# 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: Show all work - answers without supporting work will not receive credit.
Rule 7: Do not leave the room until you have completed the exam.

Problem 1: Consider the circuit below:


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

Assume the OpAmp is ideal with $\mathrm{V}_{d d}=9 \mathrm{~V}$.


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. $\mathrm{V}_{\text {IN }}$ is a triangular waveform with 1 V peak-to-peak voltage and 4.5 V DC offset. What type of waveform is $V_{\text {Out }}$ ?
(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. $\mathrm{V}_{\text {IN }}=0 \mathrm{~V}$. What is Vout?
4. $\mathrm{V}_{\text {IN }}=-3 \mathrm{~V}$. What is $\mathrm{V}_{\text {OUT }}$ ?
5. $\mathrm{V}_{\text {IN }}=3 \mathrm{~V}$. What is $\mathrm{V}_{\text {OUt }}$ ?

Assume the OpAmp is ideal with $\mathrm{V}_{d d}=9 \mathrm{~V}$.

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. $\mathrm{V}_{\text {IN }}$ is a triangular waveform with 1 V peak-to-peak voltage and 0 V DC offset. What type of waveform is Vout?
(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 $\mathrm{V}_{\text {IN }}=0 \mathrm{~V}$, what is $\mathrm{V}_{\text {OUT }}$ ? $\qquad$
9. When $\mathrm{V}_{\mathrm{IN}}=4.5 \mathrm{~V}$, what is $\mathrm{V}_{\text {OUT }}$ ? $\qquad$
10. When $\mathrm{V}_{\text {IN }}=9 \mathrm{~V}$, what is $\mathrm{V}_{\text {OUT }}$ ? $\qquad$

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


For the questions below circle the most correct answer:

1. $\mathrm{V}_{\text {IN }}$ is a sine wave with a frequency of 150 kHz and a peak-to-peak voltage of 5 V . V VUT 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 $\mathrm{V}_{\text {Out }}$ ?
(a) low pass filter
(b) high pass filter
(c) band reject filter
(d) all of the above
(e) none of the above
2. $\mathrm{V}_{\text {IN }}$ is a square wave with a $50 \%$ duty cycle, a frequency of 50 kHz , and a peak-to-peak voltage of 5 V . Vout 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 $\mathrm{V}_{\text {OUT }}$ ?
(a) low pass filter
(b) band pass filter
(c) band reject filter
(d) high pass filter
(e) none of the above
3. $\mathrm{V}_{\text {IN }}$ 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 7 th 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. $\mathrm{V}_{\text {IN }}$ 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. $\mathrm{V}_{\text {IN }}$ 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 7 th 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:

$$
\begin{aligned}
& R_{1}= \\
& R_{2}= \\
& L=
\end{aligned}
$$

