USN

INTERNAL ASSESSMENT TEST – II

Sub	DIGITAL SIGNAL PROCESSING							Code	18EC52
Date	16/12/2021	Duration	90 mins	Max Marks	50	Sem	V	Branch	ECE

Answer any 5 full questions

		Marks	**CO**	**RBT**
1	State and prove the following properties of DFT i) Circular time shift property ii) Circular frequency shift property iii) Circular time reversal property	[10]	CO2	L3
2	Compute the circular convolution of $x[n]=[2,-1,4,-2]$ and $h[n]=[4,-1,-3,2]$ using DFT-IDFT method. Verify the result using matrix method.	[10]	CO2	L3
3	Find the output of an LTI system whose impulse response is $h[n]=[2,2,1]$ for the input $x[n]=[3,0,-2,0,2,1,0,-2,-1]$ using overlap-save method. Use 7-point circular convolution.	[10]	CO1	L3

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		Marks	CO	RBT
4	Derive radix-2 DIT-FFT for $N = 8$. Draw the complete signal flow graph.	[10]	CO3	L3
5	Compute the DFT of $x[n] = \cos\left(\frac{\pi n}{4}\right), 0 \leq n \leq 7$ using DIF-FFT.	[10]	CO3	L3
6	Find the IDFT of the following sequence using DIF-IFFT. $$X[k] = [20, \quad -5.828 - j2.414, \quad 0, \quad -0.172 - j0.414, \quad 0, \quad -0.172 + j0.414, \quad 0, \quad -5.828 + j2.414]$$	[10]	CO3	L3
7	Find the circular convolution of $x[n] = [4,2,0,3]$ and $h[n] = [3,1,5,2]$ using DIT-FFT algorithms.	[10]	CO3	L3

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Scheme Of Evaluation
Internal Assessment Test II – Dec 2021

Sub:	DIGITAL SIGNAL PROCESSING							Code:	18EC52
Date:	16/12/2021	Duration:	90 mins	Max Marks:	50	Sem:	V	Branch:	ECE

Note: Answer 5 Questions

	Description	Marks Distribution		Max Marks
1	State and prove the following properties of DFT i) Circular time shift property ii) Circular frequency shift property iii) Circular time reversal property		10	10
	• Circular time shift property • Circular frequency shift property • Circular time reversal property	4 3 3		
2	Compute the circular convolution of x[n]=[2,-1,4,-2] and h[n]=[4,-1,-3,2] using DFT-IDFT method. Verify the result using matrix method.		10	10
	• Finding $X(k)$ • Finding $H(k)$ • Finding $Y(k) = X(k)H(k)$ • Finding $y(n)$	3 3 1 3		
3	Find the output of an LTI system whose impulse response is h[n]=[2,2,1] for the input x[n]=[3,0,-2,0,2,1,0 ,-2,-1] using overlap-save method. Use 7-point circular convolution.		10	10
	• Making smaller blocks • Finding output of each block • Finding final output	2 6 2		
4	Derive radix-2 DIT-FFT for N=8. Draw the complete signal flow graph.		10	10
	• First stage of decimation • Second stage of decimation • Third stage of decimation	4 4 2		
5	Compute the DFT of $x[n] = cos(\frac{\pi n}{4}), 0 \le n \le 7$ using DIF-FFT.		10	10
	• First stage output • Second stage output	2 4		

	• Third stage output	4		
6	Find the IDFT of the following sequence using DIF-IFFT. X[k]=[20,-5.828-j2.414,0,-0.172-j0.414,0,-0.172+j0.414,0,-5.828+j2.414]		10	10
	• First stage output • Second stage output • Third stage output	2 4 4		
7	Find the circular convolution of x[n]=[4,2,0,3] and h[n]=[3,1,5,2] using DIT-FFT algorithms.		10	10
	• Finding $X(k)$ • Finding $H(k)$ • Finding $Y(k) = X(k)H(k)$ • Finding $y(n)$	3 3 1 3		

CMR INSTITUTE OF TECHNOLOGY
DEPT OF ECE
DIGITAL SIGNAL PROCESSING
INTERNAL ASSESSMENT TEST – 2
16.12.2021
SOLUTIONS

Q.No.	Question	Marks
1	State and prove the following properties of DFT i) Circular time shift property ii) Circular frequency shift property iii) Circular time reversal property	10
	If $x(n) \xleftrightarrow[N]{DFT} X(k)$ then, $x[(n-l)_N] \xleftrightarrow[N]{DFT} e^{-j\frac{2\pi}{N}lk} X(k)$ Proof: We know that, DFT of $x(n) = \sum_{n=0}^{N-1} x(n) e^{-j\frac{2\pi}{N}}$ $0 \leq$ $\therefore$ DFT of $x[(n-l)_N]$ $= \sum_{n=0}^{N-1} x[(n-l)_N] e^{-j\frac{2\pi}{N}kn}$ $= \sum_{n=0}^{N-1} x(n-l+pN) e^{-j\frac{2\pi}{N}kn}$ where p is an in	

Let $n-l+pN = m$.

