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| **1.(20%)**  Consider a causal LTI system for which the input and output are related by the difference equation *y*[*n*] = *ay*[*n* − 1] + *x*[*n*] − *aNx*[*n* − *N*], where *N* is a positive integer.  (a) Derive analytically and sketch (write a MATLAB program to plot it) a plot of the impulse response of this system. Hint: Use linearity and time‐invariance to simplify the solution.  (b) Is the system in part (a) an FIR or an IIR system? Explain.  (c) For what values of *a* is the system stable? Explain.  (d) Write two brief MATLAB programs (really just single statements) that implement the system in part (b) for a = 0.8 and N=10. One program should use filter( ) and the other should use conv( ). Test your programs with an impulse input to verify that they produce the same impulse response |
| (a)  a=0.8;N=10;  B=[1 0 0 0 0 0 0 0 0 0 a^N];  A=[1 -a];  n = 0:9;  x = (n==0);  y=filter(B,A,x);  stem(n,y,'linewidth',2)  xlabel('n');  ylabel('y');    (b)  FIR system ,因為h[n]取傅立葉轉換後沒有nonzero pole。  (c)  a<1 ,若系統穩定，則收斂半徑須包含到單位圓。此系統的收斂半徑為∣z∣>a，因此，當a<1時，收斂半徑包含到單位圓，系統穩定。  (d)  a=0.8;N=10;  n = 0:9;  x = (n==0);  for i=0:9  h(i+1)=a^i;  end  y = conv(x,h);  stem(y,'linewidth',2)  xlabel('n');  ylabel('y'); |
| **2.(20%)**  Use the built‐in functions filter( ) and freqz( ) of MATLAB to compute 51 samples of the impulse response and frequency response of the system defined by the difference equation  *y*[*n*] *=* 1.7163*y*[*n −* 1] *−* 1.1724*y*[*n −* 2] *+* 0.2089*y*[*n −* 3] *+*0.5264*x*[*n*] *−* 1.5224*x*[*n −* 1] *+* 1.5224*x*[*n* − 2] *−* 0.5264*x*[*n* − 3].  (To compute the impulse response, make an input vector for filter( ) consisting of one unit sample followed by 50 zero samples). Hand in a stem( ) plot of the impulse response. Use subplot( ) and plot( ) to make a two panel plot of the magnitude and phase of the frequency response |
| B=[-1.5224,1.5224,-0.5264];  A=[1,-1.7163,1.1724,-0.2089];  n = 0:50;dw=2\*pi/50;w = -pi:dw:pi-dw;  x = (n==0); %impluse function  subplot(3,1,1);  y=filter(B,A,x);  stem(n,y,'linewidth',2)  title('impulse response')  xlabel('n');ylabel('y');  subplot(3,1,2);  H=freqz(B,A,w);  mag=abs(H); phase=angle(H);  plot(w,20\*log10(mag))  title('Magnitude ')  xlabel('Frequency (rad/s)')  ylabel('Magnitude (dB)')  subplot(3,1,3);  plot(w,(phase\*180/pi()))  title('Phase')  xlabel('Frequency (rad/s)')  ylabel('Phase (degree)') |
| **3. (10%)**  Write a MALLAB program (using residuez, filter, conv, etc.) to solve 101 points (plot *y*[*n*]) of the *y*[*n*], *n*>= 0 of following difference equation:  *y*[*n*] = (1/3){*x*[*n*] + *x*[*n*-1] + *x*[*n*-2]} + 0.95*y*[*n*-1] - 0.9025*y*[*n*-2], where *x*[*n*] = cos(*n*/3)*u*[*n*] and *y*[-1] = -2, *y*[-2] = -3, *x*[-1] = 1 and *x*[-2] = 1. Use subplot to plot the *x*[*n*] and *y*[*n*]. |
| n=0:100;  for t=0:100  x(t+1)=cos(pi()/3\*t);  end  B0=[1/3 ,1/3 ,1/3];  A0=[1,-0.95,0.9025];  B1=conv([1.474,2.14],[1,-1.732,1]);  A1=conv([1,-0.866],[1,-0.95,0.9025]);  B=conv(B0,A1)+conv(A0,B1);  A=conv(A0,A1);  y=filter(B,A,x);  subplot(2,1,1);  stem(n,x,'linewidth',1)  title('x[n]')  xlabel('n');  ylabel('x');  subplot(2,1,2);  stem(n,y,'linewidth',1)  title('y[n]')  xlabel('n');  ylabel('y'); |
| **4. (10%)**  Consider the following LCCDE:  y[n] = 2 cos(**0)y[n − 1] − y[n − 2],  with no input but with initial conditions y[−1] = 0 and y[−2] = −A sin(**0).   1. Show that the solution of the above LCCDE is given by the sequence   y[n] = A sin[(n + 1)**0]u[n]. This system is known as a digital oscillator.  (b) For A = 2 and **0 = 0.1π, verify the operation of the above digital oscillator using MATLAB |
| (a)  (b)  A = 2;  w0 = 0.1\* pi();  n=0:100;  for t=0:100  y(t+1)=A \* sin(w0 \* t);  end  subplot(2,1,1);  stem(n,y,'linewidth',1)  title('x[n]')  xlabel('n');  ylabel('x'); |
