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# HirasugarInstitute ofTechnology, Nidasoshi.

*Inculcating Values, Promoting Prosperity*

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| EEE Dept. |
|---|
| Exam. |
| Internal Assessment |
| EvenSem(2017-18) |

## FIRST INTERNAL ASSESSMENT

**Sem :VI** **Sub: Digital Signal Processing** **Sub. Code: 15EE63**

**Date:06/03/2018** **Time: 11:00AM-12.00 noon** **Max. Marks: 25**

*Note: Answer two full questions, draw sketches wherever necessary.*

| Q. No | | Discription of Question | Marks | CO | RBT Level |
|---|---|---|---|---|---|
| 1 | a | Determine 8 point DFT of the sequence x(n) = (1,1,1,1,1,1,0,0). | 8 | 317. 1 | L3 |
| | b | State and prove Circular time shift property of DFT. | 5 | 317. 1 | L1 |
| | | **OR** | | | |
| 2 | a | Determine IDFT of X(k)<br>X(k)= (12, -1.5+j2.598, -1.5+j0.866, 0 , -1.5-j0.866, -1.5-j2.598) | 6 | 317. 1 | L3 |
| | b | Determine the circular convolution of the following sequences<br>$x_1(n)$ =(1,1,2,1) and $x_2(n)$ = (1,2,3,4) and also verify the result using matrix method. | 7 | 317. 1 | L3 |
| 3 | a | Evaluate y(n) of a filter with impulse response h(n) = (3,2,1) and input x(n) =(2,1,-1,-2,-3,5,6,-1,2,0,2,1) using Overlap Save method. Use 8-point Circular convolution in your approach. | 6 | 317. 1 | L5 |
| | b | Evaluate y(n) using Overlap add method for 6-point Circular convolution where x(n) = (1,0,1,-2,1,2,3,-1,0,2) and h(n) = (1,-1,2). | 6 | 317. 1 | L5 |
| | | **OR** | | | |
| 4 | a | Determine 4-point Circular Convolution of two given sequences x(n) and h(n). Where x(n) = $\cos(\pi n/2)$ and h(n) = $2^n$. Verify the result using matrix method. | 6 | 317. 1 | L3 |
| | b | Find DFT of a sequence x(n)=$(-1)^n$ for N=4. Also draw the magnitude spectrum. | 6 | 317. 1 | L1 |

**Course Coordinator** **Module Coordinator** **HOD**

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E&E Engg Dept
Exam
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2017-18 Even Sem

## SCHEME OF EVALUATION

Page. No.: 1 / 6

Sem : VI | Subject : Digital Signal Processing | Sub Code : 15EE62 | Date : 6/3/2018

| Q. No. | Bit | Description | Marks | CO's |
|---|---|---|---|---|
| | | Scheme | | |
| 1) | (a) | For finding X(k) = (6, −0.707+j1.707, 1−j, 0.707+j0.293, 0, 0.707−j0.293, 1+j, −0.707+j1.707) | 8 | 317.1 |
| | | For every correct answer – 1 mark. 1×8=8 | | |
| | (b) | For the statement | 1 | 317.1 |
| | | For the proof | 4 | |
| | | | 5 | |
| 2 | (a) | For finding x(n) = (1, 1, 2, 2, 3, 3) | 6 | 317.1 |
| | | x(n) for every correct answer 1 mark. 1×6=6 | | |
| | (b) | For the circular convol$^n$ y(n) = (13, 14, 11, 12) 1.5×4 | 6 | 317.1 |
| | | For finding answer using matrix method 1 | 1 | |
| | | | 7 | |
| 3 | (a) | For finding $x_1(n)$, $x_2(n)$ & $x_3(n)$ | 2 | 317.1 |
| | | For finding $y_1(n)$, $y_2(n)$ & $y_3(n)$ | 3 | |
| | | For the final answer y(n) | 1 | |
| | | | 6 | |
| | (b) | For finding $x_1(n)$, $x_2(n)$ & $x_3(n)$ | 2 | 317.1 |
| | | For finding $y_1(n)$, $y_2(n)$ & $y_3(n)$ | 3 | |
| | | For the final answer | 1 | |
| | | | 6 | |
| 4 | (a) | For finding answer y(n) | 4 | 317.1 |
| | | For finding y(n) using matrix method | 2 | |
| | (b) | For finding X(k) | 4 | 317.1 |
| | | For magnitude spectrum of X(k) | 2 | |
| | | | 6 | |

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Page. No.: 2 / 6

## SCHEME OF EVALUATION

Sub Code: 15EE63 | Date: 6/3/2018

Sem: VI | Subject: Digital Signal Processing

| Q. No. | Bit | Description | Marks | CO's |
|---|---|---|---|---|
| 1 | (a) | Solution $X(k) = \sum_{n=0}^{7} x(n) \cdot e^{-j2\pi kn/N}$, $k = 0, 1, 2 \ldots N-1$ <br> $X(0) = 6$, $X(1) = -0.707 - j1.707$, $X(2) = 1 - j$. <br> $X(3) = 0.707 + j0.293$, $X(4) = 0$, $X(5) = 0.707 - j0.293$ <br> $X(6) = 1 + j$. $X(7) = -0.707 + j1.707$ | | |
| | (b) | If DFT $x(n) = X(k)$ <br> then DFT $\{x((n-m))_N\} = e^{-j2\pi km/N} X(k)$ <br> Proof: DFT$[x((n-m))_N] = \sum_{n=0}^{N-1} x((n-m))_N e^{-j2\pi kn/N}$ <br> $= \sum_{n=0}^{m-1} x((n-m))_N e^{-j2\pi kn/N} + \sum_{n=m}^{N-1} x((n-m))_N e^{-j2\pi kn/N}$ — (1) <br> $\sum_{n=0}^{m-1} x((n-m))_N e^{-j2\pi kn/N} = \sum_{n=0}^{m-1} x(N-m+n) \cdot e^{-j2\pi kn/N}$ <br> put $l = (N-m+n)$. <br> $= \sum_{l=N-m}^{N-1} x(l) \cdot e^{-j2\pi k(-N+m+l)/N}$ <br> $= \sum_{l=N-m}^{N-1} x(l) \cdot e^{-j2\pi k(-N+m+l)/N}$ — (2) <br> Similarly $\sum_{n=m}^{N-1} x((n-m))_N e^{-j2\pi kn/N} = \sum_{l=0}^{N-1-m} x(l) \cdot e^{-j2\pi k(l+m)/N}$ — (3) <br> Substituting Eq (2) & (3) in Eq (1) we get <br> DFT$[x((n-m))_N] = e^{-j2\pi km/N} \sum_{l=0}^{N-1} x(l) \cdot e^{-j2\pi kl/N}$ <br> $= e^{-j2\pi km/N} X(k)$ // | | |

