32 in class
+2
34

ECE 214 — Exam #1

Estimated time for completion: ≤ 1.25 hour
5 March 2020

Rules of the Exam

Rule 1: The examination period begins at 9:30 am on Thursday, 5 March 2020, and ends at 10:45 am on Thursday, 5 March 2020.

Rule 2: The exam is worth 20% of your grade.

Rule 3: The exam is closed book and closed notes. You may use your ECE 214 Laboratory Notebook, a ruler, and a calculator.

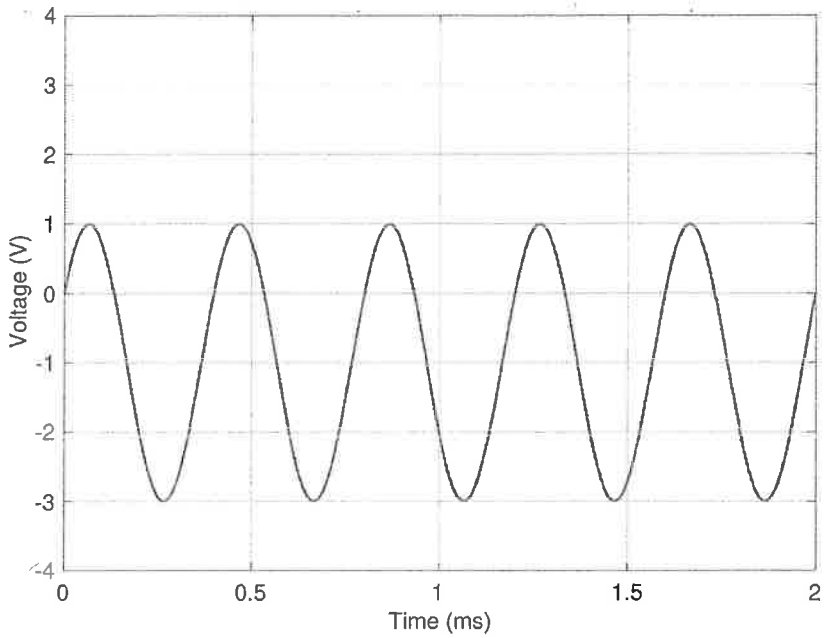
Rule 4: To receive credit for an answer, include the units along with the numerical answer.

Rule 5: Show all work - answers without supporting work will not receive credit.

Rule 6: Do not leave the room until you have completed the exam.

Answer Key
Name

Problem 1 (6 points): Consider the voltage signal V(t) shown below:



This signal can be described as:

$$V(t) = A_1 \cos(\omega_1 t + \phi_1) + V_{DC1}.$$

T = 0.4 ms

f = 2.5 kHz

1. What is A_1? 2V

2. What is ω_1? 5000π or 15708 rad/s

3. What is V_{DC1}? −1 V

4. What is ϕ_1 in degrees? -60°

5. What is ϕ_1 in radians? $-\frac{\pi}{3}$ or −1.05 radians

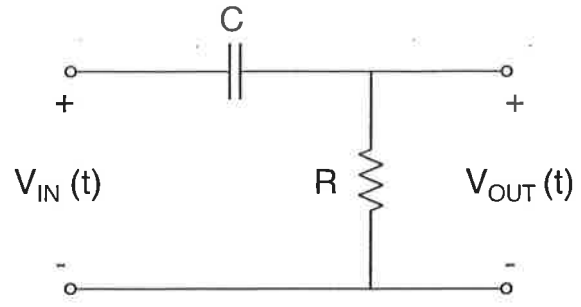
$V(t) = 0 = 2\cos(\phi_1) - 1$

$2\cos(\phi_1) = 1$

$\cos(\phi_1) = 1/2$

6. If V(t) is measured using a DVM with a 5 MΩ input resistance, and set to measure an AC voltage, what voltage would the DVM measure? $2/\sqrt{2} = 1.414$ V

Problem 2 (6 points): In the filter circuit shown below, C = 400 pF and R = 80 kΩ.