| **5.(20%)**  Consider the 3rd-order IIR systems function: . Use Matlab functions or write Matlab programs to answer the following problems.   1. Write a MATLAB program to determine the poles and zeros of this system function and plot them in the *z*‐plane. What is the region of convergence for this system function? (roots(),zplane()) 2. From the pole‐zero plot, sketch the log‐magnitude of the frequency response, phase response, and group delay for  in [0,2] of this system as accurately as is possible. (freqz(), grpdelay()) 3. Use the MATLAB conv( ) to obtain third‐order polynomials for the numerator and denominator and then use freqz( ) to evaluate and plot the log‐magnitude of the frequency response. Compare to your answer in part (b). 4. Make partial fraction expansion of *H*(*z*). (residuez()) 5. Compute and plot the impulse response of the system using the function impz(b,a,L). Try and pick suitable L (length) to plot the impulse response. |
| (a)  B0=[0.05634,0.05634];  B1=[1,-1.0166,1];  A0=[1,-0.683];  A1=[1,-1.4461,0.7957];  B=conv(B0,B1);  A=conv(A0,A1);  Z=roots(B)  P=roots(A)  zplane(B,A)    Z =  0.5083 + 0.8612i  0.5083 - 0.8612i  -1.0000 + 0.0000i  P =  0.7230 + 0.5224i  0.7230 - 0.5224i  0.6830 + 0.0000i  ROC: ∣z∣>0.8  (b)  syms H(z);  syms h(n);  H(z)=(0.05634\*(1+z^(-1))\*(1-1.0166\*z^(-1)+z^(-2)))/((1-0.683\*z^(-1))\*(1-1.4461\*z^(-1)+0.7957\*z^(-2)));  h(n)=iztrans(H,z,n);  n=0;  h1=double(h(0:800));  B0=[0.05634,0.05634];  B1=[1,-1.0166,1];  A0=[1,-0.683];  A1=[1,-1.4461,0.7957];  B=conv(B0,B1);  A=conv(A0,A1);  Z=roots(B)  P=roots(A)  zplane(B,A)  [H,w1] =freqz(h1,801,'whole');  mag=abs(H);  subplot(3,1,1);  plot(w1,20\*log10(mag))  title('Magnitude ')  xlabel('Frequency (rad/s)')  ylabel('Magnitude (dB)')  subplot(3,1,2);  phase=angle(H);  plot(w1,(phase\*180/pi()))  title('Phase')  xlabel('Frequency (rad/s)')  ylabel('Phase (degree)')  subplot(3,1,3);  sos = zp2sos(Z,P,0.05634)  grpdelay(sos,300);  title('group delay ')  xlabel('Frequency (rad/s)')  ylabel('Group and phase delays')    (c)  B0=[0.05634,0.05634];  B1=[1,-1.0166,1];  A0=[1,-0.683];  A1=[1,-1.4461,0.7957];  B=conv(B0,B1);A=conv(A0,A1);  [H,w1] =freqz(B,A,'whole',2001);  mag=abs(H);  plot(w1,20\*log10(mag))  title('Magnitude ')  xlabel('Frequency (rad/s)')  ylabel('Magnitude (dB)')    (d)  B0=[0.05634,0.05634];  B1=[1,-1.0166,1];  A0=[1,-0.683];  A1=[1,-1.4461,0.7957];  B=conv(B0,B1);A=conv(A0,A1);  [r,p,k] = residuez(B,A);  r =  -0.1153 - 0.0182i  -0.1153 + 0.0182i  0.3905 + 0.0000i  p =  0.7230 + 0.5224i  0.7230 - 0.5224i  0.6830 + 0.0000i  k =  -0.1037  H(z)= + + - 0.1037  (e)  B0=[0.05634,0.05634];  B1=[1,-1.0166,1];  A0=[1,-0.683];  A1=[1,-1.4461,0.7957];  B=conv(B0,B1);A=conv(A0,A1);  [r,p,k] = residuez(B,A);  impz(B,A,60); |
| **6. (20%)**  Consider the impulse response sequence *h*[*n*]=*Arn*cos(**0*n*+**)*u*[*n*]. Use Matlab to study its *z*-transform.   1. Write a Matlab function [b,a]=coef(A,r,omega0,phi),which can compute the coefficient vectors of this system. 2. Use your coef() function and filter() to compute the impulse response of this system. Compare the result with that directly computed by the *h*[*n*] equation. Plot both of them for *A*=20, *r*=0.95, **0=2/17, ** =/4. 3. Use the values [R,P,K] returned by the function [R,P,K]=residuez(b,a) to compute and plot the impulse response over the interval 0 ≤ *n* ≤ 50, and compare it to the results of part (b).   Use freqz() to plot the frequency response of this system. |
| (a)  function [b,a] = coef(A,r,omega0,phi)  b=[A\*cos(phi) ,A\*r\*cos(omega0-phi)];  a=[1,-2\*r\*cos(omega0),r^2];  end  (b)  A=20; r=0.95; omega0=2\*pi/17; phi =pi/4;  [b,a]=coef(A,r,omega0,phi);  n=0:50;x=(n==0);  y = filter(b,a,x);  subplot(2,1,1)  stem(n,y,'linewidth',2)  title('coef()+filter()')xlabel('n')ylabel('h')  syms h(i);  h(i)=A\*(r)^(i)\*cos(omega0\*i+phi);  h1=double(h(0:50));  subplot(2,1,2)  stem(n,h1,'linewidth',2)  title('directly computed')xlabel('n')ylabel('h')    (c)  A=20; r=0.95; omega0=2\*pi/17; phi =pi/4;  [b,a]=coef(A,r,omega0,phi);  [R,P,K]=residuez(b,a);  syms H(z);  syms h(n);  H(z)=(R(1))/(1-P(1)\*z^(-1))+(R(2))/(1-P(2)\*z^(-1));  h(n)=iztrans(H,z,n);  i=0:50;  h1=double(h(i));  stem(i,h1,'linewidth',2) |