Course Coordinator | Module Coordinator | HOD

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## SCHEME OF EVALUATION

Sem: VI | Subject: DIP | Sub Code: 15EE63 | Date: 6/3/2018

| Q. No. | Bit | Description | Marks | CO's |
|---|---|---|---|---|
| 2 | (a) | | | |

$x(n) = \frac{1}{N} \sum_{k=0}^{N-1} X(k) \cdot e^{j2\pi kn/N}$ $N = 6$, $n = 0$ to $5$

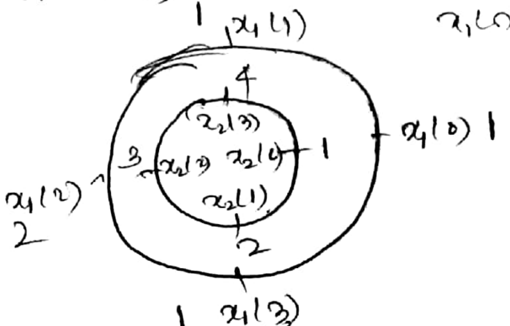
$x(n) = \frac{1}{6} \sum_{k=0}^{5} X(k) \cdot e^{j2\pi kn/6}$

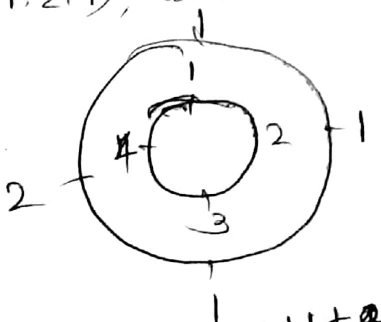
$x(0) = 1$, $x(1) = 1$, $x(2) = 2$, $x(3) = 2$, $x(4) = 3$, $x(5) = 3$

$x(n) = (1, 1, 2, 2, 3, 3)$

(b) Circular convolution using concentric circle method

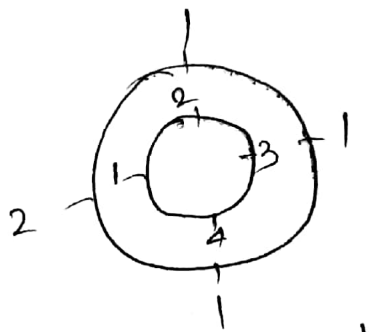
$x_1(n) = (1, 1, 2, 1)$, $x_2(n) = (1, 2, 3, 4)$

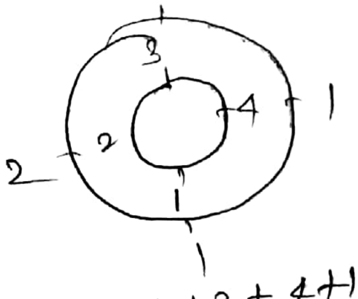


$x_3(0) = 1\times1 + 1\times4 + 2\times3 + 1\times2 = 13$

$x_3(1) = 1\times2 + 1 + 8 + 3 = 14$





$x_3(3) = 4 + 3 + 4 + 1 = 12$

$x_3(2) = 3 + 2 + 2 + 4 = 11$

$x_3(n) = (13, 14, 11, 12)$

$$x_3(n) = \begin{bmatrix} 1 & 4 & 3 & 2 \\ 2 & 1 & 4 & 3 \\ 3 & 2 & 1 & 4 \\ 4 & 3 & 2 & 1 \end{bmatrix} \begin{bmatrix} 1 \\ 1 \\ 2 \\ 1 \end{bmatrix} = \begin{bmatrix} 13 \\ 14 \\ 11 \\ 12 \end{bmatrix}$$

$x_3(n) = (13, 14, 11, 12)$

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## SCHEME OF EVALUATION

Sub Code: 15EE63 | Date: 6.3.18
Sem: VI | Subject: DSP

| Q. No. | Bit | Description | Marks | CO |
|---|---|---|---|---|

3 (a) overlap save method.

