic to the fundamental at the output of the filter?
 - (a) -3.0 dB
 - (b) -8.0 dB
 - (c) -10.9 dB
 - (d) -13.9 dB
 - (e) -16.9 dB
 - (f) -19.9 dB
 - (g) -22.8 dB
 - (h) -27.8 dB
 - (i) -30.8 dB

Optional Bonus Problem: In the circuit below, the 3 A source delivers no power and absorbs no power. The circuit dissipates a total of 155 W of power and stores 0.1 mJ of energy.



What are:



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