ECE 2260 Final Exam

Week of: April 22, 2019

Student's name: _____

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You have 12 hours for 6 problems. Taking additional time beyond the allotted time will result in point deductions.

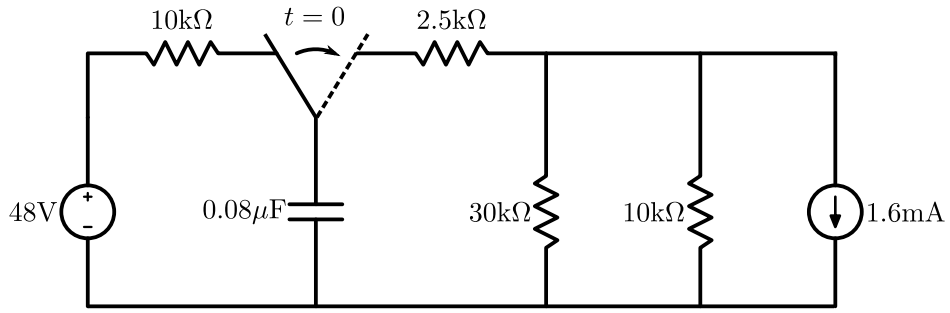
- Show enough (neat) work in the clear spaces on this exam to convince us that you derived, not guessed, your answers.
- Put your final answers in the boxes at the bottom of the page.

This test is take-home due to worldwide health concerns. As such, this is open book, open notes, and open computer. HOWEVER, you cannot collaborate with anybody else on this exam.

Problem	Score	Possible Points
1		25
2		20
3		20
4		20
5		20
6		20
Total score		125

1 Short answer

(a) What is the time-constant τ for this circuit?



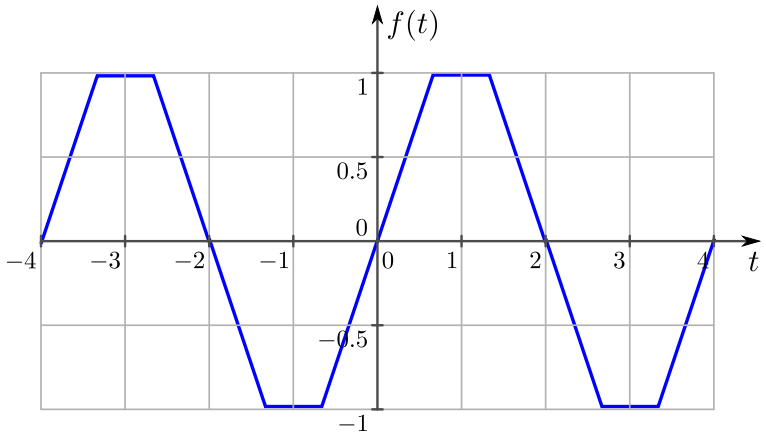
$\tau =$

(b) Find the Laplace transform of

$$f(t) = -t(u(t) - u(t-1))$$

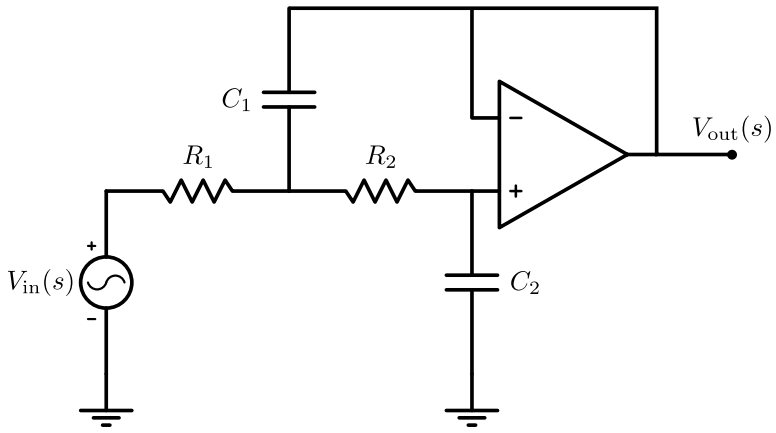
$F(s) =$

(c) What is types of symmetry does this signal have (circle all that apply)?



even	odd	half-wave symmetry	quarter-wave symmetry

(d) Is this circuit a passive or active filter (circle one)?

