CLASSIFICATION OF SIGNALS

CT signals and DT signals can further be categorised into other categories

Analog Signal: This falls under CTS, it can take up any value within the time domain

x(t)

Digital Signal: This falls under a DTS, it can take any number of finite discrete values

Real Signals: These are signals whose values are real numbers

Complex Signals: These are signals whose values are complex numbers.

x(t) = x\_n(t)+j x\_m(t)

x\_n and x\_m are real values

j = sqrt{-1}

Deterministic Signal:

A signal whose values are completely specified for any given time interval e.g. step signal x(t) = A

Random Signal:

The value of this signal are not explicitly specified and are random at any given instant of time e.g. a noise signal or speech signal

Even signals:

These are signals that are symmetrical about the y or x(t) axis

CTS

DTS

When the signal remains the same after time reversal.

TIME REVERSAL

Time reversal is that operation on signals that multiplies the time scale of the signal by some parameter. Let’s say

{%alpha}=-1

This operation is meant to perform a folding operation on the signal

Assume:

i/p ---- [{%alpha}=-1] ------ o/p

Odd Signals:

This is a signal that is anti-symmetrical about the x(t) axis/y-axis

x(-t) = -x(t)

Time reversed component = -x(t)

x[-n] = -x[n]

An odd signal must be 0 at time t=0 i.e. graphically it passes through the origin

Example: Show that the product of two even signals is an even signa;

Solution

x(t) = x\_1(t) cdot x\_2(t)

If x\_1(t) and x\_2(t) are even, then

x(-t) = x\_1(-t) cdot x\_2(-t)

x(-t) = x\_1(t) cdot x\_2(t)

x(-t)=x(t)

Hence, x(t) is even

Example: Show that product of two odd signals is an even signal

Let x(t) = x\_1(t) cdot x\_2(t)

If x\_1(t) and x\_2(t) are both odd

then x(-t) = x\_1(-t) cdot x\_2(-t)

Recall that for odd signals x(-t) = -x(t)

x(-t) = [-x\_1(t)] cdot [-x\_2(t)]

x(-t) = x\_1(t) cdot x\_2(t)

x(-t) = x(t)

Hence x(t) is even

Example: Show that the product of an even and odd signal is an odd signal

NB:

A signal is usually a combination of the even and odd component

Conjugate Symmetric Signal

This is a signal whose original signal x(t) is the same as the complex conjugate of the time reversed version of the orginal signal..

Given the signal x(t),

Time reversed signal x(-t)

The conjugate of the time reversed version x\*(-t)

The condition for conjugate symmetric

x(t) = x\*(-t)

If x(t) = x\_1(t) + j x\_2(t)

x\*(-t) = x\_1(t) – j x\_2(t)

But to obtain the conjugate symmetric signal we have to perform the folding operation on the signal

Let’s say x(t) = x\_1(t) + j x\_2(t)

Folding x(-t) = x\_1(-t) + j x\_2(-t)

x\*(-t) = x\_1(t) – j x\_2(-t)

x(t) <> x\*(-t)

The signal is not a conjuage symmetric

Conjugate anti-symmetric signal

Condition for conjugate anti-symmetric.

x(t) = -x\*(-t)

x(t) = x\_1(t) + jx\_2(t)

x(-t) = x\_1(-t)+j x\_2(-t)

x\*(-t) = x\_1(-t) – j x\_2(-t) --- Complex conjugate

Then we perform amplitude reversal

-x\*(-t) = -x\_1(-t) + j x\_2(-t)

AMPLITUDE REVERSAL

This is a special case of amplitude scaling [multiplying the amplitude by a parameter]

Assuming

x(t) ---- [k] ---- y(t) = k cdot x(t)

For time reversal, k = -1

Periodic Signal

A continuous time signal x(t) is said to be periodic when we have a positive non-zero value at the time period

x(t) = x(t+T)

x(t) is said to be periodic if there’s a non-zero value of T

The fundamental time period T is the smallest possible value of T for which the signal is periodic

Similarly, the discrete time sequence x[n] is said to be periodic when period N if there is a positive integer N for which x[n]

x[n] = x[n+N]

The fundamental time period N\_o of x[n] is the smallest positive integer N for which the sequence is periodic

NB: Whe the sequence/signal is not periodic, we say it is non-periodic/aperiodic

ENERGY SIGNAL

A signal x(t) is said to be an energy signal if and only if the total energy is finite

0<E<{%infinite};

P=0 (Power)

NB: Energy signal must be absolutely integrabble