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INTERNAL ASSESSMENT TEST – II

Sub	DIGITAL SIGNAL PROCESSING							Code	18EC52
Date	01/12/2022	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 propertyii) Circular frequency shift property iii) Circular time reversal property	[10]	CO2	L2
2	If $x_1[n] = [2,4,6,8]$ has DFT $X_1[k] = [20, -4+4j, -4, -4-4j]$, find the DFT of the following sequences without explicitly computing their DFT. i) $x_2[n] = [2,8,6,4]$ ii) $x_3[n] = [8,2,4,6]$ iii) $x_4[n] = \cos\left(\frac{\pi}{2}n\right) x_1(n)$	[10]	CO2	L2
3	Prove that multiplication of DFTs results in circular convolution the respective time domain sequences.	[10]	CO2	L3

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		Marks	CO	RBT
4	Compute the circular convolution of $x[n] = [2, -1, 3, -2]$ and $h[n] = [-3, 1, 2, -1]$ using DFT-IDFT method. Verify the result using matrix method.	[10]	CO2	L3
5	Consider a filter $h[n] = [1,2]$. If the input is $x[n] = [1,4,3,0,7,4,-7,-7,-1,3,4,3]$ compute the output using overlap-add method. Use block length of 5.	[10]	CO1	L3
6	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
7	Compute the DFT of $x[n] = \cos\left(\frac{\pi n}{4}\right), 0 \le n \le 7$ using DIT-FFT.	[10]	CO3	L3

		Marks	CO	RBT
4	Compute the circular convolution of $x[n] = [2, -1, 3, -2]$ and $h[n] = [-3, 1, 2, -1]$ using DFT-IDFT method. Verify the result using matrix method.	[10]	CO2	L3
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7	Compute the DFT of $x[n] = \cos\left(\frac{\pi n}{4}\right), 0 \le n \le 7$ using DIT-FFT.	[10]	CO3	L3

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Scheme Of Evaluation

Internal Assessment Test II – Dec 2022

Sub:	DIGITAL SIGNAL PROCESSING							Code:	18EC52
Date:	01 / 12 / 2022	Duration:	90 mins	Max Marks:	50	Sem:	V	Branch:	ECE

Note: Answer All Questions

Question #		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 Proof • Circular frequency shift property Proof • Circular time reversal property Proof	4 3 3		
2		If $x_1[n] = [2,4,6,8]$ has DFT $X_1[k] = [20, -4+4j, -4, -4-4j]$, find the DFT of the following sequences without explicitly computing their DFT. i) $x_2[n] = [2,8,6,4]$ ii) $x_3[n] = [8,2,4,6]$ ii) $x_4[n] = \cos\left(\frac{\pi}{2}n\right) x_1(n)$		10	10
		• DFT of $x_2(n)$ • DFT of $x_3(n)$ • DFT of $x_4(n)$	3 3 4		
3		Prove that multiplication of DFTs results in circular convolution the respective time domain sequences.		10	10
		• Expression for $X_3(k)$ • α^n formula • Simplification	2 2 6		
4		Compute the circular convolution of $x[n] = [2, -1, 3, -2]$ and $h[n] = [-3, 1, 2, -1]$ using DFT-IDFT method. Verify the result using matrix method.		10	10

		• $X(k)$ • $H(k)$ • $X(k)H(k)$ • $IDFT$	3 3 1 3		
5		Consider a filter$h[n] = [1,2]$. If the input is $x[n] = [1,4,3,0,7,4,-7,-7,-1,3,4,3]$ compute the output using overlap-add method. Use block length of 5.		4	10
		• Making smaller blocks • Computing individual outputs • Computing final output	3 5 2		
6		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 • Computing individual outputs • Computing final output	3 5 2		
7		Compute the DFT of $x[n] = \cos\left(\frac{\pi n}{4}\right), 0 \le n \le 7$ using DIT-FFT.		10	10
		• First stage output • Second stage output • Third stage output	3 3 4		

Solution IAT2

Q1.i) Statement: If DFT of x(n) is X[k], then DFT of x((n-m))$_N$ is then $x\langle(n-m)\rangle_N \xleftrightarrow{DFT} W_N^{mk}X[k]$ 1M