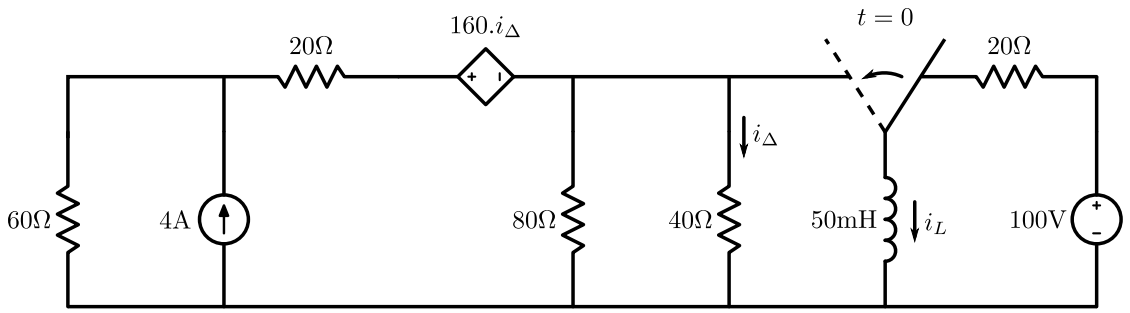


passive	active

(e) What is the order of the filter in the previous problem?

2 RL step response with dependent source

Let's try this again...in the circuit below, the switch toggles at time $t = 0$.



(a) Find the value of the value of $i_L(t)$ when $t < 0$.

$i_L(t < 0) =$

(b) Find the value of $i_L(t)$ when $t \to \infty$.

$i_L(t \to \infty) =$

(c) Find the value of the time constant τ.

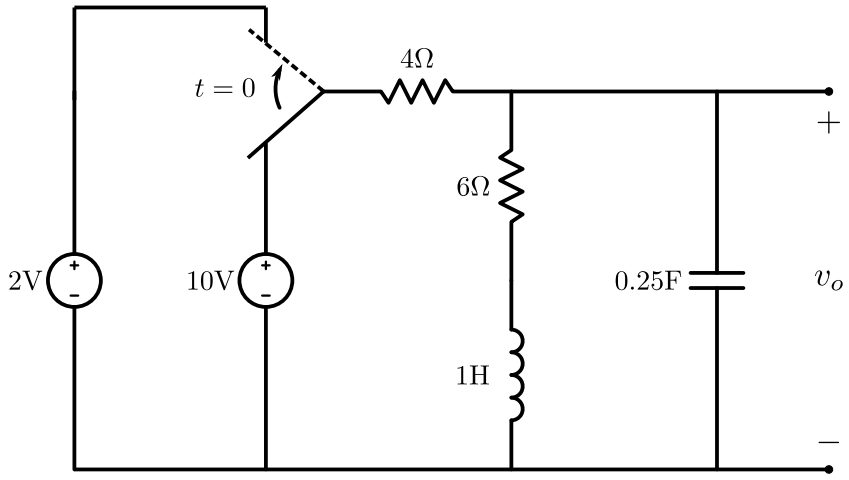
$\tau =$

(d) Write an expression for $i_L(t)$

$i_L(t) =$

3 Circuits in s-domain

For the following circuit, please do the following.



(a) Redraw the circuit in the s-domain.

(b) Solve for $V_0(s)$ in the s-domain.

Your work, continued...

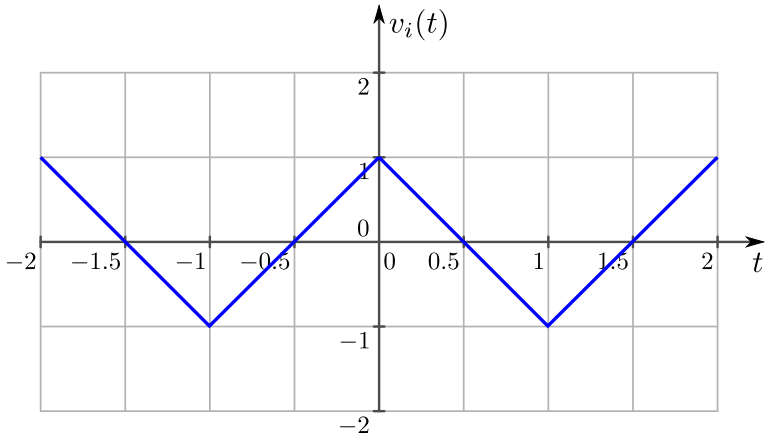
$V_0(s) =$

(c) Solve for $v_0(t)$ in the time domain.