$x(n) = (2, 1, -1, -2, -3, 5, 6, -1, 2, 0, 2, 1)$

$h(n) = (3, 2, 1)$ $N=8$, $L=6$

$x_1(n) = (0, 0, 2, 1, -1, -2, -3, 5)$

$x_2(n) = (-3, 5, 6, -1, 2, 0, 2, 1)$

$x_3(n) = (2, 1, 0, 0, 0, 0, 0, 0)$

$h(n) = (3, 2, 1, 0, 0, 0, 0, 0)$

$y_1(n) = (7, 5, 6, 7, 1, -7, -14, 7)$

$y_2(n) = (-5, 10, 25, 14, 10, 3, 8, 7)$

$y_3(n) = (6, 7, 4, 1, 0, 0, 0, 0)$

7, 5, 6, 7, 1, -7, -14, 7
-5, 10, 25, 14, 10, 3, 8, 7
6, 7, 4, 1, 0, 0, 0, 0

$y(n) = \{6, 7, 1, -7, -14, 7, 25, 14, 10, 3, 8, 7, 4, 1\}$

(b) Overlap Add method $N=6$, $L=4$

$x(n) = (1, 0, 1, -2, 1, 2, 3, -1, 0, 2)$

$h(n) = (1, -1, 2, 0, 0, 0)$

$x_1(n) = (1, 0, 1, -2, 0, 0)$

$x_2(n) = (1, 2, 3, -1, 0, 0)$

$x_3(n) = (0, 2, 0, 0, 0, 0)$

$y_1(n) = (1, -1, 3, -3, 4, -4)$

$y_2(n) = (1, 1, 3, 0, 7, -2)$

$y_3(n) = (0, 2, -2, 4, 0, 0)$

1, -1, 3, -3, 4, -4
1, 1, 3, 0, 7, -2
0, 2, -2, 4, 0, 0

$y(n) = (1, -1, 3, -3, 5, -3, 3, 0, 7, 0, -2, 4)$

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Sem : VI Subject : DSP

## SCHEME OF EVALUATION

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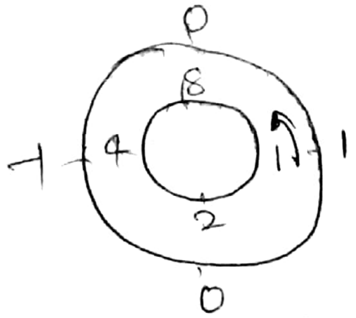
Sub Code : 15EE63 Date : 6.3.18

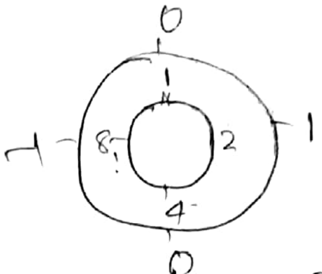
| Q. No. | Bit | Description | Marks | CO's |
|---|---|---|---|---|
| 4 | (a) | | | |

$x(n) = \cos\left(\frac{\pi n}{2}\right) = (1, 0, -1, 0)$

$h(n) = 2^n = (1, 2, 4, 8)$

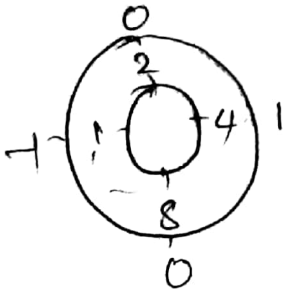
$y(n) = x(n) \circledast_N h(n)$

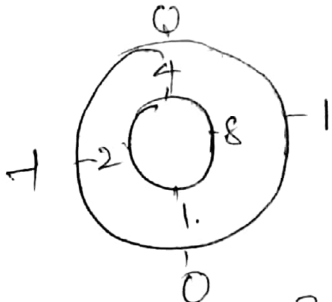



$y(0) = 1 + 0 + (-4) + 0 = -3$

$y(1) = 2 + 0 - 8 + 0 = -6$




$y(3) = 8 + 0 - 2 + 0 = 6$

$y(2) = 4 + 0 - 1 + 0 = 3$

$\therefore y(n) = (-3, -6, 3, 6)$

$$y(n) = \begin{bmatrix} 1 & 8 & 4 & 2 \\ 2 & 1 & 8 & 4 \\ 4 & 2 & 1 & 8 \\ 8 & 4 & 2 & 1 \end{bmatrix} \begin{bmatrix} 1 \\ 0 \\ -1 \\ 0 \end{bmatrix} = \begin{bmatrix} -3 \\ -6 \\ 3 \\ 6 \end{bmatrix}$$

$y(n) = (\underset{\uparrow}{-3}, -6, 3, 6)$ //

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## SCHEME OF EVALUATION

Sub Code : 15EE63 | Date : 6.3.18

Sem : VI | Subject : DSP

| Q. No. | Bit | Description | Marks | CO |
|---|---|---|---|---|
| 4 | (b) | $x(n) = (-1)^n$ $\quad N = 4$ | | |

$x(n) = (1, -1, 1, -1)$

$X(k) = \sum_{n=0}^{N-1} x(n) \cdot e^{-j2\pi kn/N}$, $\quad k = 0, 1, 2 \ldots N-1$

$X(0) = \sum_{n=0}^{3} x(n) = x(0) + x(1) + x(2) + x(3)$

$= 1 - 1 + 1 - 1 = 0$

$X(0) = 0$ ✓

$X(1) = 0$

$X(2) = 4$

$X(3) = 0$

$X(k) = (0, 0, 4, 0)$

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## SECOND INTERNAL ASSESSMENT

**Sem :VI**
**Date:12/04/2018**

**Sub: Digital Signal Processing**
**Time: 11:00AM-12.00PM**

**Sub. Code: 15EE63**
**Max. Marks: 25**

***Note: Answer two full questions, draw sketches wherever necessary.***

| Q. No | | Discription of Question | Marks | CO | RBT Level |
|---|---|---|---|---|---|
| 1 | a | Calculate the number of multiplications needed in the calculation of DFT and FFT with 8,16,32,64,128,1024 point sequences. Also find Speed improvement factor. | 8 | 317.2 | L3 |
| | b | Compute DFT of the sequence $x(n)=\cos(n\pi/2)$ where N=4 using DIF-FFT algorithm. | 5 | 317.2 | L3 |
| | | **OR** | | | |
| 2 | a | An 8- point sequence is given by x(n) = {2, 2, 2, 2, 1, 1, 1, 1}. Compute 8- point DFT of x(n) by using radix- 2, DIT-FFT algorithm. | 8 | 317.2 | L3 |
| | b | What are the difference and similarities between DIT and DIF Algorithms? | 5 | 317.2 | L1 |
| 3 | a | Given $x(n)=2^n$, and N=8 find X(k) using DIT-FFT algorithm. | 8 | 317.2 | L3 |
| | b | Compute the DFT of a sequence x(n) = {1, -1, 1, -1} using DIF-FFT algorithm. | 4 | 317.2 | L3 |
| | | **OR** | | | |
| 4 | a | Find the IDFT of the sequence X(k)={4,1-j2.414, 0, 1-j0.414, 0, 1+j0.414,0,1+j2.414}. Using DIT algorithm. | 8 | 317.2 | L3 |
| | b | Find the IDFT of the Sequence X(k)= {10, -2+j2, -2, -2-j2}. Using DIT algorithm. | 4 | 317.2 | L3 |

