ECE 3210 Midterm 1

Week of: September 30, 2019

Student's name and section: ______________________________

Instructor:
Eric Gibbons
ericgibbons@weber.edu
801-626-6861

You have 120 minutes for 5 problems.

- 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.

You can use one page of notes and a calculator.

Problem	Score	Possible Points
1		20
2		20
3		20
4		20
5		20
Total score		100

1 Short answer

(a) What is the verb form of "convolution"?

(b) Given the following system differential equations or impulse response functions, determine if each system is stable, marginally stable, or unstable. Show work if needed.

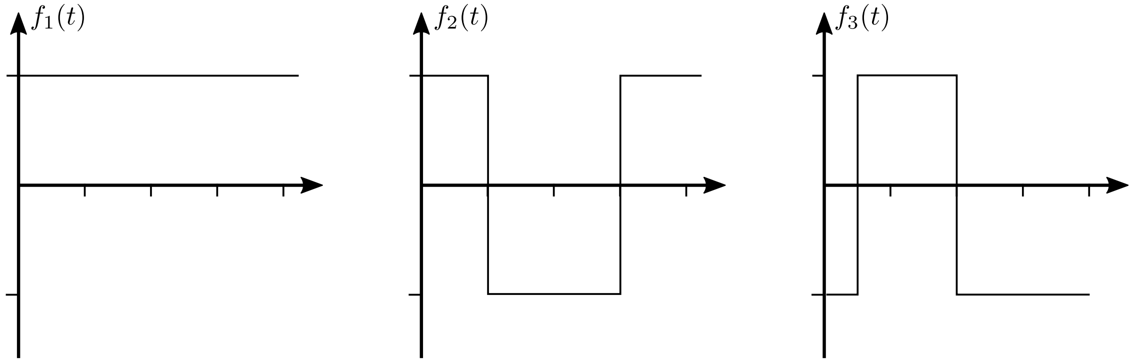
(i) $(D^4 + 6D^3 + 9D^2)y(t) = (D - 1)f(t)$

(ii) $h(t) = e^{-t/2}u(t)$

(iii) $(D^3 + 10D^2 + 26D)y(t) = D^2 f(t)$

(i) (ii) (iii)

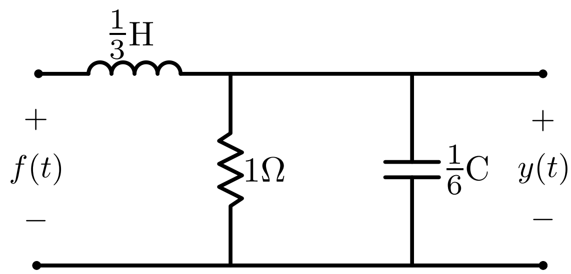
(c) Determine if the following functions $f_1(t)$, $f_2(t)$ and $f_3(t)$ are mutually orthogonal. Extensive derivation is not needed for this problem.



True or False:

2 Circuit analysis

Using the circuit below, please answer the following questions.



(a) Derive a differential equation relating the input $f(t)$ and the output $y(t)$. In your final answer, don't worry about including the units; write the ODE in the form we have seen in class.

(b) Determine the zero-input response for this system. Assume $y'(0) = 1$ and $y(0) = 0$.

$y_n(t) =$

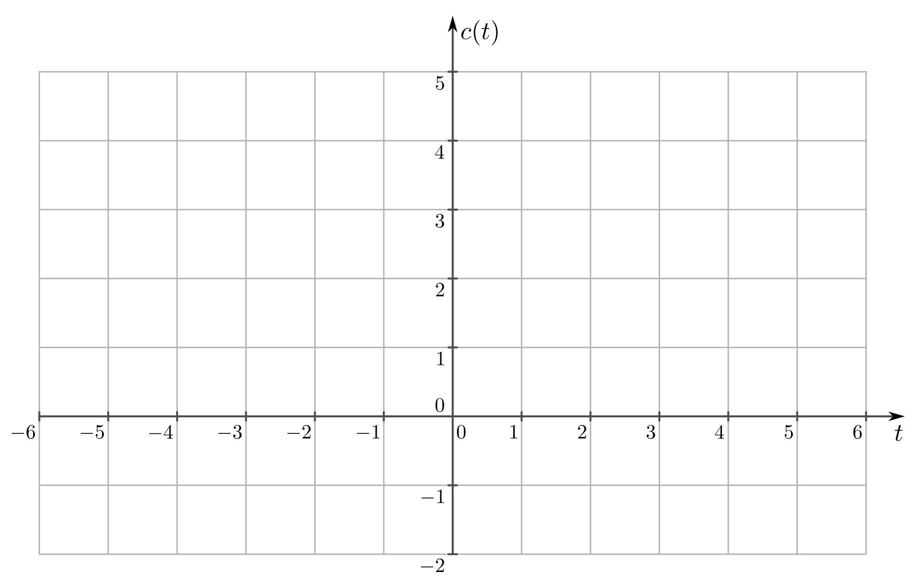
(c) Determine the impulse response $h(t)$ for this system.

