EEE2047S: Signals and Systems I

Class Test 1

15 September 2017

Name:

Student number:

Information

- The test is closed-book.
- This test has *four* questions, totaling 20 marks.
- There is an information sheet attached at the end of this paper.
- Answer *all* the questions.
- You have 45 minutes.

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1. (5 marks) Consider the system described by the input-output relationship

$$y(t) = \int_{-\infty}^{t} x(\tau - 2) d\tau,$$

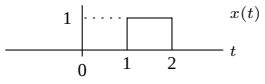
with $y(t)$ the output when $x(t)$ is the input.

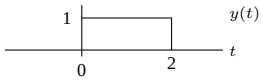
(a) Suppose you want to calculate $y(0)$. For what set of values of t do you need to know $x(t)$?

(b) Is this system causal? Why or why not?

(c) You don't need to show it, but the system is linear and time invariant. Find and sketch the impulse response $h(t)$, which is the output when the input is $x(t) = \delta(t)$.

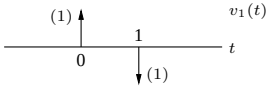
2. (5 marks) When the input to a LTI system is $x(t)$ below then the output is $y(t)$:



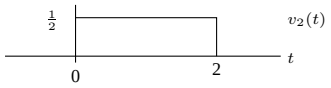


Find and plot the following:

(a) The output when the input is the signal $v_1(t)$ below:



(b) The output when the input is the signal $v_2(t)$ below:



3. (5 marks) This question has two independent parts:

(a) The signal

$$x(t) = \sin\left(\frac{7\pi t}{3} + \frac{\pi}{3}\right)$$

can be written in the form $x(t) = ce^{7\pi t/3} + c^* e^{-7\pi t/3}$, where c^* is the complex conjugate of c. Find c in polar form.

(b) The signal $w(t) = \delta(t-3)\frac{4-jt^2}{2t}$ can be written in the form $w(t) = k\delta(t-3)$ for some complex number k. Find k in rectangular form.

4. (5 marks) Let $x(t)$ be a periodic function, with fundamental frequency $\omega_0 = 4$ rad/s and with Fourier series in exponential form

$$x(t) = \sum_{k=-\infty}^{\infty} \frac{j|k|}{1+k^2} e^{4jkt} = \sum_{k=-\infty}^{\infty} c_k e^{4jkt}.$$

(a) What is the fundamental period of the signal?

(b) Plot the magnitude and phase of the Fourier series coefficients c_k over the range $k = -3$ to $k = 3$.

(c) What is the average value of the signal over one period?

(d) How much signal power is contained in the second harmonic?