**Course Coordinator** **Module Coordinator** **HOD**

## SCHEME OF EVALUATION

Sem : VI | Subject : Digital Signal Processing | Sub Code : 15EE63 | Date : 12/04/2018

| Q. No. | Blt | Description | Marks | CO's |
|---|---|---|---|---|
| | | Scheme | | |
| 1 | a | For calculating no of multiplications needed to calculate DFT & FFT 01×06=06 | 06 | 317.2 |
| | b | For calculating x(n) ~~stress~~ = ——— | 1 | 317.2 |
| | | For calculating DFT of x(n) = X(K) ——— | 4 / 5 | |
| 2 | a | For computing 8 point DFT with flow diagram | 8 | 317.2 |
| | b | For differences between DIT & DIF At least three points (1×3=3) | 3 | 317.2 |
| | | Similarities between DIT & DIF At least two points 1×2=2 | 2 / 5 | |
| 3 | a | For finding X(K) using DIT-FFT with flow diagram | 8 | 317.2 |
| | b | For finding X(K) using DIF-FFT | 4 | 317.2 |
| 4) | a | For finding ~~xxxx~~ x(n) using DIT Algorithm | 8 | 317.2 |
| | b | For finding x(n) using DIT Algorithm | 4 | 317.2 |

Solution

1 (a)

| No of point N | No of Multiplications needed DFT | FFT | Speed Imp. Factor |
|---|---|---|---|
| 8 | 64 | 12 | 5.33 |
| 16 | 256 | 32 | 8 |
| 32 | 1024 | 80 | 12.8 |
| 64 | 4096 | 192 | 21.33 |
| 128 | 16384 | 448 | 36.57 |
| 1024 | 1048576 | 5120 | 204.8 |

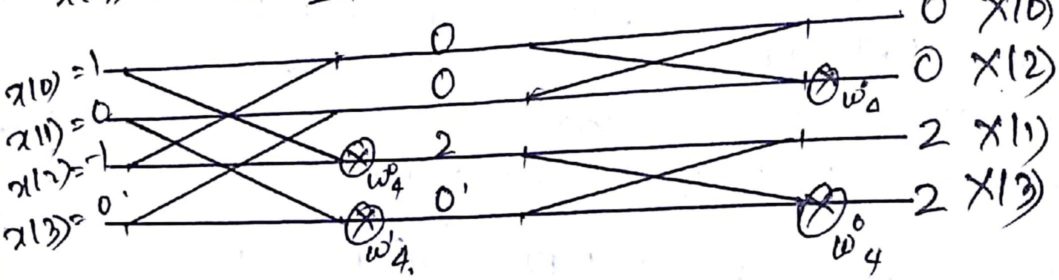
Course Coordinator    Module Coordinator    HOD

## SCHEME OF EVALUATION

Sub Code: 15EE63 | Date: 12/4/18

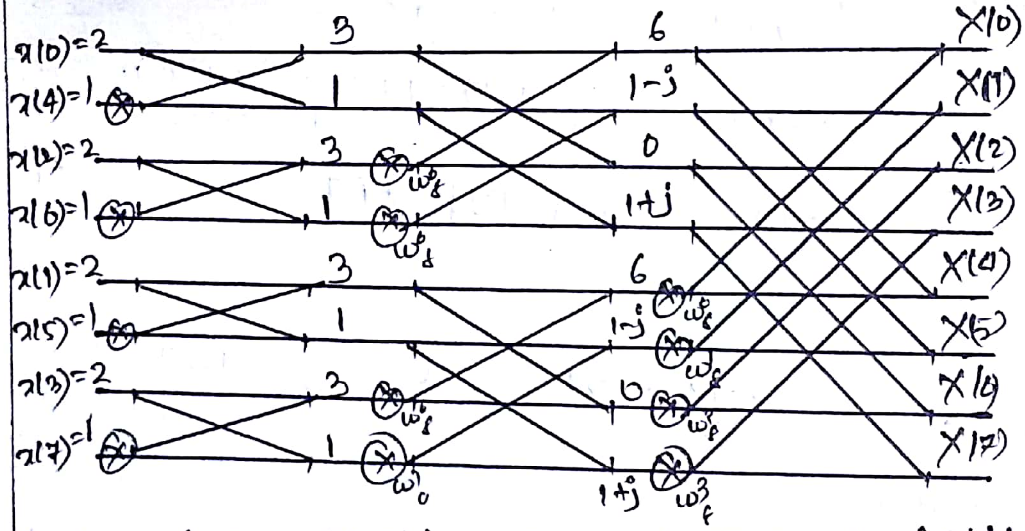
Sem: VI | Subject: Digital Signal Processing

| Q. No. | Bit | Description | Marks | CO |
|---|---|---|---|---|
| 1 | (b) | $x(n) = \cos\frac{\pi n}{2} = (1, 0, -1, 0)$ | 5 | |




$X(k) = (0, 2, 0, 2)$

| Q. No. | Bit | Description | Marks |
|---|---|---|---|
| 2 | (a) | $x(n) = (2, 2, 2, 2, 1, 1, 1, 1)$ | 8 |




$X(k) = (12, 1-j2.414, 0, 1-j0.4142, 0, 1+j0.4142, 0, 1+j2.414)$

(b) Difference between DIT & DIF (5 marks)

