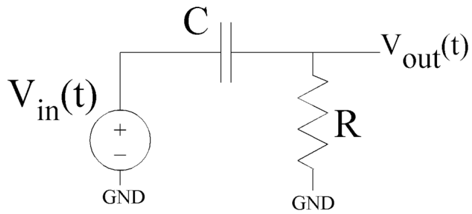
ECE 2040 Midterm Exam 2
Fall 2020

General Instructions instructions:

- Exam is closed book / closed notes other than the one-page of handwritten notes.
- Questions are worth 4 points unless otherwise stated.
- Only the final answers, as indicated by the question, will be considered correct for each question.
- Choose the best possible answer available in all cases.

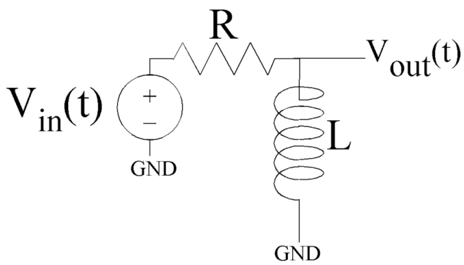
Honorlock instructions:

- The only notes allowed is a one-page of handwritten notes plus the one page of notes from Exam 1. Front and back of the sheet are allowed. Sheet should be shown to the camera.
- Restroom breaks are not encouraged, although if necessary, it is allowed when asking the proctoring system. Timing will be recorded.
- Blank scratch paper is allowed, and needs to be shown to the proctor.
- Music is allowed assuming it is at a low volume and not conveying any exam answers.
- Individuals should be allowed to work using their scratch piece of paper (should not be a violation). The initial scan should include the space around the desk where the individual will be writing so there are no issues when writing on their scratch piece of paper.



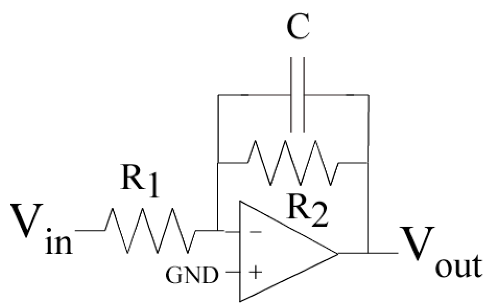
$$H(s) = \frac{1}{1 + s\tau}$$

Question 1: (True/False) The circuit has the resulting H(s) transfer function.



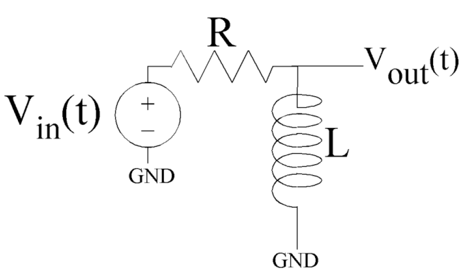
$$H(s) = \frac{s\tau}{1 + s\tau}$$

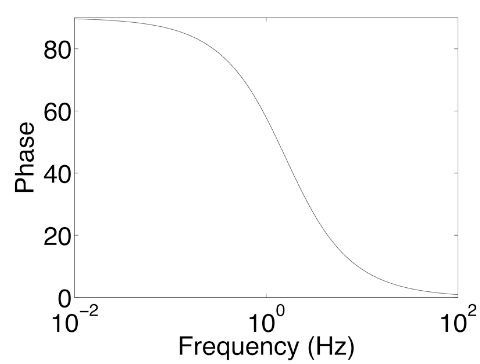
Question 2: (True/False) The circuit has the resulting H(s) transfer function.



