Experiment : Transformation of the independent variable [Time index].

Tutorial:

We can categorize the operations that can be done on the independent variable [time index here] of the signal to:

1- Shift: a. Delay b. Advance

2- Inversion

3- Scaling a. Compression b. Expansion

How to draw signals?

1) If you know the equation of the signal:

If you are required to draw the signal x[n] =3n+1 from n=-3 to n=7, then you start by defining the time axis you will use:

>> nx=[-3:7]

Then you initialize the signal to be all zeros “here not important but in general you will need it”

It's useful from software perspective to reserve the required memory storage for the array first.

>>x=zeros(length(nx),1);

>>x=3 * nx +1

>> stem (nx,x)

for continuous time signals, all you need is to make the define the time axis to have smaller steps; ie:

>>tx=[-3:.001:7]

And you make the same stuff.

2) If you don't know the equation, then you must initialize it explicitly.

>> nx=[-3:7];

>>x=zeros(length(nx),1);

>> x(1)=1 % equivalent to x(nx==-3)=1

>>stem(nx,x);

Students experiment:

a) Define and stem the signal x[n] where:

x[n]=2 at n=0, 1 at n=2, -1 at n=3, 3 at n=4, 0 otherwise

Draw it from n= -3 → 7

b) Draw the following signals by defining the new axes:

y1[n]=x[n-2]; ***%delayed by 2 samples***

y2[n]=x[n+1]; ***%advanced by on sample***

y3[n]=x[-n]; ***%flipped version***

y4[n]=x[-n+1]; ***%flipped then advance***

Experiment 2) Periodicity of discrete time signals:

Tutorial:

For discrete time signals, the signals are periodic if x[n]=x[n+N]. For discrete time sinusoids, x[n]=cos(Omega*n) will be periodic IF and only IF Omega=2*pi*m/N, where m is an integer representing the number of periods in the continuous domain included in one period in discrete domain, and N is the period in samples in the discrete domain.

Now, we want you to understand:

1) What's the meaning of (m).

2) If Omega is in any form other than a rational number multiplied by 2*pi, the signal will not be periodic

Ex :

```
>>n=[0:40];

>>x=cos(2*pi*3/20*n);

%this is periodic signal with period 20 and the discrete period includes 3
continuous periods

>>subplot(2,1,1);stem(n,x);%discrete plotting

>>t=[0:.1:40]; %Now let's draw a continuous version of the

%function, we will take more samples between 0 and 40 "10 samples in every
second"

>>xt=cos(2*pi*3/20*t);

>>subplot(2,1,2);plot(t,xt);%continuous plotting
```

Students experiment:

a) Consider the discrete time signal

$X_m[n]$ =sin (2*pi*M*n/N)

And assume N=12. For M=4, 5, 7 and 10, plot $X_m[n]$ on the interval n=0→2N-1. What is the fundamental period of each signal? In general, how can the fundamental period be determined from arbitrary integer values of M and N? Be sure to consider the case in which M>N.

b) Consider the signal: $X_k[n]$ =sin (w_k*n)

Where w_k=2*pi*k/5. Stem X_k for k=1,2,4,6 from n=0→9 in one figure using the subplot command. How many unique signals have you plotted? Explain.

Experiment 3) Calculation of Energy and Power of discrete time signals:

Tutorial:

For discrete time signal, we define the energy of the signal as E=sum (x. ^2).

This is the energy of the whole signal, so we should square the samples, and then add these squares for all time indices.

We define also the energy of a part of the signal from N1 to N2 as E=sum(x[N1:N2].^2). The power of discrete signal between N1→N2 is defined as the energy divided by (N2-N1+1).The power of the whole signal equals to 0 if the signal is limited, and equals to the Power of one period if the signal was periodic.

ex:

```
>>x=randn([1,51]);
% x is random signal normally distributed with mean 0 and variance 1.
>>subplot(2,1,1); stem (x);
>>Etot=sum(x.^2); %this is the energy of the whole signal
>>j=0;
>>for N1=1:5:46
>>j=j+1;
>>E(j)=sum(x(N1:N1+4).^2);  % energy for every 5 samples
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>>P(j)=sum(x(N1:N1+4).^2/5; % average power
>>end;
>>subplot(2,1,2);stem(E);
```

Students experiment:

In this experiment, you are required to calculate the power of a periodic signal in two ways:

The power is formally defined as the average energy with respect to time. But for periodic signals, the power of the whole signal equals to the power of one period.

a) Define a sinusoidal signal with period = 10, stem it and calculate the power of this signal

b) Define the above signal from n= 0 →12, calculate the energy of the signal, calculate its power. Compare it with the result in (a)

c) Define the signal from n=0 →1005, calculate the energy of the signal, calculate its power. Compare it with the result in (a) Comment on your observations