Digital Signal Processing MATLAB HW - q1

Table of Contents

Professor: Dr. Sheikhzadeh Author: [SeyedAli] - [SeyedHosseini] E-mail: [alisnake@aut.ac.ir] %which I`m about to change ASAP University: Amirkabir University of Technology

Clear recent data

```
clear; close all; clc;
```

Verifying By Matlab(Part B)

```
%define parameters
%times
n1 = -15:35;
n2 = 0:25;
n3 = -10:10;
%signals
x11 = cos(pi*n1 / 4);  %cosine part
[x12,n12] = stepseq(-5,-15,35); %step plot : u(n+5)
[x13,n13] = stepseq(25,-15,35); %step plot : u(n-25)
[x14,n14] = sigadd(x12,n12,-x13,n13); %step plot : u(n+5) - u(n-25)
x1 = x11.*x14; % x1(n) = cos(pi*n/4) * {u(n+5) - u(n-25)}
x21 = 0.9 .^ -n2; %exponential part
[x22,n22] = stepseq(0,0,25);  %step plot : u(n)
[x23,n23] = stepseq(20,0,25); %step plot : u(n-20)
x24 = x22 - x23;   %step plot : u(n) - u(n-20)
x2 = x21.*x24;  %x2(n) = (0.9^-n ) * {u(n) - u(n-20)}
w = -1 + (1+1)*rand(1,20); %randomly w(n)
x3 = round(w.*5); %x(3) = round[5w(n)]
```

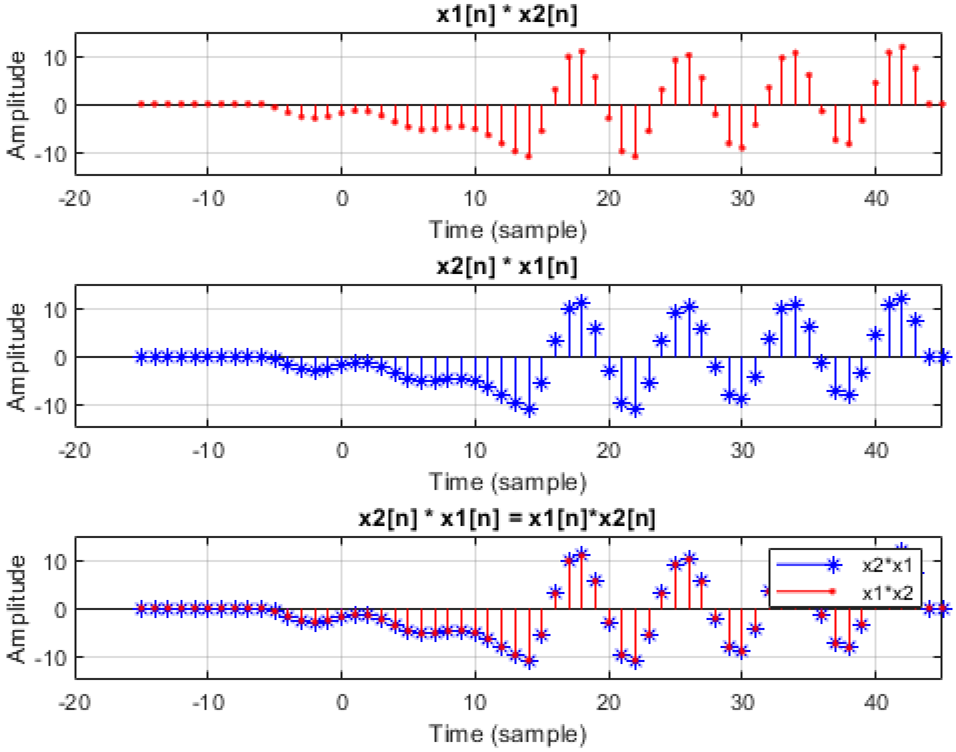
Commutative property

To prove the Commutation property of convolution we must prove that : x1(n)*x2(n) = x2(n)* x1(n) calculate convolution

```
[yc1,nyc1] = conv_m(x1,n1,x2,n2);  %x1(n) * x2(n)
[yc2,nyc2] = conv_m(x2,n2,x1,n1);  %x2(n) * x1(n)
ycdiff = max(abs(yc1 - yc2));
display("y diff is :")
display(ycdiff)
display("so they are equal")
```