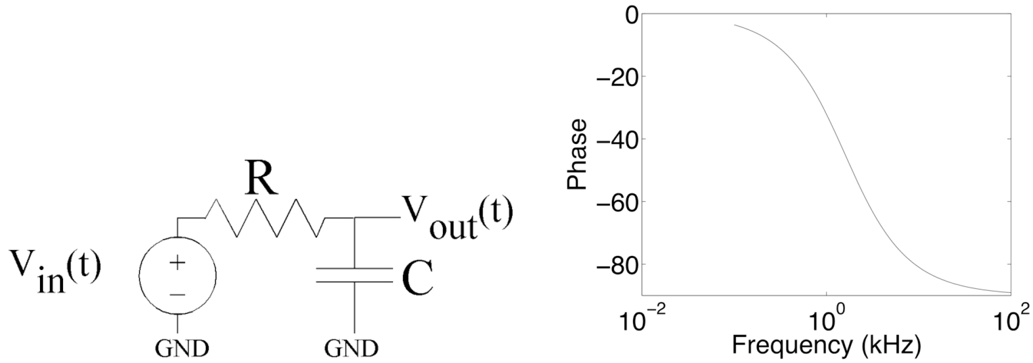
$$H(s) = -\frac{1}{1 + s\tau}$$

Question 3: (True/False) The circuit has the resulting H(s) transfer function for $R_1 = R_2$.

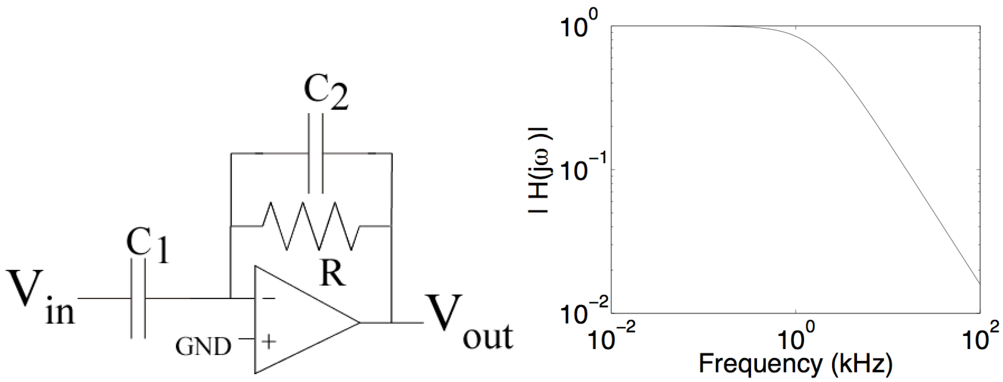




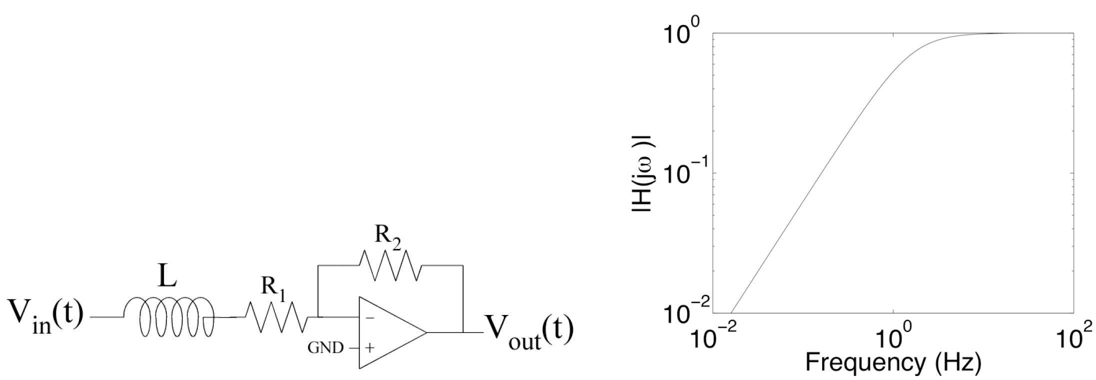
Question 4: (True/False) The circuit has the resulting phase response as shown.



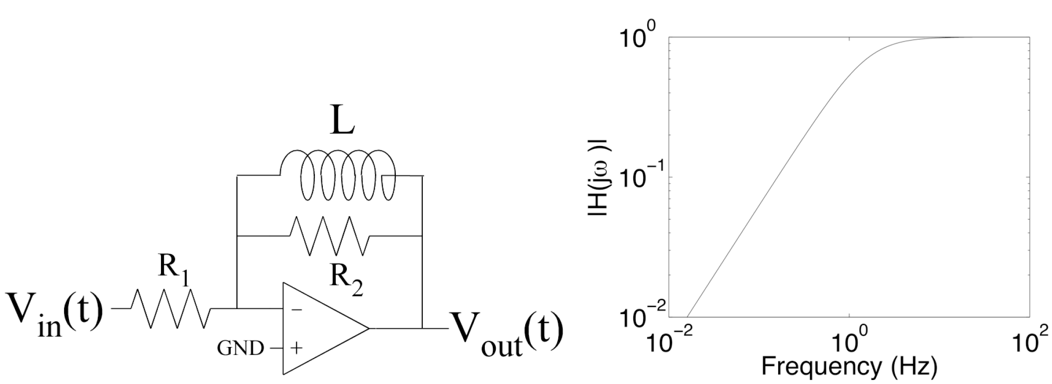
Question 5: (True/False) The circuit has the resulting phase response as shown.