$h(t) =$

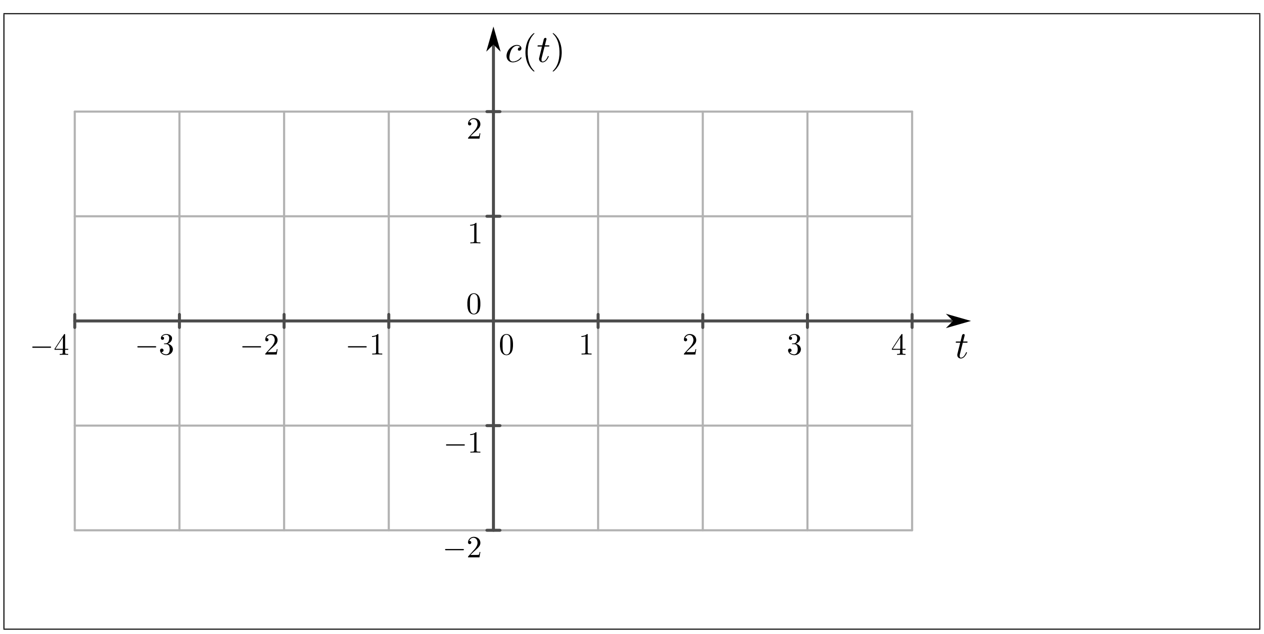
3 Convolution

Using direct integration or graphical (i.e., "flip-and-drag") methods, plot the following convolutions. (I.e., determine what the convolution is and then plot the result.)

(a) $(u(t-1) - u(t-3)) * 2\text{rect}\left(\frac{t}{4}\right)$



(b) $(u(t-1) - u(t-3)) * \cos(\pi t)$



4 Fourier series system response

We will use the triangle wave that we used in our Lab 3 exercise. We recall that Fourier series was written as

$$f(t) = \sum_{n=1}^{\infty} \frac{8}{n^2\pi^2} \sin\left(\frac{n\pi}{2}\right) \sin(\pi n t).$$

(a) Convert $f(t)$ into the complex exponential Fourier series form.

$f(t) =$

(b) If a LTIC system is governed by the differential equation $(D^2 + 4D + 2)y(t) = Df(t)$, derive its transfer function $H(s)$.

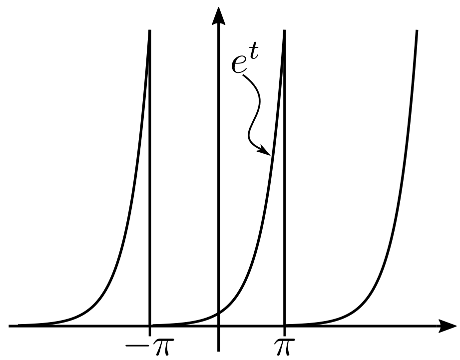
$H(s) =$

(c) Using this transfer function, determine the system response $y(t)$ if the input is $f(t)$.

$y(t) =$

5 Fourier derivation

(a) Find the complex Fourier series of function in the following figure. Please reduce your expression to its simplest form. Recalling hyperbollic functions $\sinh(t) = \frac{e^t - e^{-t}}{2}$ and $\cosh(t) = \frac{e^t + e^{-t}}{2}$ will be helpful.



$f(t) =$

(b) Find the Fourier transform of $f(t) = 2\text{sinc}(\pi t)\cos(\pi t)$. You may use tables or direct integration.

$F(\omega) =$

END OF EXAM