Class- B.tech 2nd yr ECE
Subject: Signal & System
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Topic: Properties of DFT

1. Linearity

Statement: If $x_1(n) \xleftrightarrow[N]{DFT} X_1(k)$ and

$x_2(n) \xleftrightarrow[N]{DFT} X_2(k)$ then

$$a_1x_1(n) + a_2x_2(n) \xleftrightarrow[N]{DFT} a_1X_1(k) + a_2X_2(k)$$

here a_1 and a_2 are constant

Period | Subject

Proof :- Acc. to definition of DFT,

$$X(k) = \sum_{n=0}^{N-1} x(n) \cdot W_N^{kn} \quad (1)$$

here $x(n) = a_1 x_1(n) + a_2 x_2(n)$

$$\therefore X(k) = \sum_{n=0}^{N-1} [a_1 x_1(n) + a_2 x_2(n)] W_N^{kn}$$

$$= \sum_{n=0}^{N-1} a_1 x_1(n) W_N^{kn} + \sum_{n=0}^{N-1} a_2 x_2(n) \cdot W_N^{kn}$$

Since a_1 and a_2 are constants, we can take it out of the summation sign

$$\therefore X(k) = a_1 \sum_{n=0}^{N-1} x_1(n) \cdot W_N^{kn} + a_2 \sum_{n=0}^{N-1} x_2(n) \cdot W_N^{kn} \quad (2)$$

Comparing eq (2) with definition of DFT

$$X(k) = a_1 X_1(k) + a_2 X_2(k).$$

2. Periodicity

Statement :

If $x(n) \xleftrightarrow[N]{DFT} X(k)$ then

$x(n+N) = x(n)$ for all n

& $X(k+N) = X(k)$

3 Duality Property :

Statement : If $x(n) \xleftrightarrow[N]{DFT} X(k)$.

then. $x(n) \xleftrightarrow[N.]{DFT} N\,X[(-k)]_N$.

4. Circular Convolutions:

If $x_1(n) \xleftrightarrow[N]{DFT} X_1(k)$ &

$x_2(n) \xleftrightarrow[N]{DFT} X_2(k)$ then,

$x_1(n) \, N \, x_2(n) \xleftrightarrow[N]{DFT} X_1(k) . X_2(k)$.

here N Indicate Circular Convolutions

5. Time Reversal Property:

If $x(n) \xleftrightarrow[N]{DFT} X(k)$.

then $x((-n))_N = x(N-n) \xleftrightarrow[N]{DFT} X((-k))_N$

$= X(N-k)$

Days Period	Class Subject	Class Work Forecast	Home Work
	6.	circular time shift argument.	
Statement:		If $x(n) \xleftrightarrow[N]{DFT} X(k)$ then	
		$x((n-l))_N \xleftrightarrow[N]{DFT} X(k)e^{-j2\pi kl/N}$	
	or	$x((n-l))_N \xleftrightarrow[N]{DFT} X(k)\,W_N^{kl}$	
	7.	circular frequency shift:	
Statement:		If $x(n) \xleftrightarrow[N]{DFT} X(k)$ then	
		$x(n)e^{j2\pi ln/N} \xleftrightarrow{DFT} X((k-l)_N) = X(k+l)$	
	OR	$x(n)e^{-j2\pi ln/N} \xleftrightarrow[N]{DFT} X((k+l))_N = X(k-l)$	

Remarks :

8 circular correlations:

Statement: If $x(n) \xleftrightarrow[N]{DFT} X(k)$ and

$y(n) \xleftrightarrow[N]{DFT} Y(k)$ then

$$\tilde{r}_{xy}(l) \xleftrightarrow[N]{DFT} R_{xy}(k) = X(k)Y^*(k)$$

9 Parsenal Theorem:

Statement: If $x(n) \xleftrightarrow[N]{DFT} X(k)$ and

$y(n) \xleftrightarrow[N]{DFT} Y(k)$

then

$$\sum_{n=0}^{N-1} x(n)y^*(n) = \frac{1}{N}\sum_{k=0}^{N-1} X(k)Y^*(k)$$

Remarks :

Days Period | Subject | | Home Work

10 Complex Conjugate Property!

Statement! If $x(n) \xleftrightarrow[N]{DFT} X(k)$ then

$$x^*(n) \xleftrightarrow[N]{DFT} X^*((-k)_N) = X^*(N-k).$$

11. Multiplication of Two sequence:

If $x_1(n) \xleftrightarrow[N]{DFT} X_1(k)$ and

$x_2(n) \longleftrightarrow X_2(k)$ then

$$x_1(n) \cdot x_2(n) \xleftrightarrow[N]{DFT} \frac{1}{N}\left[X_1(k) \; N \; X_2(k)\right]$$