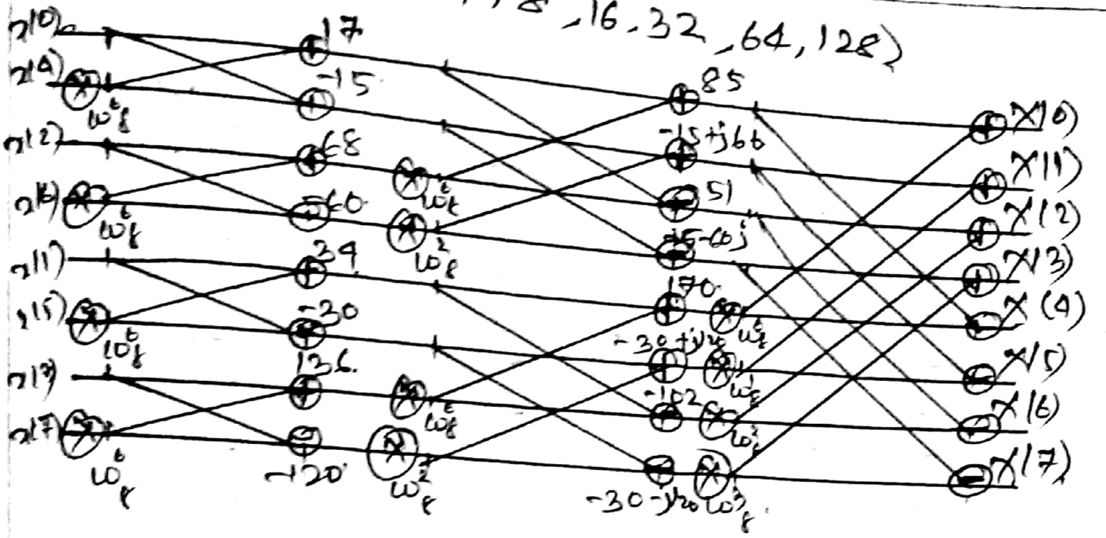
In DIT input is in bit reversed form & output is in natural order. In DIF its reverse

Similarities

Both algorithms require $N\log_2 N$ operations to compute DFT.

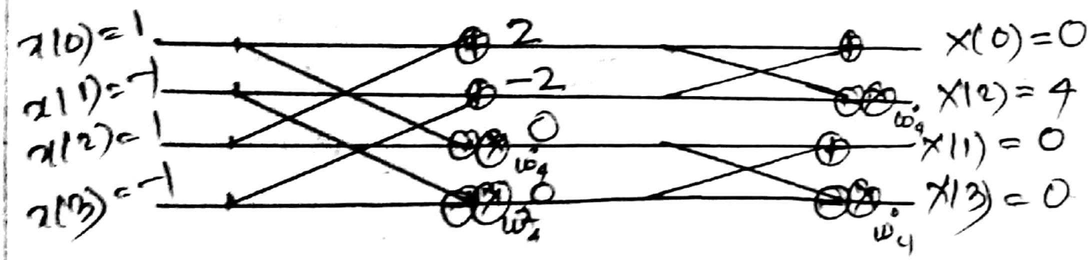
Course Coordinator — Module Coordinator — HOD

| Q. No. | Bit | Description | Marks | CO's |
|---|---|---|---|---|
| 3 | (a) | $x(n) = 2^n = (1, 2, 4, 8, 16, 32, 64, 128)$ | | |




$X(K) = (255, 48.63 + j166, -51 + j102, -78.63 + j46.05, -85, -78.63 - j46.05, -51 - j102, 48.63 - j166)$ — Marks: 8, CO's: 317.2