Proof: 2.5M

ii) Statement: If DFT of x(n) is X[k], then DFT of $W_N^{mn}x$(n) is then $W_N^{mn}x$(n) $\xleftrightarrow{DFT} X\langle k+m\rangle_N$ 1M

Proof: 2.5M

iii) Statement: If DFT of x(n) is X[k], then DFT x((-n))$_N$ is then $x((-\text{n}))\text{N} \xleftrightarrow{DFT} X[-k]$ 1M

Proof: 2M

Q2. i) $x_2[n] = x_1\langle(-n)\rangle_N$ So $X_2[k] = X_1[-k] = [20, -4-4j, -4, -4+4j]$ 3M

ii) $x_3[n] = x_1\langle(n-1)\rangle_N$ So $X_3[k] = W_4^k X_1[k]$ $\therefore X_3[k] = [20, W_4^1(-4-4j), W_4^2(-4), W_4^3(-4+4j)]$

$\therefore X_3[k] = [20, 4+4j, 4, 4-4j]$ 3M

ii) $x_4[n] = \frac{1}{2}\left(e^{\frac{j2\pi n}{4}} + e^{\frac{-j2\pi n}{4}}\right)x_1(n)$ So $x_4[n] = \frac{1}{2}(W_4^{-n} + W_4^{n})x_1(n)$ 4M

$\therefore X_1[k-1] = (-4-4j, 20, -4+4j, -4)$ $\therefore X_1[k+1] = [-4+4j, -4, -4-4j, 20]$

$\therefore X_4[k] = [-4, 8, -4, 8]$

Q3. Statement 3 M and Proof 7 Marks.

Q4.To find DFT of$[n] = [2,-1,3,-2]$ and $h[n] = [-3,1,2,-1]$

$$\begin{bmatrix} X[0] \\ X[1] \\ X[2] \\ X[3] \end{bmatrix} = \begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & -j & -1 & j \\ 1 & -1 & 1 & -1 \\ 1 & j & -1 & -j \end{bmatrix} \begin{bmatrix} 2 \\ -1 \\ 3 \\ -2 \end{bmatrix} = \begin{bmatrix} 2 \\ -1-j \\ 8 \\ -1+j \end{bmatrix}$$ 3M

$$\begin{bmatrix} H[0] \\ H[1] \\ H[2] \\ H[3] \end{bmatrix} = \begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & -j & -1 & j \\ 1 & -1 & 1 & -1 \\ 1 & j & -1 & -j \end{bmatrix} \begin{bmatrix} -3 \\ 1 \\ 2 \\ -1 \end{bmatrix} = \begin{bmatrix} -1 \\ -5-2j \\ -1 \\ -5+2j \end{bmatrix}$$ 3M

$Y[k] = X[k] * H[k]$, $\therefore Y[k] = [-2, 3+7j, -8, 3-7j]$ 1M

$$\begin{bmatrix} y[0] \\ y[1] \\ y[2] \\ y[3] \end{bmatrix} = \frac{1}{4}\begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & j & -1 & -j \\ 1 & -1 & 1 & -1 \\ 1 & -j & -1 & j \end{bmatrix} \begin{bmatrix} -2 \\ 3+7j \\ -8 \\ 3-7j \end{bmatrix} \therefore y[n] = [-1, -2, -4, 5]$$ 3M

Q5.Given $x[n] = [1,4,3,0,7,4,-7,-7,-1,3,4,3]$ and $h[n] = [1,2]$ ∴M=2,

We have to use Block Length N=5 ∴sub section length L=N-M+1=4

$x_1[n] = [1,4,3,0,0]$, $x_2[n] = [7,4,-7,-7,0]$ and $x_3[n] = [-1,3,4,3,0]$ 2M

$\therefore h[n] = [1,2,0,0,0]$

$y_1[n] = x_1[n] \circledast h[n]$

$$\begin{bmatrix} y_1[0] \\ y_1[1] \\ y_1[2] \\ y_1[3] \\ y_1[4] \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 2 \\ 2 & 1 & 0 & 0 & 0 \\ 0 & 2 & 1 & 0 & 0 \\ 0 & 0 & 2 & 1 & 0 \\ 0 & 0 & 0 & 2 & 1 \end{bmatrix} \begin{bmatrix} 1 \\ 4 \\ 3 \\ 0 \\ 0 \end{bmatrix} \quad \therefore y_1[n] = [1,6,11,6,0]$$ 2M