$v_0(t) =$

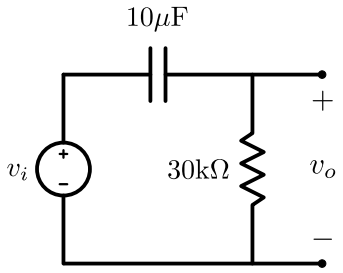
4 Fourier Series

(a) Derive the trigonometric Fourier series representation for $v_i(t)$ as seen in the plot below.



$v_i(t) =$

(b) Derive the first three terms (DC, $n = 0$, and $n = 1$) in the Fourier series that represents the steady-state voltage $v_o(t)$ in the circuit below if the input voltage is $v_i(t)$ which you derived in the previous part.



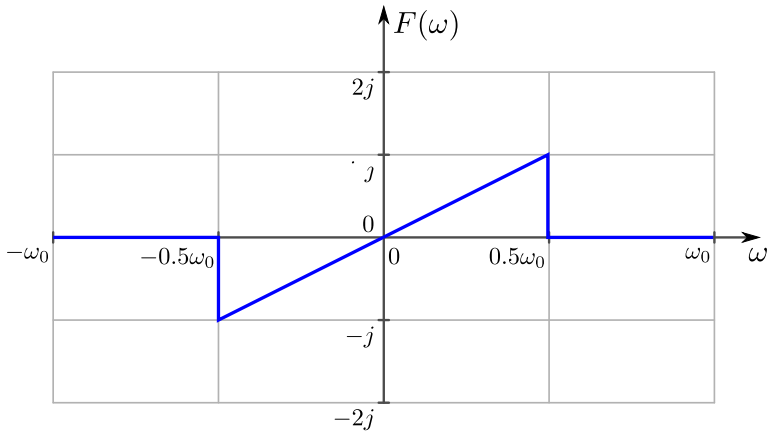
$v_{o,\mathrm{DC}}(t) =$

$v_{o,1}(t) =$

$v_{o,2}(t) =$

5 Fourier Transform and Bode Plots

(a) The Fourier transform of $f(t)$ is shown below. Find $f(t)$ (i.e., find the inverse Fourier transform of $F(\omega)$ in the plot below).