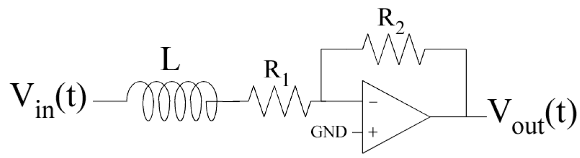
Question 6: (True/False) The circuit has the resulting frequency response shown for $C_1 = C_2$.



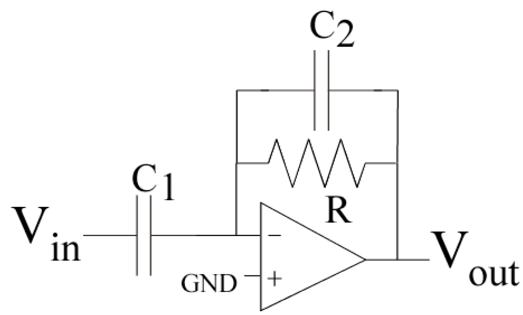
Question 7: (True/False) The circuit has the resulting frequency response shown for $R_1 = R_2$.



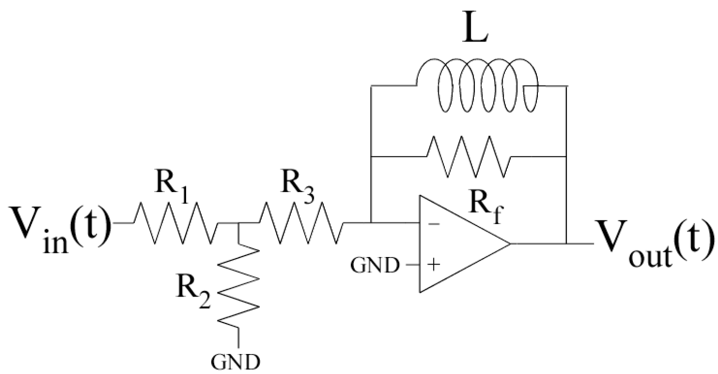
Question 8: (True/False) The circuit has the resulting frequency response shown for $R_1 = R_2$.



Question 9: (True/False) The circuit is a first-order low-pass filter.



Question 10: (True/False) The circuit is a first-order high-pass filter.



The following four questions refer to this circuit figure.

Question 11: Assume the Op-amp is ideal with infinite gain. $R_1 = 300k\Omega$, $R_2 = 300k\Omega$, $R_3 = 150k\Omega$, $R_f = 3M\Omega$. L = 6mH. The value of the largest (or only) timeconstant:
a. 2ns
b. 20ns
c. 200ns
d. 2µs
e. 20µs

Question 12: Assume the Op-amp is ideal with infinite gain. $R_1 = 300k\Omega$, $R_2 = 300k\Omega$, $R_3 = 150k\Omega$, $R_f = 3M\Omega$. L = 6mH. What is the magnitude of the constant gain region for this circuit?
a. 1
b. 2
c. 5
d. 10
e. 20

Question 13: (True/False) Assume the Op-amp is ideal with infinite gain. This circuit is a first-order low-pass filter.

