HW13

Sunday, December 3, 2023 2:43 AM

$$H(s) = \frac{1}{s^3 + 0.4s^2 + 1.14s + 0.22}$$

Write the phase variable state model

$H(s) = \frac{y(s)}{u(s)}$

$\Rightarrow$ Split the system into Output = System • Input

$y(s) = H(s) \cdot u(s)$

$y(s)\left(s^3 + 0.4s^2 + 1.14s + 0.22\right) = u(s)$

$s^3 y(s) + 0.4 s^2 y(s) + 1.14 s\, y(s) + 0.22\, y(s) = u(s)$

$\Rightarrow$ Change to differential equation

$\dddot{y} + 0.4\ddot{y} + 1.14\dot{y} + 0.22\, y = u$

$\Rightarrow$ Define state variables $(q_1, \cdots q_n)$ n=highest order of s in a single input & single output system

$s^3 \Rightarrow q_1, q_2$ & q_3

$q_1 = y$
$q_2 = \dot{y}$
$q_3 = \ddot{y}$

} plant matrix

$\dot{q}_1 = q_2$

$\dot{q}_2 = q_3$

$\dot{q}_3 = \dddot{y} = -0.4\ddot{y} - 1.14\dot{y} - 0.22y + u$
$= -0.4q_3 - 1.14q_2 - 0.22q_1 + u$

$\Rightarrow$ Arrange $\dot{q}_1$, $\dot{q}_2$, & $\dot{q}_3$ in terms state-space variable

$\dot{q}_1 = 0 + q_2 + 0 + u$

$\dot{q}_2 = 0 + 0 + q_3 + u$

$\dot{q}_3 = 0.22 q_1 - 1.14 q_2 - 0.4 q_3 + u$

$$\begin{bmatrix} \dot{q}_1 \\ \dot{q}_2 \\ \dot{q}_3 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0.22 & -1.14 & -0.4 \end{bmatrix} \cdot \begin{bmatrix} q_1 \\ q_2 \\ q_3 \end{bmatrix} + \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix} \cdot u$$

$$y = \begin{bmatrix} 1 & 0 & 0 \end{bmatrix} \begin{bmatrix} q_1 \\ q_2 \\ q_3 \end{bmatrix}$$

```
>> syms z;
%Step defien the two transfer functions
H_1 = 0.2 / (1 + 0.5*z^(-1));
H_2 = (0.8 - 0.2*z^(-1)) / (1 - z^(-1) + 0.5*z^(-2));
%Step2 since the 2 TF are in parallel add the TF
H_z = H_1 + H_2
H = simplifyFraction(H_z)

H_z =

1/(5*(1/(2*z) + 1)) - (1/(5*z) - 4/5)/(1/(2*z^2) - 1/z + 1)


H =

(4*z^3)/((2*z + 1)*(2*z^2 - 2*z + 1))

>>
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% Name: Lamin Jammeh
% Class: EE480 Online
% Semster: Fall 2023
% HW_13

% Basic Problems
%% ********** 10.36c **********
clear;
clc;
syms z;
%Step defien the two transfer functions
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H_2 = (0.8 - 0.2*z^(-1)) / (1 - z^(-1) + 0.5*z^(-2));
%Step2 since the 2 TF are in parallel add the TF
H_z = H_1 + H_2
H = simplifyFraction(H_z)
```