plotting Commutative property

```
clc;
figure(1);
subplot(3, 1, 1);
stem(nyc1 , yc1 , 'r.');
grid on;
axis([-20 45 -15 15]);
title("x1[n] * x2[n]");
xlabel('Time (sample)');
ylabel('Amplitude');

subplot(3, 1, 2);
stem(nyc2 , yc2 , 'b*');
grid on;
axis([-20 45 -15 15]);
title("x2[n] * x1[n]");
xlabel('Time (sample)');
ylabel('Amplitude');

subplot(3, 1, 3);
stem(nyc2 , yc2 , 'b*');
hold on;
stem(nyc1 , yc1 , 'r.');
grid on;
axis([-20 45 -15 15]);
title("x2[n] * x1[n] = x1[n]*x2[n]");
xlabel('Time (sample)');
ylabel('Amplitude');
legend('x2*x1','x1*x2')
```



Association property

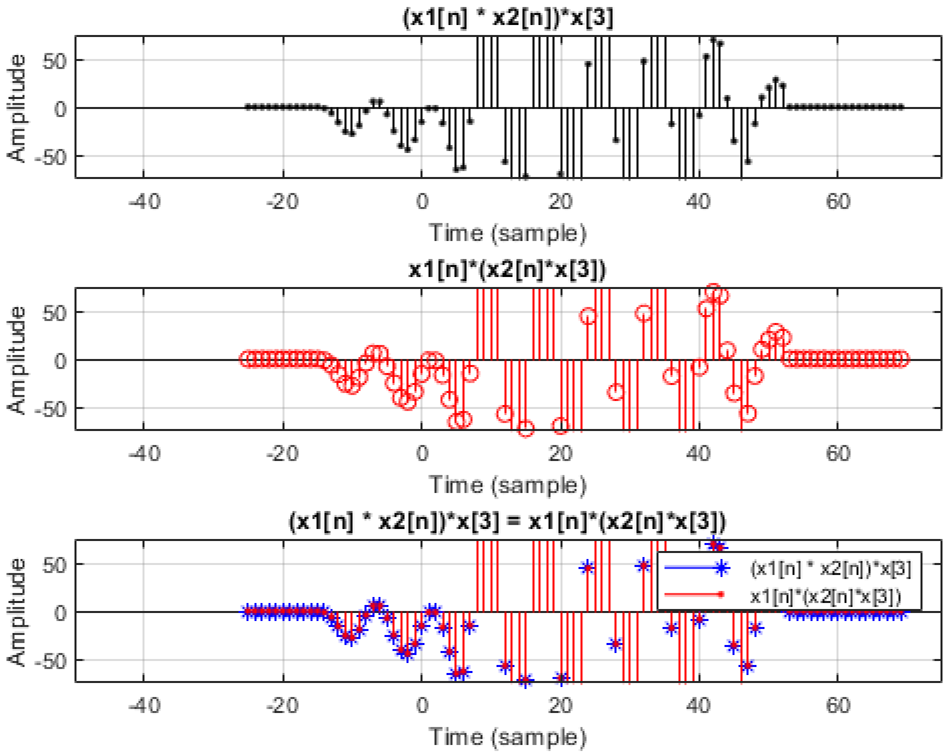
To prove the Association property of convolution we must prove that : (x1(n)*x2(n))*x3(n) = x1(n)*(x2(n)*x3(n))

```
[ya1,nya1] = conv_m(x1,n1,x2,n2);  %y1(n) = x1(n) * x2(n)
[ya1,nya1] = conv_m(ya1,nya1,x3,n3); %y1(n) = y1(n) * x3(n) = (x1(n) * x2(n))*x3(n)
[ya2,nya2] = conv_m(x2,n2,x3,n3);  %y2(n) = x2(n) * x3(n)
[ya2,nya2] = conv_m(x1,n1,ya2,nya2); %y2(n) = y2(n) * x1(n) = x1(n)*(x2(n) * x3(n)) for associations
ydiff2 = max(abs(ya1 - ya2));
display("y_association diff2 is :")
display(ydiff2)
display("so they are equal")
```

```
    "y_association diff2 is :"


ydiff2 =

   1.1369e-13

    "so they are equal"
```