3 (b) $x(n) = (1, -1, 1, -1)$ using DIF Algorithm



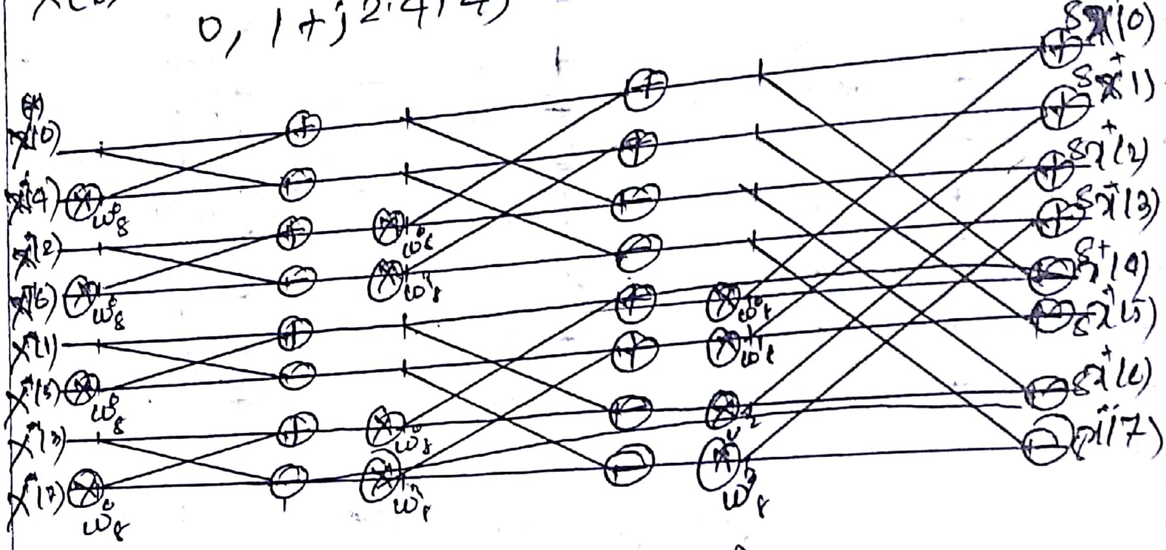

Marks: 4, CO's: 317.2

$X(K) = (0, 0, 4, 0)$

Sem : VI | Subject : Digital Signal Processing | Description | Marks

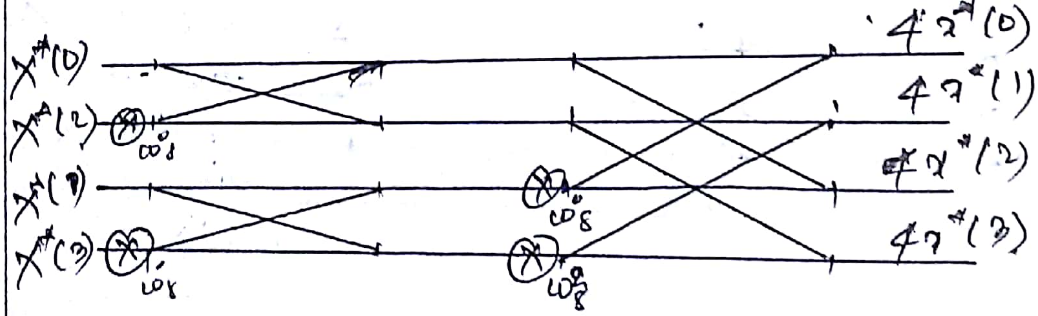
Q. No. | Bit

4 (a) $X(k) = (4, 1-j2.414, 0, 1-j0.414, 0, 1+j0.414, 0, 1+j2.414)$ using DIT Algorithm



$x(n) = (1, 1, 1, 1, 0, 0, 0, 0)$ 8

4 (b) $X(k) = (10, -2+j2, -2, -2+j2$



$x(n) = (1, 2, 3, 4)$ 4

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## THIRD INTERNAL ASSESSMENT

Sem : VI
Date: 19/05/2018

Sub: Digital Signal Processing
Time: 11:00AM-12.00PM

Sub. Code: 15EE63
Max. Marks: 25

*Note: Answer two full questions, draw sketches wherever necessary.*

| Q. No | | Discription of Question | Marks | CO | RBT Level |
|---|---|---|---|---|---|
| 1 | a | Design an analog butterworth filter for the following specifications. $0.9 \le \lvert H(j\Omega)\rvert \le 1$ for $0 \le \Omega \le 0.2\pi$, where $\lvert H(j\Omega)\rvert < 0.2$ for $0.4\pi < \Omega < \pi$. | 7 | 317.3 | L3 |
| | b | For the given specifications $\alpha_p$=3 dB; $\alpha_s$= 16 dB; $f_p$= 1 KHz and fs= 2 KHz. Determine the order of the filter using Chebyshev approximation. Find H(s). | 6 | 317.3 | L3 |
| | | **OR** | | | |
| 2 | a | Design a butterworth filter using the bilinear transformation for the following specifications $0.8 \le \lvert H(e^{j\varphi})\rvert \le 1$ for $0 \le \omega \le 0.2\pi$, $\lvert H(e^{j\varphi})\rvert \le 0.2$ for $0.6\pi \le \omega \le \pi$, | 7 | 317.3 | L3 |
| | b | For the analog transfer function $H(s) = 2 / [(s+1)(s+2)]$. Determine H(z) using impulse invariant method. | 6 | 317.3 | L3 |
| 3 | a | Describe the advantages and disadvantages of the FIR filter over IIR filter. | 6 | 317.4 | L1 |
| | b | Design an ideal lowpass filter with a frequency response $H_d(e^{j\varphi})= 1$ for $(-\pi/2) \le \varphi \le \pi/2$; $= 0$ for $(\pi/2) \le \lvert\varphi\rvert \le \pi$. Find the values of h(n) for N=11. Find H(Z). | 6 | 317.4 | L3 |
| | | **OR** | | | |
| 4 | a | Design an ideal highpass filter with a frequency response $H_d(e^{j\varphi})= 1$ for $(-\pi/4) \le \lvert\varphi\rvert \le -\pi$; $= 1$ for $(\pi/4) \le \lvert\varphi\rvert \le \pi$; $= 0$ otherwise. Find the value of h(n) for N=11. Find H(z). Using Hanning Window. | 6 | 317.5 | L3 |
| | b | Describe the rectangular window and Hanning window techniques. | 6 | 317.5 | L1 |

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## SCHEME OF EVALUATION

Subject : Digital Signal Processing | Sub Code : 15EC62 | Date : 15-5-18

| Q.No | Description | Marks | CO's |
|---|---|---|---|
| | Scheme | | |
| | Finding N - order of the filter = 4 — | 2 | 3? |
| 5 (a) | for the Expression of H(s) — | 2 | 3 |
| | for Finding $\Omega_c$ - cut off frequency — | 1 | |
| | for Finding $H(s)\|_{s \to \frac{S}{0.247}}$ — | 2 | |
| | for | 7 | |
| (b) | for Finding value of N = 2 — | 02 | |
| | for Finding value of a & b — | 02 | |
| | for Finding H(s) — | 02 | |
| | for | 06 | |
| (a) | for Finding the value of N — | 02 | |
| | for Finding the value of H(s) — | 01 | |
| | for the value of $\Omega_c$ — | 01 | |
| | for Finding value of Ha(s) — | 01 | |
| | for Finding the value of H(z) — | 02 | |
| | for | 07 | |
| (b) | for Finding value of A & B. — 3 | 03 | |
| | for Finding value of H(z) — | 03 | |
| | | 06 | |
| (a) | Four Advantages of FIR over IIR - 4 pts — | 04 | |
| | Disadvantages of FIR over IIR 2 pts — | 02 | |
| | | 08? | |
| (b) | for Finding $h_d(n)$ — 1 | 1 | |
| | for Finding h(0), h(1), h(2), h(3), h(4), h(5) — 4 | 4 | |
| | for Finding H(z) — 1 | 1 | |
| | | 6 | |
| (a) | for Finding $\omega H_d(0)$ to $\omega H_d(5)$ — (1) | | |
| | for Finding $h_d(0)$ to $h_d(5)$ — (1) | | |
| | for Finding h(0) to h(5) — (2) | | |
| | for Finding H(z) & H'(z) — (1) | | |
| | for Finding $\bar{H}(e^{jw})$ — (1) | 6 | |
| (b) | Explanation about rectangular window — | 3 | |
| | " Hanning window — | 3 | |
| | " | 6 | |

