In the Name of God

University of Tehran

Electrical and Computer Engineering faculty

Signals and Systems, Fall 95

Computer Assignment #4

Due Date: Monday, 4 Bahman 1395, 11:55 AM

Problem 1

1. Consider the differential equation $y'''(t) + y'(t) - 2y(t) = \delta(t)$ where $y(0) = 1, y'(0) = 3,$ $y''(0) = 1$, and $\delta(t)$ is the Dirac function.

   ❖ Provide all the following parts in one mfile.

   1.a) Use the Laplace transform to compute the solution of the differential equation ($y(t)$).

   ❖ Read the PDF files about differential equations.

   1.b) Find the Transfer function $H(s) = Y(s)/X(s)$, then insert the numerator and denominator coefficients in vectors *num* and *den.*

   1.c) Define the transfer function using ‘’*H=tf(num,den)*’’ command.

   1.d) Define the transfer function in zero/pole/gain form using ‘’*H2=*’’*zpk(H)*’’ command.

   1.e) Find the roots of the numerator and the denominator of the transfer function using ‘’z=*roots(num)*’’ and ‘’p=*roots(den)*’’ commands.

   1.f) Repeat part 1.e) using ‘’[z,p,k]=*tf2zp*’’command, then do the reverse using ‘’[n,d]=*zp2tf(z,p,k)*’’command.

   1.g) Check the stability using ‘’*pzmap(H or H2)*’’or ‘’*pzmap(num,den)*’’ command.

   1.h) Find the frequency response of the transfer function using ‘’Hw=*freqresponse(H or H2,ω)*’’ command which ω is the frequency duration ($-10 \le \omega \le 10$) and then Plot (amplitude and phase) it.

   1.i) Plot the step and impulse response of the system using ‘’*step(H or H2 or num,den,t)*’’ and ‘’*impulse(H or H2 or num,den,t)*’’ commands ($-10 \le t \le 10$).

2. Consider the difference equation $y[n] - 3y[n-1] + y[n-2] = x[n] - x[n-1]y'(t)$, where $x[n] = 0.9^n u[n]$, and the initial conditions are $y[-1] = -1, y[-2] = -2$.

   ❖ Provide all the following parts in one mfile.

2.a) Use the z-transform to compute the solution of the difference equation ($y(t)$).

❖ Read the PDF files about difference equations.

2.b) Find the Transfer function $H(Z) = Y(Z)/X(Z)$, then insert the numerator and denominator coefficients in vectors *num* and *den.*

2.c) Define the transfer function using ‘’*H=tf(num,den,ts)*’’ command, and *ts* is the sampling time.

2.d) Define the transfer function in zero/pole/gain form using ‘’*H2=*‘’*zpk(H)*’’ command.

2.e) Find the roots of the numerator and the denominator of the transfer function using ‘’z=*roots(num)*’’ and ‘’p=*roots(den)*’’ commands.

2.f) Repeat part 2.e) using ‘’[z,p,k]=*tf2zp*’’command, then do the reverse using ‘’[n,d]=*zp2tf(z,p,k)*’’command.

2.g) Check the stability using ‘’*pzmap(H or H2)*’’or ‘’*pzmap(num,den)*’’ command.

2.h) Find the frequency response of the transfer function using ‘’Hw=*freqresponse(H or H2,ω)*’’ command which ω is the frequency duration ($-10 \leq \omega \leq 10$) and then Plot (amplitude and phase) it.

❖ Plot the results of the next part in the one figure using subplot.

2.i) Plot the step response of the system using the following steps

```
dstep(num,den)
```

and

```
S=dstep(num,den)
stairs(0:length(s)-1,s);
legend('Step response')
```

and

```
n=0:80;
s=dstep(num,den,n);
stairs(n,s)
legend('Step response')
```

and

```
stepz(num,den)
```

❖ Plot the results of the next part in the one figure using subplot.

2.j) Plot the impulse response of the system using the following steps

```
dimpulse(num,den)
```

and

```
h=dimpulse(num,den);

stairs(0:length(h)-1,h)

legend('Impulse response')
```

and

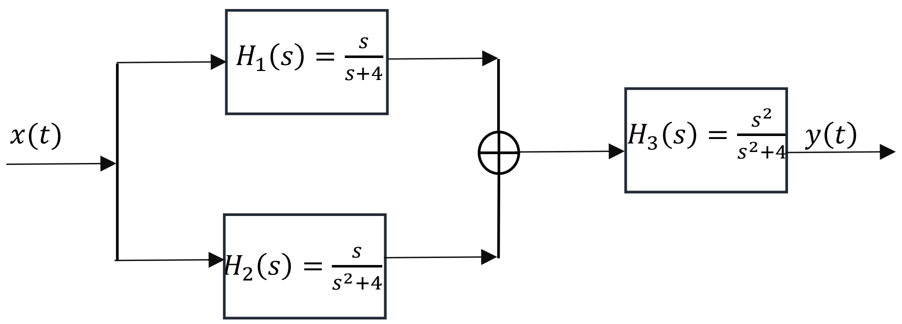
```
n=0:50;

y=dimpulse(num,den,n);

stairs(n,y)

legend('h[n]')
```

and

```
impz(num,den)
```

Problem 2

Consider the system that is shown in the figure below.



Use commands, ''*tf*'', ''*parallel*'', ''*series*'', to define every system and then combine them. Then use the command ''*printsys*'' to print the derived coefficients in rational form.

1. Compute the transfer function ($H(s)$) of the system that is shown in the above figure.
2. Compute and plot the system response $y(t)$ to the input signal $x(t) = \cos(2\pi t)\,, 0 \leq t \leq 10$ using command ''*lsim(H,x,t)*''

Problem 3

Compute the response of the discrete-time system with transfer function $H(z) = \frac{0.1z-0.1}{z^2-1.5z+0.7}$

to the input signal $x[n] = (-1)^n, 0 \le n \le 50$.

Use command ''*filter(num,den,x)*''.