Question 14: Assume the Op-amp is ideal with infinite gain. $R_1 = 300k\Omega$, $R_2 = 300k\Omega$, $R_3 = 150k\Omega$, $R_f = 3M\Omega$. L = 6mH. A 2V input step after starting 0V at t=0 would result in the output response:

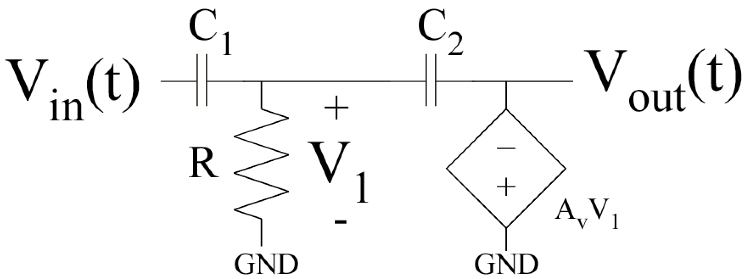
a. $V_{out}(t) = 10e^{-t/(20ns)}u(t)$

b. $V_{out}(t) = -10e^{-t/(2ns)}u(t)$

c. $V_{out}(t) = 10\left(1 - e^{-t/(2ns)}\right)u(t)$

d. $V_{out}(t) = -10\left(1 - e^{-t/(20ns)}\right)u(t)$

e. $V_{out}(t) = 10\left(1 - e^{-t/(200ns)}\right)u(t)$



The following six questions refer to this circuit figure.

Question 15: (True/False) Assuming R is infinite, the circuit could be minimally reduced for arbitrary inputs to a first-order differential equation.

Question 16: Assuming R is infinite with C_1 = 2pF, C_2 =1pF, and A_v = 10,000, in the region for nearly constant gain for this circuit for a change in V_{in}, resulting in a change in V_{out}, that gain would be

a. -2
b. -1
c. -0.5
d. 0.5
e. 2

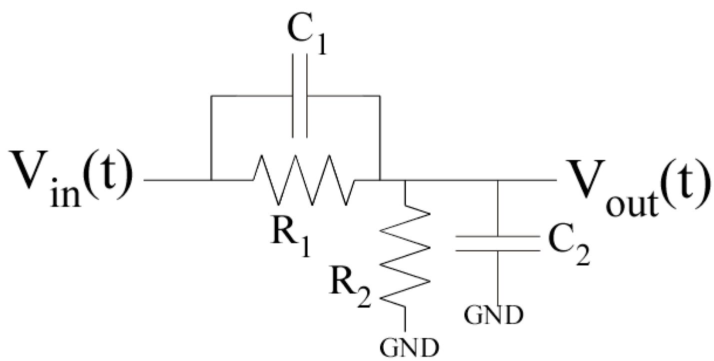
Question 17: (True/False): V_{out} could be 2V for a constant V_{in} = 0V.

Question 18: Assuming R = 1MΩ, C_1 = 2pF, C_2 =1pF, and A_v = 10,000, what is the largest timeconstant or single timeconstant (if only one) for this circuit?

a. 1µs
b. 10µs
c. 100µs
d. 1ms
e. 10ms

Question 19: (True/False) Assuming R = 1MΩ, the circuit could be minimally reduced for arbitrary inputs to a first-order differential equation.

Question 20: (True/False): Assuming R = 1MΩ, V_{out} could be 2V for a constant V_{in} = 0V.



The following five questions refer to this circuit figure.

Question 21: (True/False) The circuit could be minimally reduced for arbitrary inputs to a second-order differential equation.

Question 22: For an input, $V_{in}(t)$ = 4V u(t), where R_1 = 1kΩ, R_2 = 1kΩ, C_1 = 3μF, C_2 =1μF, what is the output voltage, V_{out}, for t=-1ms?
a. 0V
b. 1V
c. 2V
d. 3V
e. 4V

Question 23: For an input, $V_{in}(t)$ = 4V u(t), where R_1 = 1kΩ, R_2 = 1kΩ, C_1 = 3μF, C_2 =1μF, what is the output voltage, V_{out}, at steady state?
a. 0V
b. 1V
c. 2V
d. 3V
e. 4V

Question 24: For an input, $V_{in}(t)$ = 4V u(t), where R_1 = 1kΩ, R_2 = 1kΩ, C_1 = 3μF, C_2 =1μF, what is the output voltage, V_{out}, just after t=0?
a. 0V
b. 1V
c. 2V
d. 3V
e. 4V

Question 25: For an input, $V_{in}(t)$ = 4V u(t), where R_1 = 1kΩ, R_2 = 1kΩ, C_1 = 3μF, C_2 =1μF, what is the largest timeconstant to converge to steady state?
a. 1ms
b. 2ms
c. 3ms
d. 4ms
e. 6ms