plotting Association property

```
figure(2);
subplot(3, 1, 1);
stem(nya1 , ya1 , 'k.');
grid on;
axis([-50 75 -75 75]);
title("(x1[n] * x2[n])*x[3]");
xlabel('Time (sample)');
ylabel('Amplitude');

subplot(3, 1, 2);
stem(nya2 , ya2 , 'r');
grid on;
axis([-50 75 -75 75]);
title("x1[n]*(x2[n]*x[3])");
xlabel('Time (sample)');
ylabel('Amplitude');

subplot(3, 1, 3);
stem(nya2 , ya2 , 'b*');
hold on;
stem(nya1 , ya1 , 'r.');
grid on;
axis([-50 75 -75 75]);
title("(x1[n] * x2[n])*x[3] = x1[n]*(x2[n]*x[3])");
xlabel('Time (sample)');
ylabel('Amplitude');
legend("(x1[n] * x2[n])*x[3]","x1[n]*(x2[n]*x[3])")
```



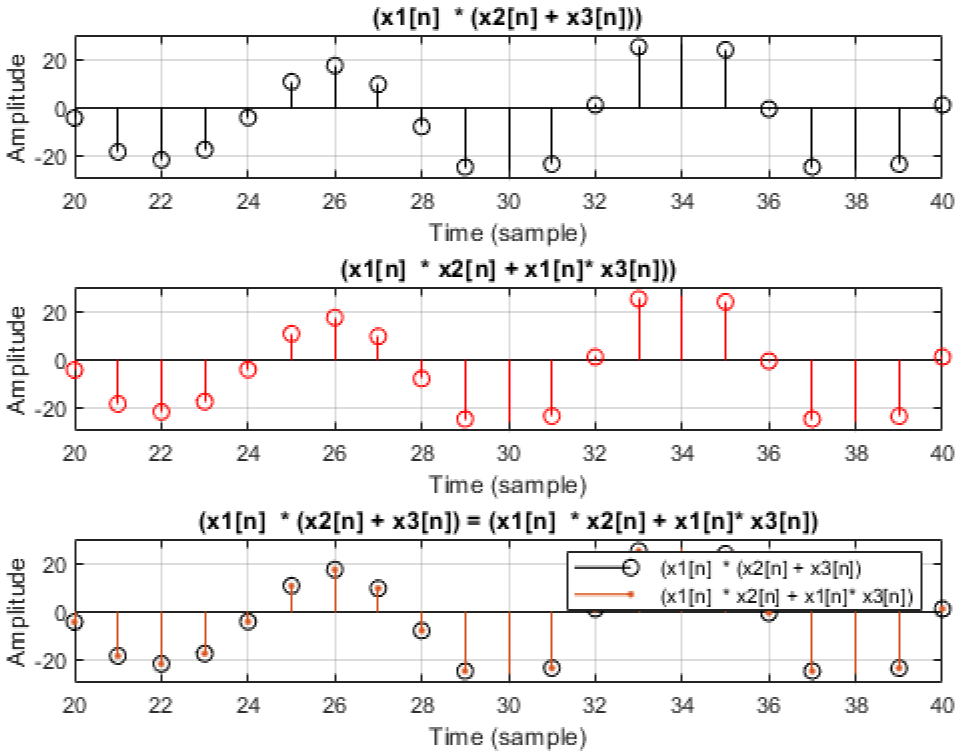
Distribution

```
clc;
x3(end+1 : length(x2)) = 0;
y1d = x3 + x2;
yd1 = conv(x1,y1d); %yd1 = x1[n] * (x2[n] + x3[n])
yd2 = conv(x1,x2) + conv(x1,x3); %y2d = x1[n]*x2[n] + x1[n]*x3[n]
ydiffD2 = max(abs(yd1 - yd2));
display("y_association diff2 is :")
display(ydiffD2)
display("so they are equal")
n3(end+1 : length(yd1)) = 0;
```

```
    "y_association diff2 is :"


ydiffD2 =

   7.1054e-15

    "so they are equal"
```