The voltage input signal $V_{IN}(t)$ is given by:

$$V_{IN}(t) = 5\cos(9,940\pi t + 45°) + 2 \text{ V},$$

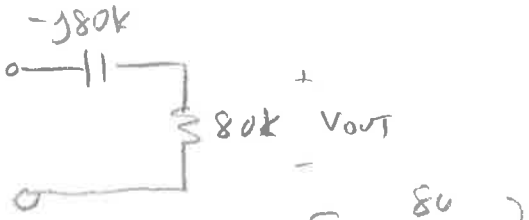
$= 5\angle 45°$

$\omega = 9940\pi$

$Z_c = -\frac{j}{\omega C} = -j80,000 = -j80k\Omega$

and the voltage output signal $V_{OUT}(t)$ by:

$$V_{OUT}(t) = A_2\cos(\omega_2 t + \phi_2) + V_{DC2}$$



$V_{out}(t) = 5\angle 45° \left[\frac{80}{80 - j80}\right]$

$= 3.53\,j$

1. What is A_2? 3.53 V
2. What is ω_2? 9940π or 31227.4
3. What is ϕ_2? 90°
4. What is V_{DC2}? 0 V
5. Is this circuit a high-pass, band-pass, band-reject, or low-pass filter? _____
6. If $V_{OUT}(t)$ is connected to an oscilloscope having an input resistance of 1 MΩ and an input capacitance of 13 pF, with a cable having a capacitance of 27 pF, what is the approximate value of A_2 that is measured? 3.24 V

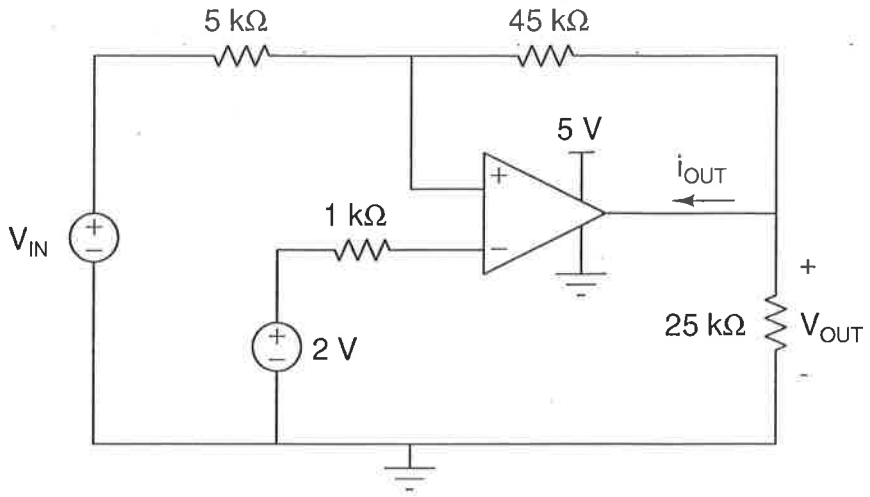
$40pF \Rightarrow Z_c = -j800k\Omega$

$\left(\frac{1}{80} + \frac{1}{1000} - \frac{1}{j80}\right)^{-1} = 73.4 - j6.8$

$73.8\angle -5.3°\ k\Omega$

$5\angle 45° \left(\frac{73.8\angle -5.3}{73.8\angle -5.3 - j80}\right) = 3.24\angle 89.4°$

Problem 3a (4 points): Consider the OpAmp circuit shown below. The OpAmp is ideal.



What type of circuit is this? Circle one: inverting amplifier, inverting amplifier with DC offset, noninverting amplifier, noninverting amplifier with DC offset, differentiator, integrator, Schmitt trigger.