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**SCHEME OF EVALUATION**

Sub Code: 15EE63 | Date: 19-5-18

Sem: VI | Subject: DSP

| Q. No. | Bit | Description | Marks | CO's |
|---|---|---|---|---|
| 1 | (a) | Solution: $N \geq \frac{\log \lambda/\epsilon}{\log \Omega_s/\Omega_p} = \frac{\log 4.898/0.484}{\log(0.4\pi/0.2\pi)} = 3.34 \cong 4$. <br> for $N=4$ <br> $H(s) = \frac{1}{(s^2+0.76537s+1)(s^2+1.8477s+1)}$ <br> $\Omega_c = \frac{\Omega_p}{\epsilon^{1/N}} = \frac{0.2\pi}{(0.484)^{1/4}} = 0.24\pi$ <br> $H(s)\big\vert_{s=\frac{s}{0.24\pi}} = \frac{0.323}{(s^2+0.577s+0.0576\pi^2)(s^2+1.393s+0.057\ 6\pi^2)}$ | | |
| 1 | (b) | $\Omega_p = 2\pi \times 1000\ Hz = 2000\pi$ rad/s <br> $\Omega_s = 2\pi \times 2000\ Hz = 4000\pi$ rad/s <br> $N \geq \frac{\cosh^{-1}\sqrt{10^{0.1k_s}-1 / 10^{0.1k_p}-1}}{\cosh^{-1}\Omega_s/\Omega_p} = 1.97 \cong 2$. <br> $a = \Omega_p\left[\frac{\mu^{1/N}-\mu^{-1/N}}{2}\right] = 910\pi$ <br> $b = \Omega_p\left[\frac{\mu^{1/N}+\mu^{-1/N}}{2}\right] = 2197\pi$ <br> $s_1 = -643.4\pi + j1554\pi$ <br> $s_2 = -643.46\pi - j1554\pi$ <br> $H(s) = \frac{(1414.38)^2\pi^2}{s^2+1287\pi s+(1682)^2\pi^2}$. | | |
| 2 | (a) | $\omega_s = 0.6\pi$, $\omega_p = 0.2\pi$, $T = 1$ sec <br> $\Omega_s = 2\tan\frac{0.6\pi}{2} = 2.752$, $k = \frac{\Omega_p}{\Omega_s} = 0.236$ <br> $\Omega_p = 2\tan\frac{0.2\pi}{2} = 0.6498$. $\epsilon = 0.75$, $\lambda = 4.898$ <br> $N = \frac{\log \lambda/\epsilon}{\log 1/k} = 1.3 \cong 2$. <br> $H(s) = \frac{1}{s^2+\sqrt{2}s+1}$, $\Omega_c = \frac{\Omega_p}{\epsilon^{1/N}} = 0.75$. <br> $H_a(s) = \frac{(0.75)^2}{s^2+1.06s+0.5625}$ <br> $H(z) = H(s)\big\vert_{s=\frac{2}{T}\frac{(1-z^{-1})}{(1+z^{-1})}} = 0.084(1-z^{-1})^2/(1-1.028z^{-1}+0.31z^{-2})$ | | |

## SCHEME OF EVALUATION

Subject : DSP | Sub Code : 15EE63 | Date : 19-5-18

Sem: VI | Q. No. | Bit | Description | Marks | CO's

b)

$$H(s) = \frac{A}{(s+1)} + \frac{B}{(s+2)} \qquad A = 2, \; B = -2$$

$$= \frac{2}{(s-(-1))} - \frac{2}{(s-(-2))}$$

$P_1 = -1, \; P_2 = -2$

$$H(z) = \sum_{i=1}^{N} \frac{C_k}{1-e^{P_k T} z^{-1}}$$

$$H(z) = \frac{2}{1-e^{-T} z^{-1}} - \frac{2}{1-e^{-2T} z^{-1}}$$

$$= \frac{0.4652 z^{-1}}{1 - 0.5032 z^{-1} + 0.0492 z^{-2}}$$

3 a) **Advantages**

(1) FIR filters have exact linear phase
(2) FIR filters are always stable
(3) FIR filters are realized in both recursive & non recursive structure
(4) Filters with any arbitrary magnitude response can be tackled using FIR seq

**Disadvantages**

(1) For the same specifications order of FIR filter design can be as high as 5 to 10 times that of IIR design
(2) Large storage requirement
(3) Powerful computational facilities required for the implementation,

b)

$$h_d(n) = \frac{1}{2\pi} \int_{-\pi/2}^{\pi/2} e^{j\omega n} \, d\omega$$

$$= \frac{1}{2\pi j n} \Big[ e^{j\omega n} \Big]_{-\pi/2}^{\pi/2} = \frac{\sin \frac{\pi}{2} n}{\pi n}, \quad -\infty \le n \le \infty$$

$$h(n) = \frac{\sin \frac{\pi}{2} n}{\pi n} \text{ for } |n| \le 5, \; 0 \text{ otherwise}$$

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SCHEME OF EVALUATION

Sub Code : 15EE63 | Date : 19-5-18

Sem : VI | Subject : DSP

| Q. No. | Blt | Description | Marks | CO's |
|---|---|---|---|---|

$h(0) = h_d(0) = \frac{1}{2\pi}\int_{-\pi/2}^{\pi/2} d\omega = \frac{1}{2}$

$h(1) = h(-1) = \frac{1}{\pi} = 0.3183$

$h(2) = h(-2) = 0$

$h(3) = h(-3) = -0.106$

$h(4) = h(-4) = 0$

$h(5) = h(-5) = 0.0636.$

Trd fun of the filter is given by

$H(z) = h(0) + \sum_{n=1}^{\frac{N-1}{2}}[h(n)(z^n + z^{-n})]$

$= 0.5 + \sum_{n=1}^{5}[h(n)(z^n + z^{-n})]$

$= 0.5 + 0.3183(z^1 + z^{-1}) - 0.106(z^3 + z^{-3})$

$+ 0.06366(z^5 + z^{-5})$

4) (a) $\omega_H(n) = 0.54 + 0.46\cos\frac{2\pi n}{N-1}$ for $\frac{-(N-1)}{2} \le n \le \frac{(N-1)}{2}$