Plotting Distribution

```
figure(3);
subplot(3, 1, 1);
stem( yd1 , 'k');
grid on;
axis([20 40 -30 30]);
title("(x1[n]  * (x2[n] + x3[n]))");
xlabel('Time (sample)');
ylabel('Amplitude');

subplot(3, 1, 2);
stem( yd2 , 'r');
grid on;
axis([20 40 -30 30]);
title("(x1[n]  * x2[n] + x1[n]* x3[n]))");
xlabel('Time (sample)');
ylabel('Amplitude');

subplot(3, 1, 3);
stem(yd1 , 'k');
hold on;
stem(yd2, '.');
grid on;
axis([20 40 -30 30]);
title("(x1[n]  * (x2[n] + x3[n]) = (x1[n]  * x2[n] + x1[n]* x3[n])");
xlabel('Time (sample)');
ylabel('Amplitude');
legend("(x1[n]  * (x2[n] + x3[n])" ,"(x1[n]  * x2[n] + x1[n]* x3[n])")
```



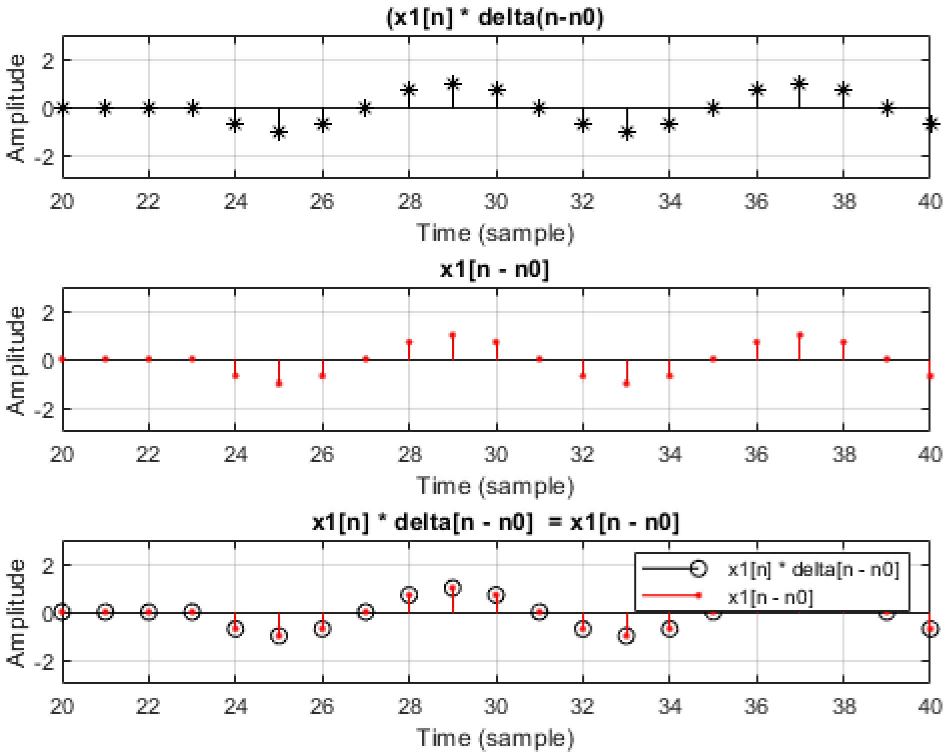
Identity property

```
clc;
% To prove the Identity property of convolution
% (x(n)*delta(n - n0)) = x(n - n0)
n0 = ceil(50*rand(1,1)-0.5);
[dl,ndl] = impseq(n0,n0,n0); %delta(n - n0)
[yI11,nyI11] = conv_m(x1,n1,dl,ndl); % y1 = x1(n) * delta(n- n0)
[yI12,nyI12] = sigshift(x1,n1,n0);  % y2 = x1(n-n0)
yI1diff = max(abs(yI11 - yI12));
display("y_Identity diff2 is :")
display(yI1diff)
display("As we see, they are equal")
```

