# EE655 – Adaptive Algorithms Homework Assignment #3

a)

clear

close all

h=rcosine(1,4,'sqrt',0.5,6); % Shaping Filter

h=h/max(h); % Normalize Shaping Filter

h2=reshape([h 0 0 0],4,13); % Reshape Shaping Filter

N\_dat=1000;

x0=(floor(2\*rand(1,N\_dat))-0.5)/0.5+j\*(floor(2\*rand(1,N\_dat))-0.5)/0.5;

x1=zeros(1,4\*N\_dat);

reg=zeros(1,13);

% form Modulator Output

m=0;

for n=1:N\_dat

reg=[x0(n) reg(1:12)];

for k=1:4

x1(m+k)=reg\*h2(k,:)';

end

m=m+4;

end

% form Demodulator Output

x4=filter(h,1,x1)/(h\*h'); % no noise, No Channel

subplot(2,2,1)

plot(1:100,real(x1(1:4:400)),'ro')

title('Real part of first 100 symbols at modulator output')

subplot(2,2,2)

plot(1:100,real(x4(1:4:400)),'ro')

title('Real part of first 100 symbols at matched filter output')

subplot(2,2,3)

plot(x1(1:4:end),'ro')

grid on

axis('square')

title('Constellation diagram at modulator output')

subplot(2,2,4)

plot(x4(1:4:end),'ro')

grid on

axis('square')

title('Constellation diagram at matched filter output')

## b)

x2=filter([1 0 0 0 0.2 0 0 j\*0.1],1,x1);

x3=x2+0.00\*(randn(1,4\*N\_dat)+j\*randn(1,4\*N\_dat))/sqrt(2);

x4=filter(h,1,x3)/(h\*h'); % with noise and Channel

xc=filter(h,1,x3)/(h\*h'); % with Channel

figure

subplot(2,12,1:6)

plot(1:100,real(x2(1:4:400)),'k')

title('Real part of first 100 symbols at channel output')

subplot(2,12,7:12)

plot(1:100,real(xc(1:4:400)),'k')

title('Real part of first 100 symbols at matched filter output (with channel)')

subplot(2,12,13:16)

plot(x1(1:4:end),'ro')

grid on

axis('square')

title('Constellation diagram at modulator output')

subplot(2,12,17:20)

plot(x2(1:4:end),'ro')

grid on

axis('square')

title('Constellation diagram at channel output')

subplot(2,12,21:24)

plot(xc(1:4:end),'ro')

grid on

axis('square')

title('Constellation diagram at matched filter output (with channel)')

## c)

reg=zeros(1,40);

wts=zeros(1,40);

wts(4+0)=1;

mu=0.002;

m=1;

err\_sv=zeros(1,N\_dat);

for n=1:4\*N\_dat

x5(n)=reg\*wts';

if n>40 && rem(n,4)==1

xd=sign(real(x5(n)))+j\*sign(imag(x5(n)));

xe=xd-x5(n);

err\_sv(m)=xe;

m=m+1;

wts=wts+mu\*reg\*conj(xe);

end

reg=[x4(n) reg(1:39)];

end

figure

subplot(2,2, [1 2])

plot(0:length(err\_sv)-1,abs(err\_sv))

title('Learning Curve of Equalizer')

subplot(2,2,3)

plot(1:100,real(x5(1:4:400)))

title('Time Series of Equalizer (first 100 samples)')

subplot(2,2,4)

plot(x5(1:4:1000),'bo')

grid on

axis('square')

hold on

plot(x5(1001:4:end),'ro')

title('Constellation Diagram of Equalizer')

## d)

figure

subplot(3,1,1)

plot(real(x2(1:4:end)),'ro')

title('1000 symbols at channel output')

subplot(3,1,2)

plot(real(x4(1:4:end)),'ro')

title('1000 symbols at matched filter output')

subplot(3,1,3)

plot(real(x5(1:4:end)),'ro')

title('1000 symbols at equalizer output')