EC401 HW08 Spring 2020

Due Date: Wednesday April 15, 2020

You must submit your homework in pdf form to the EC401 Blackboard Learn site by 12:30pm on the due date. Please be sure to write your name on the first page of the homework you submit. Additionally, if you have collaborated on the homework with other individuals enrolled in EC401 this semester, please identify them as your collaborators on the first page of the submitted homework.

HW08.1

Sketch the magnitude of the DTFT of each of the following periodic signals.

(a) $x[n] = \sum_{k=0}^{3}(0.5)^k e^{jk2\pi n/4}$
(b) $x[n] = \sum_{k=0}^{3}(0.5)^k \cos\left(\frac{2\pi n}{4}\right)$
(c) $x[n] = \sum_{k=0}^{3}(0.5)^k \cos\left(\frac{2\pi n}{4} + \frac{\pi}{3}\right)$
(d) $x[n] = 2 + (-1)^n$

HW08.2

For each of the parts of this problem, determine and sketch the *magnitude* of the continuous-time Fourier transform (CTFT) of the given signal. *Show your work*.

(a) $x(t) = u(t) - u(t-3)$

(b) $x(t) = u(t-1) - u(t-4)$

(c) $x(t) = u(t+2) - u(t-1)$

(d) $x(t) = u(t) - u(t-10)$

HW08.3

For each of the parts of this problem, determine the continuous-time Fourier transform (CTFT) of the given signal and sketch the *magnitude* of the CTFT. *Show your work.*

(a) $x(t) = e^{-2t}u(t)$

(b) $x(t) = e^{-2(t-3)}u(t-3)$

(c) $x(t) = (-1)^t$

(d) $x(t) = 1 + \cos\left(\frac{\pi t}{5}\right) + \cos\left(\frac{2\pi t}{5}\right) + \cos\left(\frac{3\pi t}{5}\right) + \cos\left(\frac{4\pi t}{5}\right)$

(e) $x(t) = \sin\left(\frac{\pi t}{5}\right) + \sin\left(\frac{2\pi t}{5}\right) + \sin\left(\frac{3\pi t}{5}\right) + \sin\left(\frac{4\pi t}{5}\right)$

(f) $x(t) = \cos\left(\frac{2\pi t}{5}\right)\sin\left(\frac{4\pi t}{5}\right)$

HW08.4

Throughout this problem, let $x(t)$ be a signal whose continuous-time Fourier transform (CTFT) is $X(j\omega)$.

(a) Show that the magnitude of the CTFT of $\cos(2000\pi t)$ is an even function of frequency.
(b) Show that the magnitude of the CTFT of $\sin(3000\pi t)$ is an even function of frequency.
(c) Show that if $x(t)$ is any *real* signal, then $X(j\omega)$ is an *even* function of frequency.
(d) Show that if $x(t)$ is any *real* and *even* signal, then $X(j\omega)$ is also *real* and *even*.
(e) Give an example of a real and even signal whose CTFT is a real and even function of frequency.
(f) Show that the CTFT of $e^{j1000\pi t}x(t)$ is $X(j(\omega - 1000\pi))$

HW08.5

Consider an LTI system **S** with impulse response $h(t) = u(t) - u(t-8)$

(a) Sketch and label the magnitude of the CTFT of $h(t)$.
(b) Determine and sketch the output of S when the input signal is $x(t) = 1$.
(c) Determine and sketch the output of S when the input signal is $x(t) = x\ (t) = \cos\ (\frac{\pi t}{4})$
(d) Determine and sketch the output of S when the input signal is $x(t) = \sin\ (1000\pi t)$
(e) Determine all values of ω_0 for which it is *guaranteed* that if the input to **S** is $x(t) = e^{j\omega_0 t}$, then the output of **S** is $y(t) \neq 0$. Justify your answer.
(f) Determine and sketch the magnitude of the CTFT of the output of S when the input signal is $x(t) = u(t-5) - u(t-13)$. Justify your answer.

HW08.6

Consider a system S with impulse response $h(t) = e^{-2t}u(t-3)$. If the input signal to the system S is $x(t) = u(t-2) - u(t-6)$ and the output signal is $y(t)$ with CTFT $Y(j\omega)$, determine all frequencies ω_0 for which $Y(j\omega_0)$ is zero. Justify your answer.