$\therefore \; n = m+l-pN$

when $n=0, \quad m = -l+pN$

when $n = N-1, \quad m = -l+pN+N-1$

$\therefore$ (1) can be written as,

DFT of $x[(n-l)_N]$

$$= \sum_{m=-l+pN}^{-l+pN+N-1} x(m)\, e^{-j\frac{2\pi}{N}k(m+l-pN}$$

$$= \sum_{m=0}^{N-1} x(m)\, e^{-j\frac{2\pi}{N}km}\, e^{-j\frac{2\pi}{N}kl}\, e^{j\frac{2\pi}{N}}$$

$$= e^{-j\frac{2\pi}{N}kl} \sum_{m=0}^{N-1} x(m)\, e^{-j\frac{2\pi}{N}km}$$

$$= e^{-j\frac{2\pi}{N}kl}\, X(k)$$

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

then $\quad e^{j\frac{2\pi}{N}ln}\, x(n) \xleftrightarrow[N]{DFT} X[(k-l$

Proof :

We know that,

$$\text{DFT of } x(n) = \sum_{n=0}^{N-1} x(n)\, e^{-j\frac{2\pi}{N}kn}, \quad 0 \le$$

$$\therefore \text{DFT of } e^{j\frac{2\pi}{N}ln}\, x(n) = \sum_{n=0}^{N-1} e^{j\frac{2\pi}{N}ln}\, x(n)\, e^{-j\frac{2}{}}$$

$$= \sum_{n=0}^{N-1} x(n)\, e^{-j\frac{2\pi}{N}(k-l)}$$

$$= \sum_{n=0}^{N-1} x(n)\, e^{-j\frac{2\pi}{N}(k-l+pN}$$

$$= X\left[(k-l)_N\right]$$

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

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

Proof :

We know that,

$$\text{DFT of } x(n) = \sum_{n=0}^{N-1} x(n)\, e^{-j\frac{2\pi}{N}kn},$$

$$\therefore \text{DFT of } x(-n) = \sum_{n=0}^{N-1} x(-n)\, e^{-j\frac{2\pi}{N}kn}.$$

	Let $-n = m$ ie, $n = -m$ when $n=0$, $m=0$ when $n=N-1$, $m = -(N-1)$ $\therefore$ (1) can be written as, $\text{DFT of } x(-n) = \sum_{m=0}^{-(N-1)} x(m)\, e^{-j\frac{2\pi}{N}k(-1}$ $= \sum_{m=0}^{N-1} x(m)\, e^{-j\frac{2\pi}{N}(-k)m}$ $= X\left[(-k)_N\right]$	
2	Compute the circular convolution of $x[n]$=[2,−1,4,−2] and $h[n]$=[4,−1,−3,2] using DFT-IDFT method. Verify the result using matrix method.	10
	$X_1(k) = [3, -2 - j, 9, -2 + j]$ $X_2[k] = [2, 7 + 3j, 0, 7 - 3j]$ $Y[k] = X_1(k)X_2(k) = [6, -11 - 13j, \quad 0, -11 + 13j\ ]$ $y[n] = [-4, \quad 8, \quad 7, \quad -5]$	
3	Find the output of an LTI system whose impulse response is $h[n]$=[2,2,1] for the input $x[n]$=[3,0,−2,0,2,1,0 ,−2,−1] using overlap-save method. Use 7-point circular convolution.	10
	$y_1(n) = (4, 2, 6, 6, -1, -4, 2)$ $y_2(n) = (-1, 4, 6, 4, -3, -6, -4)$ $y_3(n) = (-2, -2, -1, 0, 0, 0, 0, 0)$ $y(n) = (6, 6, -1, -4, 2, 6, 4\ , -3, -6, -4, -1)$	

4	Derive radix-2 DIT-FFT for N=8. Draw the complete signal flow graph.	10
	N-point DFT of $x(n)$ is given by $X(k) = \sum_{n=0}^{N-1} x(n) W_N^{kn} \quad \ldots (1)$ $0 \leq k \leq N-1$ where $W_N = e^{-j\frac{2\pi}{N}}$ The N-point DFT given by (1) can be split into two $\frac{N}{2}$-point DFTs corresponding to even indexed and odd indexed samples of $x(n)$, as follows. $X(k) = \sum_{n\text{-even}} x(n) W_N^{kn} + \sum_{n\text{-odd}} x(n) W_N^{kn}$ $0 \leq k \leq N-1$	
	$= \sum_{n=0}^{\frac{N}{2}-1} x(2n) W_N^{2kn} + \sum_{n=0}^{\frac{N}{2}-1} x(2n+1) W_N^{k(2n+1)}$ $= \sum_{n=0}^{\frac{N}{2}-1} x(2n) W_{\frac{N}{2}}^{kn} + \sum_{n=0}^{\frac{N}{2}-1} x(2n+1) W_N^{2kn} W_N^{k}$ $= \sum_{n=0}^{\frac{N}{2}-1} x(2n) W_{\frac{N}{2}}^{kn} + W_N^{k} \sum_{n=0}^{\frac{N}{2}-1} x(2n+1) W_{\frac{N}{2}}^{kn}$ $= G(k) + W_N^{k} H(k) \quad \ldots (2)$	
5	Compute the DFT of $x[n] = cos(\frac{\pi n}{4}), 0 \leq n \leq 7$ using DIF-FFT.	10