Plotting the Identity

```
figure(4);
subplot(3, 1, 1);
stem(nyI11 , yI11 , 'k*');
grid on;
axis([20 40 -3 3]);
title("(x1[n] * delta(n-n0)");
xlabel('Time (sample)');
ylabel('Amplitude');
```

```
subplot(3, 1, 2);
stem(nyI12 , yI12 , 'r.');
grid on;
axis([20 40 -3 3]);
title("x1[n - n0]");
xlabel('Time (sample)');
ylabel('Amplitude');

subplot(3, 1, 3);
stem(nyI11 , yI11 , 'k');
hold on;
stem(nyI12 , yI12 , 'r.');
grid on;
axis([20 40 -3 3]);
title("x1[n] * delta[n - n0]  = x1[n - n0]");
xlabel('Time (sample)');
ylabel('Amplitude');
legend("x1[n] * delta[n - n0]" ,"x1[n - n0]")
```



Func (Convolution in two dimentions)

```
function [y,ny] = conv_m(x,nx,h,nh)
% Modified convolution routine for signal processing
% --------------------------------------------------
% [y,ny] = conv_m(x,nx,h,nh)
% [y,ny] = convolution result
% [x,nx] = first signal
% [h,nh] = second signal
%
nyb = nx(1)+nh(1); %begining point of y(n)
nye = nx(length(x)) + nh(length(h)); %end point of y(n)
ny = [nyb:nye];
y = conv(x,h);
end
```

```
    "y diff is :"


ycdiff =

     0

    "so they are equal"
```

Function Adding two Signals

```
function [y,n] = sigadd(x1,n1,x2,n2)
% implements y(n) = x1(n)+x2(n)
% -----------------------------
% [y,n] = sigadd(x1,n1,x2,n2)
% y = sum sequence over n, which includes n1 and n2
% x1 = first sequence over n1
% x2 = second sequence over n2 (n2 can be different from n1)
%
n = min(min(n1),min(n2)):max(max(n1),max(n2)); % duration of y(n)
y1 = zeros(1,length(n1));  % initialization
y2 =zeros(1,length(n2)); % initialization
y1(find((n>=min(n1))&(n<=max(n1))==1))=x1; % x1 with duration of y
y2(find((n>=min(n2))&(n<=max(n2))==1))=x2; % x2 with duration of y
y = y1+y2; % sequence addition
end
```

Function Step Sequence

```
function [x,n] = stepseq(n0,n1,n2)
% Generates x(n) = u(n-n0); n1 <= n <= n2
% ------------------------------------------
% [x,n] = stepseq(n0,n1,n2)
%
n = [n1:n2]; x = [(n-n0) >= 0];
end
```

Function : Shiffting signal

```
function [y,n] = sigshift(x,m,k)
% implements y(n) = x(n-k)
% -------------------------
% [y,n] = sigshift(x,m,k)
%
n = m+k; y = x;
end
```

```
    "y_Identity diff2 is :"


yI1diff =

     0

    "As we see, they are equal"
```

Function delta

```
function [x,n] = impseq(n0,n1,n2)
% Generates x(n) = delta(n-n0); n1 <= n <= n2
% ----------------------------------------------
% [x,n] = impseq(n0,n1,n2)
%
n = [n1:n2]; x = [(n-n0) == 0];
end
```

Published with MATLAB® R2020b