EE 380 Control Engineering - I, Quiz# 1
Form-A

Name: Key *Student Number:*

Question-1 (2 marks): Write the transfer functions of the systems below. If it is not possible to do that, explain why, a, b, and c are constants:

1- $\ddot{x} + a\dot{x} + c \cdot x = u^2$ 2- $\ddot{x} = u$

① $\ddot{x} + a\dot{x} + cx = u^2$ is a nonlinear system (u^2). Nonlinear systems do not have transfer functions.

② $\ddot{x} = u$ is a linear system, it have a transfer function.

$\mathcal{L}[\ddot{x}] = \mathcal{L}[u]$ ∴ $s^2X(s) = U(s)$ ∴ $H(s) = \frac{X(s)}{U(s)} = \frac{1}{s^2}$.

Question-2 (2 marks): write down the answers of the following expressions:

Expression		***Answer***
1- $f(t)\cdot\delta(t) =$	....	$f(0)$ → sifting property
2- $f(t) * \delta(t - to)$	....	$f(t-t_o)$

Where * denotes convolution and · denotes multiplication.

Question-3 (2 marks): write down the partial fraction expansion of the following rational function:

function ***expansion***

$$\frac{S}{(S+1)^2} = \frac{A}{(S+1)^2} + \frac{B}{S+1} = \frac{A + B(S+1)}{(S+1)^2}$$

∴ $S = A + B(S+1)$ $S = -1$ ∴ $A = -1$

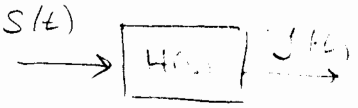
differentiate the above & substitute $S = -1$

$1 = 0 + B(0+1)$ $S = -1$ ∴ $B = 1$

$$\therefore \frac{S}{(S+1)^2} = \frac{-1}{(S+1)^2} + \frac{1}{S+1}$$

Question-4 (2 marks):A system has the transfer function H(S)=1/S. If the signal: S(t)=sin(4πt)+cos(6πt) is used as an input, write down the output signal.

$H(s) = \frac{1}{s}$ ∴ $H(\omega) = H(s)\big|_{s=j\omega} = \frac{1}{j\omega} = \frac{1}{\omega}\angle -90$

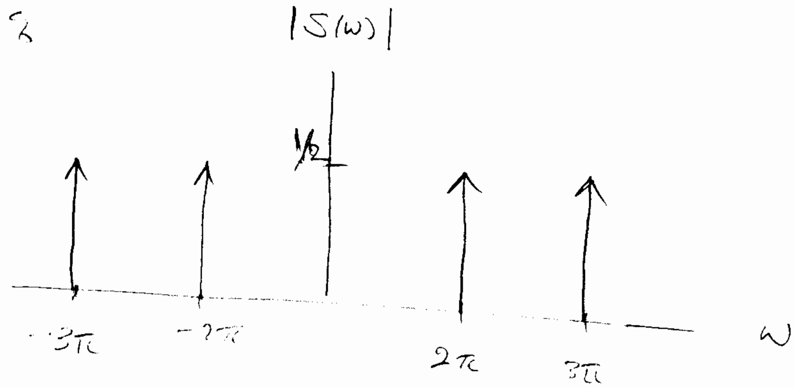


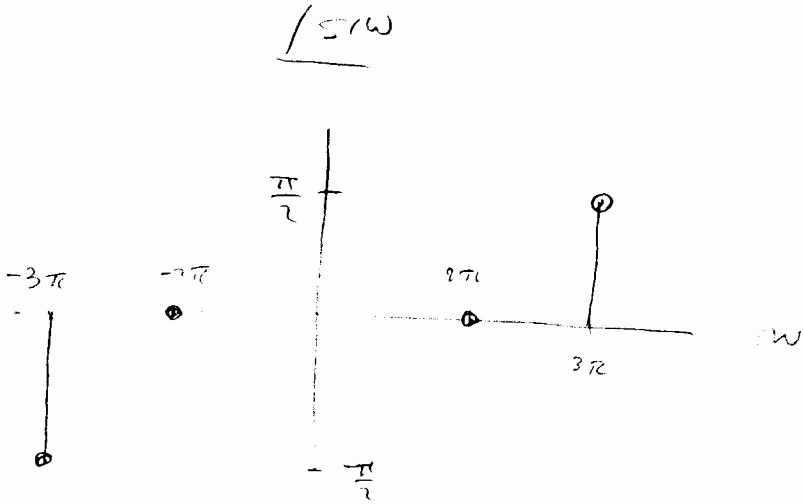
∴ $y(t) = \frac{1}{8\pi} \cdot \sin(4\pi t - 90) + \frac{1}{3\pi} \cos(6\pi t - 90)$

$= -0.16 \cdot \cos(4\pi t) + .106 \cdot \sin(6\pi t)$

Question-5 (2 marks): Draw the spectrum of the signal: S(t)=cos(4πt)+sin(6πt)

Spectrum:





EE 380 Control Engineering - I, Quiz# 1
Form-B

Name: Kay *Student Number:*

Question-1 (2 marks): Write the transfer functions of the systems below. If it is not possible to do that, explain why, a, b, and c are constants:

1- $x = au + c$ 2- $\ddot{x} + a\dot{x} + c \cdot x = u$

1) $x = au + c$ is not a linear system, therefore it doesn't have a transfer function.

2) $\ddot{x} + a\dot{x} + cx = u$ is a linear system,

$\mathcal{L}[\ddot{x} + a\dot{x} + cx] = \mathcal{L}[u] \Rightarrow s^2X(s) + asX(s) + CX(s) = U(s)$

so $\frac{X(s)}{U(s)} = \frac{1}{s^2 + as + c}$

Question-2 (2 marks): write down the answers of the following expressions:

Expression	Answer
1- $f(t) * \delta(t) =$	$f(t)$
2- $f(t) \cdot \delta(t - to)$	$f(t_o)$ → sifting property

Where * denotes convolution and · denotes multiplication.

Question-3 (2 marks): write down the partial fraction expansion of the following rational function:

function	expansion
$\frac{S}{(S-1)^2}$	$= \frac{A}{(S-1)^2} + \frac{B}{S-1} = \frac{A + B(S-1)}{(S-1)^2}$

$\therefore s = A + B(s-1)$ $\therefore$ $s = +1$ $A = 1$

differentiate the above:

$1 = 0 + B(1 - 0)$ $\therefore$ $B = 1$

$\therefore \frac{s}{(s-1)^2} = \frac{1}{(s-1)^2} + \frac{1}{s-1}$

Question-4 (2 marks):A system has the transfer function H(S)=1/S. If the signal: S(t)=cos(4πt)+sin(6πt) is used as an input, write down the output signal.

$$H(s) = \frac{1}{s} \quad \therefore \quad H(\omega) = H(s)\Big|_{s=j\omega} = \frac{1}{j\omega}$$

$$s(t) \longrightarrow \boxed{H(s)} \longrightarrow y(t)$$

$$\therefore \quad y(t) = \frac{1}{2\pi} \cos(4\pi t - 90) + \frac{1}{3\pi} \sin(6\pi t - 90)$$

$$= .16 \sin(4\pi t) - .106 \cos(6\pi t).$$

Question-5 (2 marks): Draw the spectrum of the signal: S(t)=sin(4πt)+cos(6πt)

spectrum: