Signals and Systems

Assignment 4

Fall 2020

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Question 1

Given $x(t)$ with Fourier Transform $X(j\omega)$, determine the Fourier Transform for the following signals in terms of $X(j\omega)$

(a) $x_1(t) = x(5+t) - x(-t+4)$

(b) $x_2(t) = x(3t+1)$

(c) $x_3(t) = \frac{d^3}{dt^3}x(t-5)$

(d) $x_4(t) = tx(t-1)$

Question 2

Determine the Fourier Transform for the following signals:

(a) $x(t) = 2 + cos(3\pi t + \frac{\pi}{4})$

(b) $x(t) = te^{-4t}cos(2t)u(t)$

(c) $x(t) = t\frac{sin(3t)}{\pi t}$

(d) $x(t) = \frac{4t}{(1+t^2)^2}$

(e) $x(t) = e^{-3|t|}sin(2t)$

Question 3

Determine the inverse Fourier Transform for the following signals:

(a) $X(j\omega) = 3\delta(\omega + 4)$

(b) $X(j\omega) = \frac{-j\omega+5}{-\omega^2+10j\omega+21}$

(c) $X(j\omega) = \pi e^{-5|\omega|}$

Question 5

The input and the output of a stable causal LTI system are related by the following differential equation:

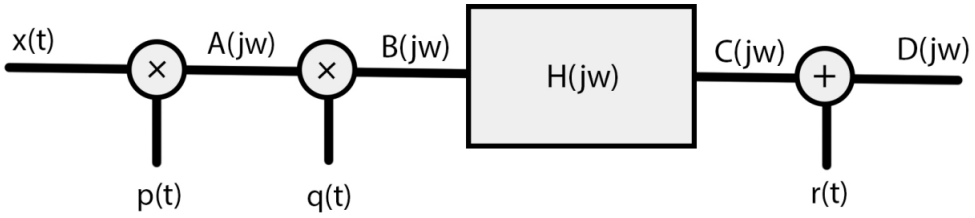
$$\frac{d^2}{dt^2}y(t) + \frac{d}{dt}y(t) - 12y(t) = 7x(t)$$

(a) Find the impulse response of this system.

(b) Determine $y(t)$ if $x(t) = te^{-4t}u(t)$

Question 6

Consider the following system (Do NOT mistake the plus sign with multiplication!). Determine $A(j\omega), B(j\omega), C(j\omega), D(j\omega)$



$$x(t) = p(t) = \frac{sin(2\pi t)}{\pi t}$$

$$q(t) = cos(4\pi t)$$

$$H(j\omega) = 2\Big(u(\omega + 2\pi) - u(\omega - 2\pi)\Big)$$

$$r(t) = \frac{sin(\pi t)}{\pi t}$$

Question 7

Given the following frequency response for the LTI and stable system S, determine the differential equation that relates the input $x(t)$ and the output $y(t)$ of S.

$$H(j\omega) = \frac{j\omega + 10}{98 - \omega^2 + 21j\omega}$$