Complete the table below:

V_{IN}	V_{OUT}	i_{OUT}
0 V	0	0
1 V	0	+20mA
5 V	5	−200mA

$i_{OUT} = \frac{1}{50K}$

$i_{OUT} = -\frac{5}{25K}$

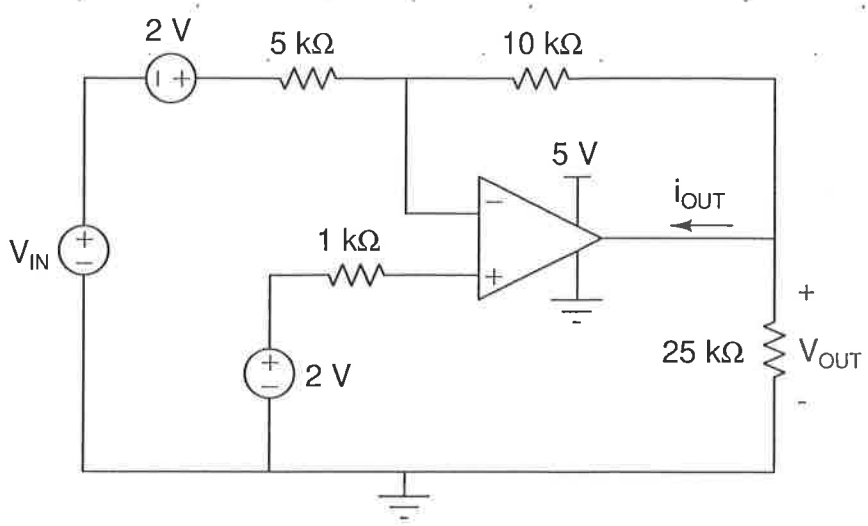
$\frac{V_{t_1} - 2}{5K} = \frac{2-5}{45K} \Rightarrow 9V_{t_1} - 18 = -3$

$V_{t_1} = \frac{15}{9} V = 1.67V$

$\frac{V_{t_2} - 2}{5K} = \frac{2}{45K} \Rightarrow 9V_{t_2} - 18 = 2$

$V_{t_2} = \frac{20}{9} V = 2.22V$

Problem 3b (4 points): Consider the OpAmp circuit shown below. The OpAmp is ideal.



What type of circuit is this? Circle one: inverting amplifier, inverting amplifier with DC offset, noninverting amplifier, noninverting amplifier with DC offset, differentiator, integrator, Schmitt trigger.

Complete the table below:

V_{IN}	V_{OUT}	i_{OUT}
0 V	2 V	-80 mA
1 V	0 V	+200 mA
5 V	0 V	+467 mA

$i_{out} = -\frac{2}{25K}$

$i_{out} = \frac{2}{10K}$

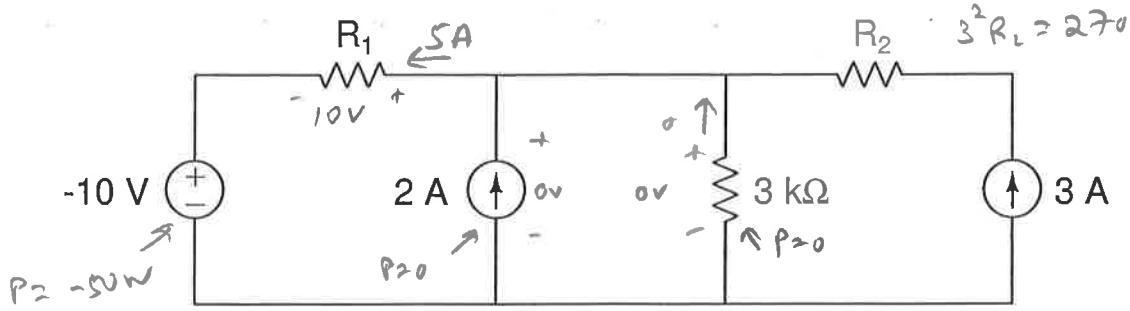
$i_{out} = \frac{7}{15K}$

$\frac{V_{in}}{5K} = \frac{2 - V_{out}}{10K}$

$2V_{in} = 2 - V_{out}$

$V_{out} = 2 - 2V_{in}$

Bonus Question (2 points): In the circuit below, the 2A source delivers no power and absorbs no power. The circuit dissipates a total of 320 W. Determine the values of R1 and R2.



$3^2 R_2 = 270$ $R_2 = 30\Omega$

50W

$R_1 = \frac{10V}{5A} = 2\Omega$

$R_1 =$ 2Ω

270W

$R_2 =$ 30Ω

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Name: _____

Blank page for calculations.

Name: _____