$y_2[n] = x_2[n] \circledast h[n]$

$$\begin{bmatrix} y_2[0] \\ y_2[1] \\ y_2[2] \\ y_2[3] \\ y_2[4] \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 2 \\ 2 & 1 & 0 & 0 & 0 \\ 0 & 2 & 1 & 0 & 0 \\ 0 & 0 & 2 & 1 & 0 \\ 0 & 0 & 0 & 2 & 1 \end{bmatrix} \begin{bmatrix} 7 \\ 4 \\ -7 \\ -7 \\ 0 \end{bmatrix} \quad \therefore y_2[n] = [7,18,1,-21,-14]$$ 2M

$y_3[n] = x_3[n] \circledast h[n]$

$$\begin{bmatrix} y_3[0] \\ y_3[1] \\ y_3[2] \\ y_3[3] \\ y_3[4] \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 2 \\ 2 & 1 & 0 & 0 & 0 \\ 0 & 2 & 1 & 0 & 0 \\ 0 & 0 & 2 & 1 & 0 \\ 0 & 0 & 0 & 2 & 1 \end{bmatrix} \begin{bmatrix} -1 \\ 3 \\ 4 \\ 3 \\ 0 \end{bmatrix} \quad \therefore y_3[n] = [-1,1,10,11,6]$$ 2M

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Last one o/p of preceding sub section should be added to first one sample of succeeding sucsection

$\therefore y_1[n] = [1,6,11,6,0]$

$\therefore y_2[n] = \quad [7,18,1,-21,-14]$

$\therefore y_3[n] = \quad [-1,1,10,11,6]$

$\therefore y[n] = [1,6,11,6,7,18,1,-21,-15,1,10,11,6]$ 2M

Q.6. Given $x[n] = [3, 0, -2, 0, 2, 1, 0, -2, -1]$ and $h[n] = [2,2,1]$ $\therefore$M=3,

We have to use Block Length N=7 $\therefore$sub section length L=N-M+1=5

$x_1[n] = [0,0,3,0,-2,0,2]$, $x_2[n] = [0,2,1,0,-2,-1,0]$

$\therefore h[n] = [2,2,1,0,0,0,0]$ 2M

$y_1[n] = x_1[n] \circledast h[n]$

$$\begin{bmatrix} y_1[0] \\ y_1[1] \\ y_1[2] \\ y_1[3] \\ y_1[4] \\ y_1[5] \\ y_1[6] \end{bmatrix} = \begin{bmatrix} 2 & 0 & 0 & 0 & 0 & 1 & 2 \\ 2 & 2 & 0 & 0 & 0 & 0 & 1 \\ 1 & 2 & 2 & 0 & 0 & 0 & 0 \\ 0 & 1 & 2 & 2 & 0 & 0 & 0 \\ 0 & 0 & 1 & 2 & 2 & 0 & 0 \\ 0 & 0 & 0 & 1 & 2 & 2 & 0 \\ 0 & 0 & 0 & 0 & 1 & 2 & 2 \end{bmatrix} \begin{bmatrix} 0 \\ 0 \\ 3 \\ 0 \\ -2 \\ 0 \\ 2 \end{bmatrix} \quad \therefore y_1[n] = [4,2,6,6,-1,-4,2]$$ 3M

$y_2[n] = x_2[n] \circledast h[n]$

$$\begin{bmatrix} y_2[0] \\ y_2[1] \\ y_2[2] \\ y_2[3] \\ y_2[4] \\ y_2[5] \\ y_2[6] \end{bmatrix} = \begin{bmatrix} 2 & 0 & 0 & 0 & 0 & 1 & 2 \\ 2 & 2 & 0 & 0 & 0 & 0 & 1 \\ 1 & 2 & 2 & 0 & 0 & 0 & 0 \\ 0 & 1 & 2 & 2 & 0 & 0 & 0 \\ 0 & 0 & 1 & 2 & 2 & 0 & 0 \\ 0 & 0 & 0 & 1 & 2 & 2 & 0 \\ 0 & 0 & 0 & 0 & 1 & 2 & 2 \end{bmatrix} \begin{bmatrix} 0 \\ 2 \\ 1 \\ 0 \\ -2 \\ -1 \\ 0 \end{bmatrix} \quad \therefore y_2[n] = [-1,4,6,4,-3,-6,-4]$$ 2M

