ECE 3210 Midterm 1

Week of: September 28, 2020

Student's name and section: ______________________________

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You have 15 hours 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.

This test is open notes, open book, and open calculator/Python. Consulting with any third party is considered cheating.

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) $(D^3 + 25D)y(t) = (D^2 + 5)f(t)$

(ii) $h(t) = e^{t/2}(u(t) - u(t - 10))$

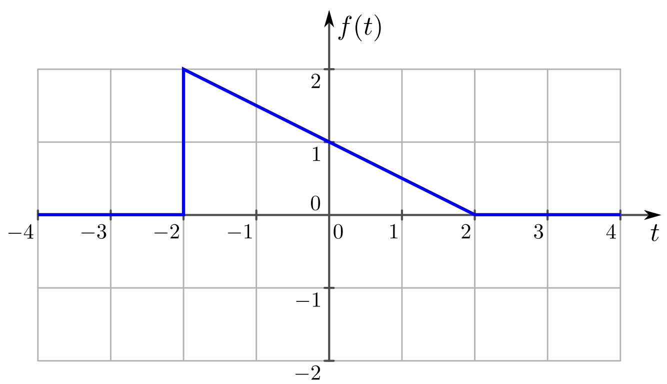
(iii) $(D^6 + 10D^5 + 49D^4 + 110D^3 + 94D^2 - 120D - 144)y(t) = D^2 f(t)$

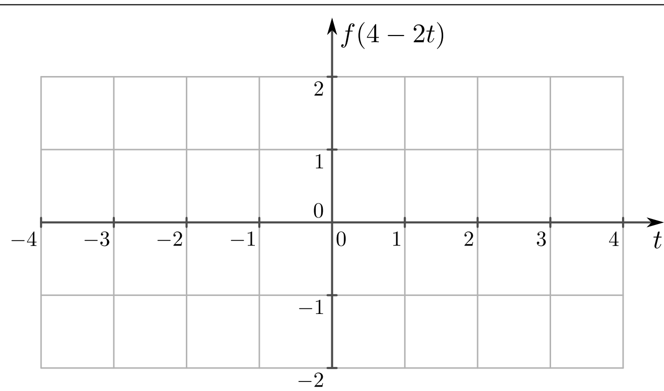
(i) (ii) (iii)

(c) True are false: are the polynomials $f_1(t) = t$, $f_2(t) = t^2$, and $f_3(t) = t^3$ mutually orthogonal on the interval $t \in [-1, 1]$?

True or False:

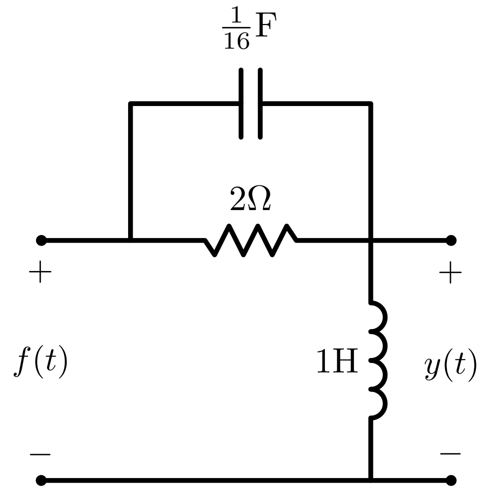
(d) Given $f(t)$ below, plot $f(4 - 2t)$.





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, just write the ODE in the form we have seen in class.

(b) Determine the zero-input response (we'll call it $y_2(t)$) for this system. Assume $y'(0) = 1$ and $y(0) = 0$.

$y_2(t) =$

(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, solve for $y(t)$ by performing the following convolutions.

(a) $y(t) = \sin(\pi t)u(t+1) * u(t-2)$

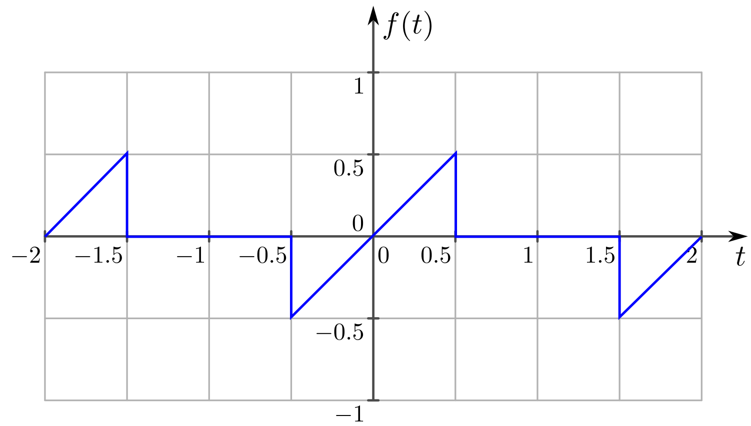
$y(t) =$

(b) $y(t) = 2(u(t+1) - u(t-1)) * e^{-t}(u(t-1) - u(t-4))$

$y(t) =$

4 Fourier series

(a) Derive the *complex exponential* Fourier series for $f(t)$ which is periodic and is shown below.



$f(t) =$

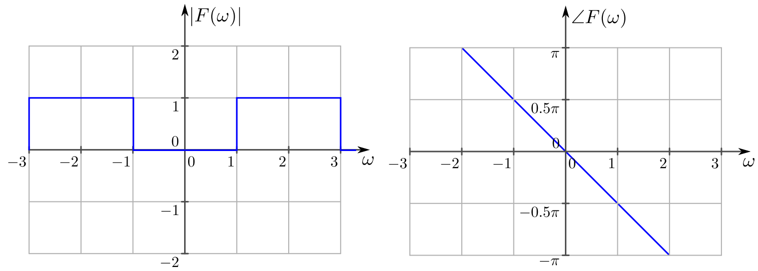
(b) Write a Python script to plot the Fourier series for $f(t)$. Include the first 50 harmonics (the summation go from -50 to +50). Plot over a time period $t \in [-2, 2]$. Please submit your code to Canvas with the PDF of your test. Name the file `LASTNAME_ece3210_mt1_q4.py`

5 Fourier transforms

(a) Find the Fourier transform for $f(t)$ which is defined piecewise

$$f(t) = \begin{cases} -t & -2 \leq t \leq 0 \\ t & 0 < t \leq 2 \\ 0 & \text{otherwise} \end{cases}$$

(b) Find the inverse transform $f(t)$ if $|F(\omega)|$ and $\angle F(\omega)$ are given below. Note: the phase $\angle F(\omega)$



extends linearly for all ω.

$f(t) =$