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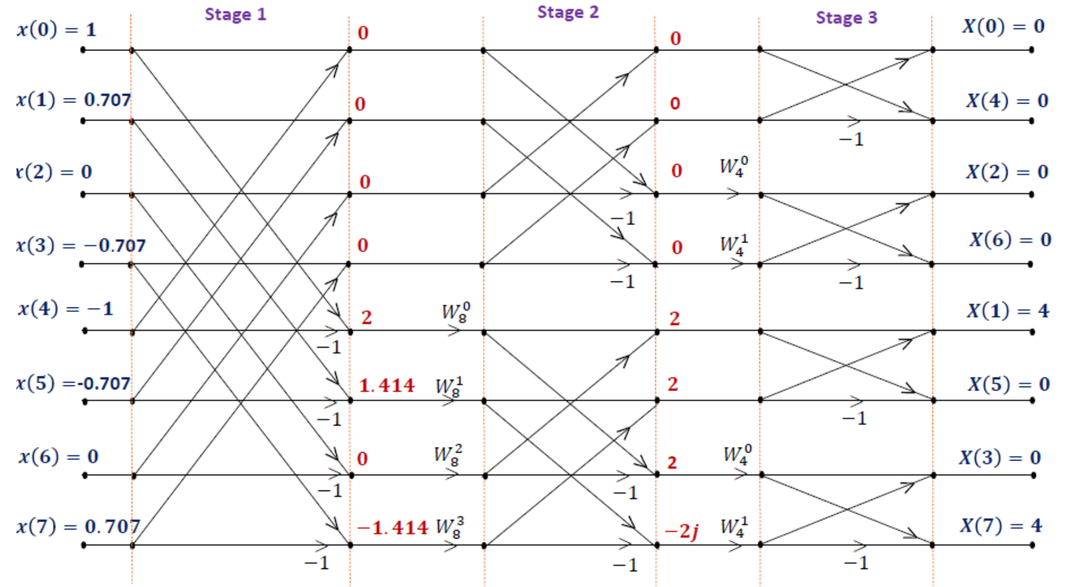
<tr><td></td><td>
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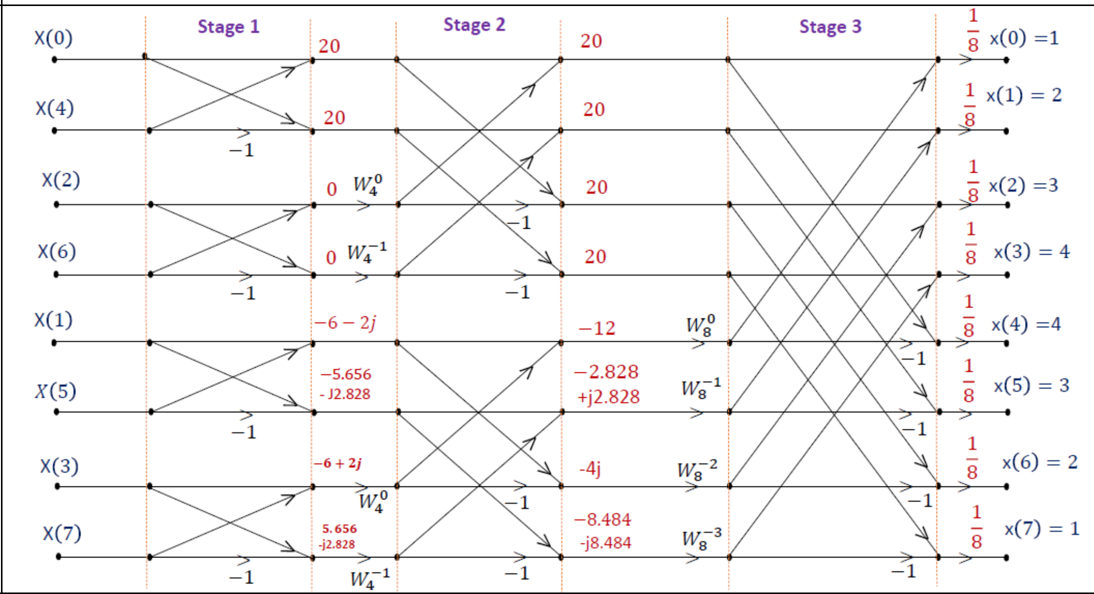
<tr><td></td><td>
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<tr><td></td><td>

$$X_1(k) = (9, 4 + 1j, -1, 4 - 1j)$$

$$X_2(k) = (11, -2 + j, 5, -2 - j)$$

$$Y(k) = X_1(k)X_2(k) = (99, -9 + 2j, -5, -9 - 2j)$$

$$y(n) = (19, 25, 28, 27)$$

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