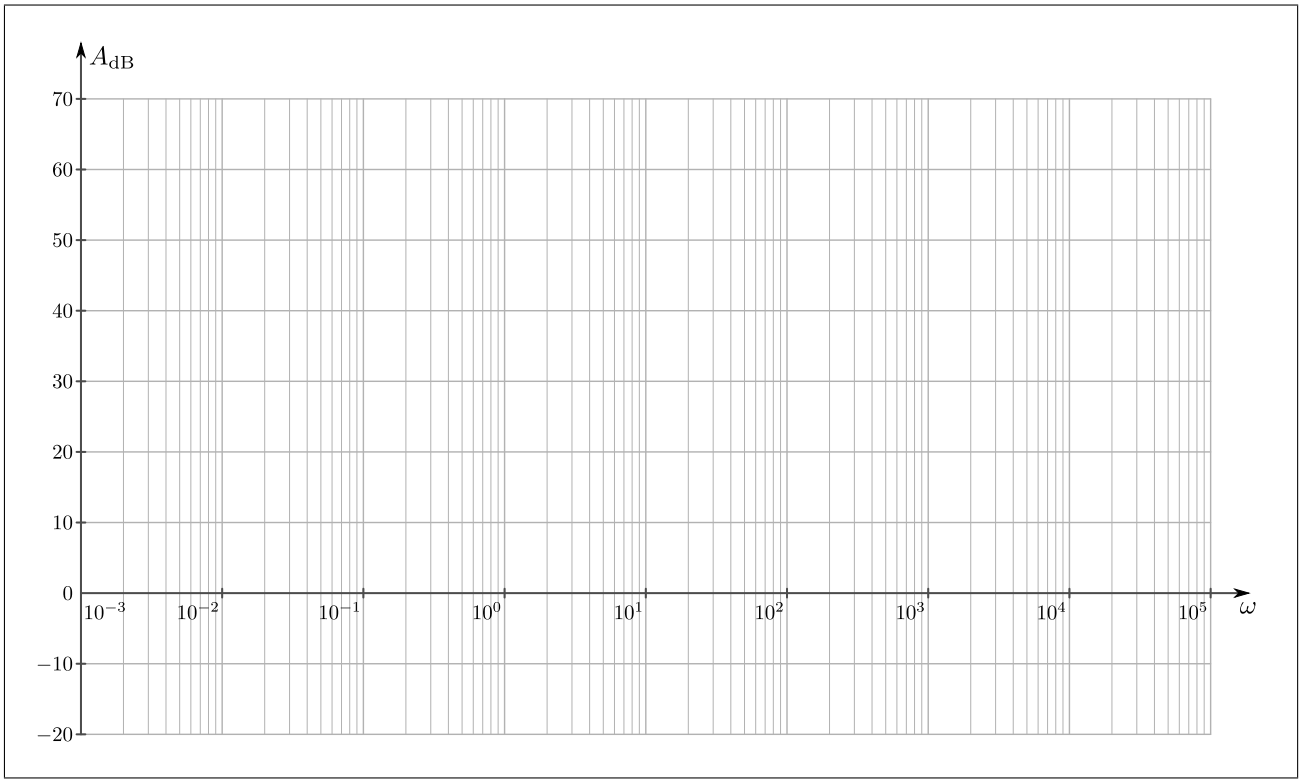


$f(t) =$

(b) For the following transfer function

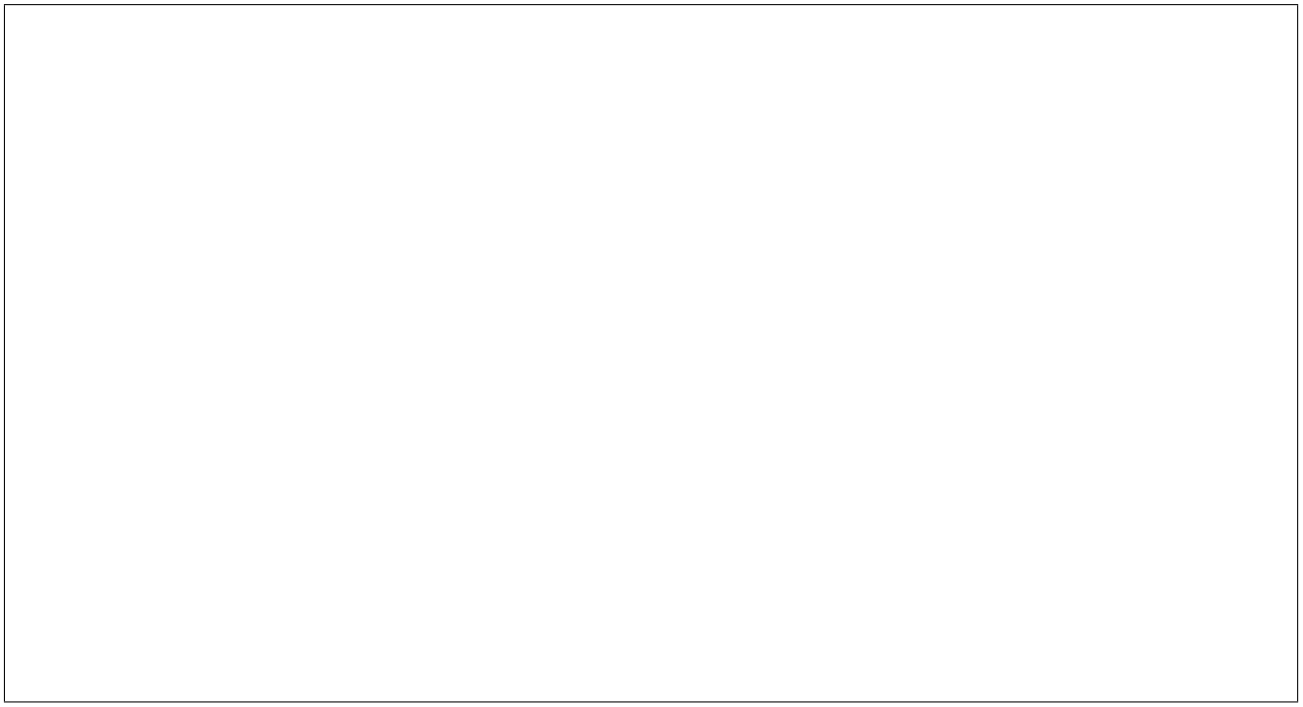
$$H(s) = \frac{s^2 + 4001s + 4000}{s^2 + 300s}$$

please sketch the magnitude Bode plot on the graph below.



6 Filter Design

(a) Using either a parallel or series RLC topology, design a *bandreject* filter with a center frequency of 5 kHz and a bandwidth of 200 Hz. You may use a single 1 kΩ resitor. You will need to specify the capacitor and inductor values.



(b) What is the transfer function $H(s)$ of your filter?

$H(s) =$

(c) What is the impulse function $h(t)$ of your filter?

$h(t) =$