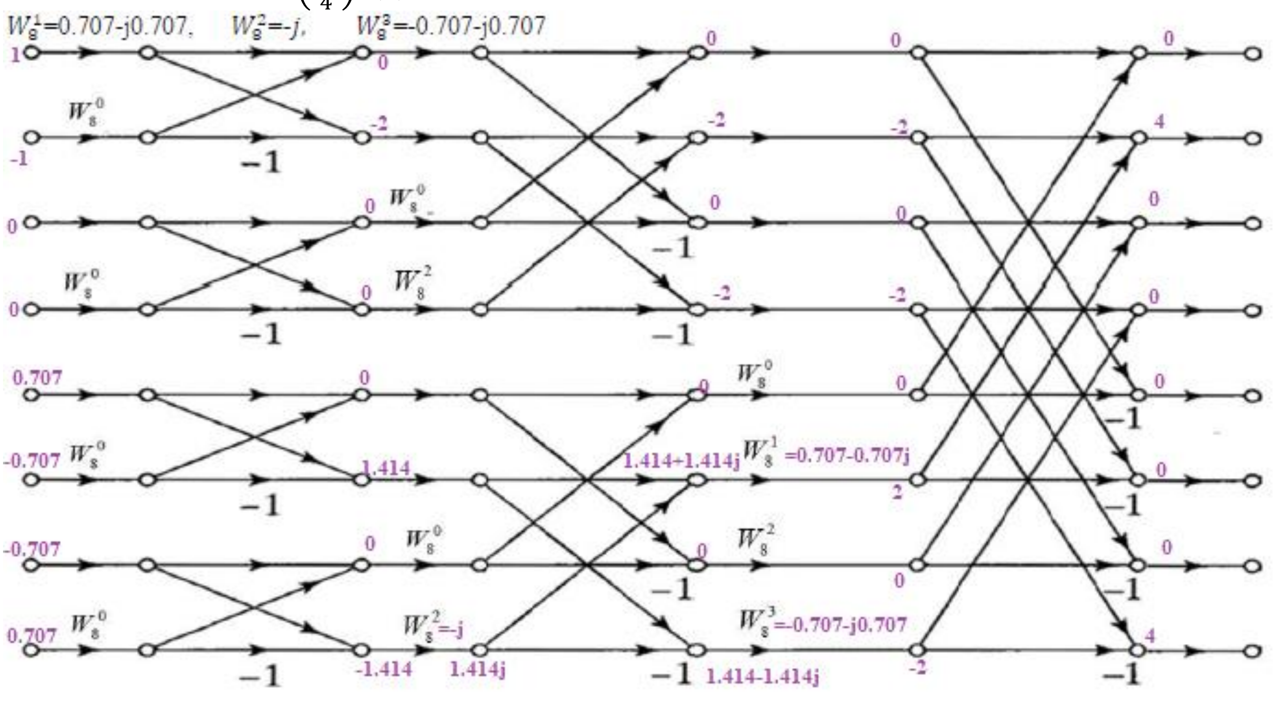
Discard first two samples of each o/p and save last L samples,; Concatenate saved O/p's to get overall O/p

$\therefore y_1[n] = [4,2,6,6,-1,-4,2]$

$\therefore y_2[n] = [-1,4,6,4,-3,-6,-4]$

$\therefore y[n] = [6,6,-1,-4,2,6,4,-3,-6,-4]$ 2M

Q7. Given $x[n] = \cos\left(\frac{\pi n}{4}\right)$x(n) = {1,0.707,0,-0.707,-1,-0.707,0,0.707}



$\therefore$X[k]={0,4,0,0,0,0,0,4}

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