$= 0$ otherwise

$\omega_H(0) = 1$

$\omega_H(1) = \omega_H(-1) = 0.912$

$\omega_H(2) = \omega_H(-2) = 0.682$

$\omega_H(3) = \omega_H(-3) = 0.398$

$\omega_H(4) = \omega_H(-4) = 0.1678$

$\omega_H(5) = \omega_H(-5) = 0.08$

$h(n) = h_d(n)\, \omega_H(n)$

$h(0) = 0.75$

$h(-1) = h(1) = -0.2052$

$h(-2) = h(2) = -0.1084$

$h(3) = h(-3) = -0.03$

$h(4) = h(-4) = 0$. $h(5) = h(-5) = 0.0036$

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| Sl No. | Description | Marks | CO's |
|---|---|---|---|
| | $H(z) = h(10) + \sum_{n=1}^{5} [h(n)(z^{n}+z^{-n})]$ | | |
| | $= 0.75 - 0.2052(z^{-1}+z) - 0.1084(z^{-2}+z^{2})$ | | |
| | $-0.03(z^{-3}+z^{3}) + 0.0036(z^{-5}+z^{5})$ | | |
| | $H'(z) = z^{-5}H(z)$ | | |
| | $= 0.0036 - 0.03z^{-2} - 0.1084z^{-3} - 0.205z^{-4}$ | | |
| | $+0.75z^{-5} - 0.205z^{-6} - 0.108z^{-7} - 0.03z^{-8}$ | | |
| | $+0.0036z^{-10}$ | | |
| | $h(0) = h(10) = 0.0036$ | | |
| | $h(1) = h(9) = 0$ | | |
| | $h(2) = h(8) = -0.03$ | | |
| | $h(3) = h(7) = -0.1084$ | | |
| | $h(4) = h(6) = -0.2052.$ | | |
| | $h(5) = 0.75$ | | |
| | $\bar{H}(e^{j\omega}) = \sum_{n=0}^{\frac{N-1}{2}} a(n)\cos(\omega n)$ $\quad a(0) = 0.75$ | | |
| | $a(n) = 2h\left[\frac{N-1}{2} - n\right]$ | | |
| | $a(1) = 2h(5-1) = 2h(4) = -0.404$ | | |
| | $a(2) = -0.2168$ | | |
| | $a(3) = -0.06$ | | |
| | $a(4) = 0$ | | |
| | $a(5) = 0.0072$ | | |
| | $\bar{H}(e^{j\omega}) = 0.75 - 0.4104\cos\omega - 0.2168\cos 2\omega + 0.0072\cos 5\omega.$ | | |
| | $-0.06\cos 3\omega$ | | |

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## SCHEME OF EVALUATION

Date :
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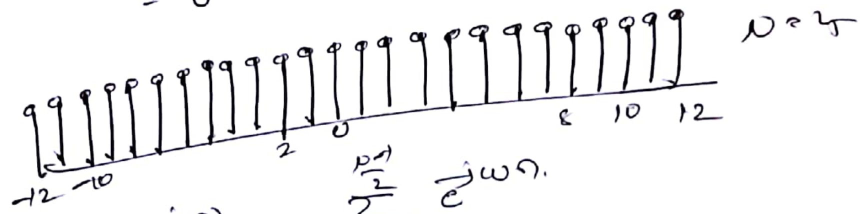
Sem : | Subject :

| Q. No. | Bit | Description | Marks | CO's |
|---|---|---|---|---|
| 4 | b) | Rectangular window sequence is given by | | |

$w_R(n) = 1$ for $-\frac{N-1}{2} \le n \le \frac{N-1}{2}$

$= 0$ otherwise.




$$W_R(e^{j\omega}) = \sum_{n=-\left(\frac{N-1}{2}\right)}^{\frac{N-1}{2}} e^{-j\omega n}$$

$$= \frac{\sin \frac{\omega N}{2}}{\sin \omega/2}.$$

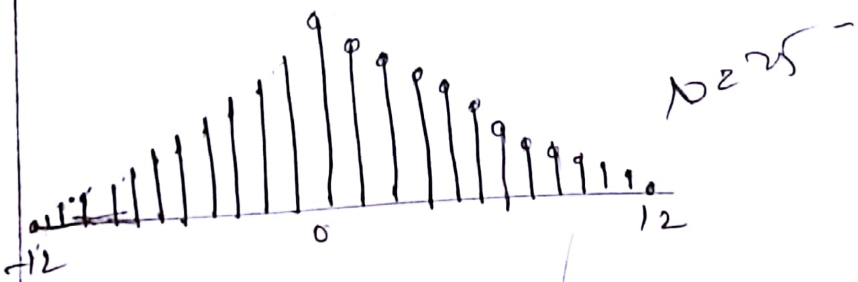
Hanning window

$w_{Hn}(n) = 0.5 + 0.5\cos 2\pi n/(N-1)$ for $\left(-\frac{N-1}{2}\right) \le n \le \frac{N-1}{2}$

$= 0$ otherwise

Frequency response of Hanning window is

$$W_{Hn}(e^{j\omega}) = 0.5\frac{\sin\frac{\omega N}{2}}{\sin\frac{\omega}{2}} + 0.25\frac{\sin(\omega N/2 - \pi N/N-1)}{\sin(\frac{\omega}{2} - \pi/N-1)} + 0.25\frac{\sin(\omega N/2 + \pi N/N-1))}{\sin(\omega/2 + \pi/N-1))}$$

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