DTE Institute Code : 6217

Estd 2009

Shri Balasaheb Mane Shikshan Prasarak Mandal's

ASHOKRAO MANE GROUP OF INSTITUTIONS

Address : Vathar Tarf Vadgaon, Tal. Hatkanangale, Dist. Kolhapur - 416 112 (Maharashtra)

Phone : (0230) 2407740, 2407760 **Fax :** (0230) 2407750 **Email :** director@amgoi.edu.in **Website :** www.amgoi.org

Approved by : AICTE, New Delhi No. F-No. MS (NewInt) 2009 / 08, Higher & Technical Education Department, Govt. of Maharashtra, Directorate of Technical Education, Mumbai. **Affiliated to** : Dr. Babasaheb Ambedkar Technological University, Lonere - Raigad. (B.Tech. & M.Tech. Programs), Shivaji University, Kolhapur. (MBA Program).

Accredited by NAAC

Founder President
Late Shri. Ashokrao Mane

Director
Dr. A. V.Deshmukh, M.E., Ph.D.

President
Hon. Shri. Vijaysinh A. Mane

Ref. No. :

Date :

Criteria 2 :TEACHING-LEARNING AND EVALUATION

Summary Sheet

2.5 - Evaluation Process and Reforms

2.5.1 - Mechanism of internal assessment is transparent and robust in terms of frequency and mode.

Sr. No.	Content
1	Sample Documents of Continuous Assessment-I (CA-I), Mid Semester Examination (MSE) and Continuous Assessment–II (CA-II) Examinations - • Exam Time Table • Question Papers • Model Answers • Marksheet • One sample of Evaluated Answer Sheet

	ASHOKRAO MANE GROUP OF INSTITUTIONS, VATHAR. *Faculty of Engineering*	
	CIRCULAR/NOTICE	Doc. No.: AMGOI -FRM-03 Rev. No.: 00 Rev. Dt: 04/07/2013

Date-04/09/2023

All the students are hereby informed that, departmental CA-1 Semester Exam is scheduled from **14/09/2023** to **15/09/2023** of **20 marks**. The details of the schedule are as follows.

DATE	TIME	SY	TY	B.Tech
14/09/2023	10.15.am to11.15am	M III	EFT	ME
14/09/2023	12.30pm to 01.30pm	EDC	DSP	FOC
14/09/2023	02.30pm to 03.30pm	-	ACOM	MCOM
15/ 09/2023	10.15.am to11.15am	DE Math	AC	ED
15/ 09/2023	12.30pm to 01.30pm	EMI	CSE	EEFM

Mr. S. A. Bhosale
Exam coordinator

4/9

Mrs. S. S. Patil
H.O.D

E & Tc. Engg.

DR. BABASAHEBAMBEDKAR TECHNOLOGICAL UNIVERSITY, LONERE

Continuous Assessment I – Nov., 2021

Course: **B. Tech in Electronics & Telecommunication Engineering** Sem: **V**
Subject Name: **Digital Signal Processing** Subject Code: **BTETC502**
Max Marks: **20** Date: **14/09/2023** Duration: **1 Hr.**

Instructions to the Students:

1. **Solve all questions .**
2. Assume suitable data if required.
3. Use of non-programmable scientific calculator is allowed.

		(Level/CO)	Marks
Q. 1	**Fill in the blank**		**05*01M**
A.	______________________is done to convert a continuous-time signal into discrete-time signal.	R/BTETC502.1	01
B.	Sampling frequency of the signal $x(t)=\sin(200\pi t)+\cos(400 \pi t)$ is_____________	Ap/BTETC502.1	01
C.	If X(k) discrete Fourier transform of x(n), then the inverse discrete Fourier transform of X(k) =__________	R/BTETC502.1	01
D.	__________ Complex multiplications and ________ complex additions requires for computing an N-point DFT.	R/BTETC502.1	01
E.	The N^{th} root of unity W_N is given as ___________	R/BTETC502.1	01
Q.2	Solve **any Three** of the following.		**03*05 M**
A.	Explain Advantages of Digital over Analog signal processing	U/BTETC502.2	05
B.	Find the DTFT of an exponential sequence: $x[n] = a^n u[n]$ where $\| a \| < 1$	Ap/BTETC502.2	05
C.	Determine 4 point DFT of a signal x(n)={1, 1} using standard formula and sketch its magnitude & Phase.	An/BTETC502.2	05
D.	Define Twiddle Factor. Explain Properties of twiddle factor & compute the DFT of 4 point sequence x(n)={0,1, 2, 3} using matrix form.	Ap/BTETC502.1	05

DR. BABASAHEBAMBEDKAR TECHNOLOGICAL UNIVERSITY, LONERE

Continuous Assessment I – Nov., 2021

Course: **B. Tech in Electronics & Telecommunication Engineering** Sem: **V**
Subject Name: **Digital Signal Processing** Subject Code: **BTETC502**
Max Marks: **20** Date: **14/09/2023** Duration: **1 Hr.**

		(Level/CO)	Marks
Q. 1	**Fill in the blank**		**05*01M**
A.	**_Sampling_** is done to convert a continuous-time signal into discrete-time signal.	R/BTETC502.1	**01**
B.	Sampling frequency of the signal x(t)=sin(200π t)+cos(400 π t) is **_400Hz_**	Ap/BTETC502.1	**01**
C.	If X(k) discrete Fourier transform of x(n), then the inverse discrete Fourier transform of X(k) = $\frac{1}{N}\sum_{k=0}^{N-1} X(k) e^{\frac{j2\pi nk}{N}}$ **for n=0,1,2……,N-1**	R/BTETC502.1	**01**
D.	**N^2** Complex multiplications and **N(N-1)** complex additions requires for computing an N-point DFT.	R/BTETC502.1	**01**
E.	The Nth root of unity W_N is given as $\mathbf{e}^{\frac{-j2\pi}{N}}$	RBTETC502.1	**01**
Q.2	Solve **any Three** of the following.		**03*05 M**
A.	Explain Advantages of Digital over Analog signal processing 1. **Flexibility and Versatility:** Digital signals can be easily manipulated using software, allowing for versatile processing. Algorithms can be altered or updated without changing the hardware, providing flexibility in adapting to different requirements. 2. **Precision and Accuracy:** Digital processing allows for high precision and accuracy in signal manipulation. Digital systems are less susceptible to noise and distortion compared to analog systems, enabling more reliable and consistent results. 3. **Signal Preservation:** Digital signals can be copied and transmitted without degradation, whereas analog signals tend to degrade with each copy or transmission due to noise and interference. 4. **Ease of Storage and Transmission:** Digital signals can be stored efficiently and transmitted over long distances without significant loss of quality. Compression techniques can be applied to reduce file sizes without compromising signal quality, making storage and transmission more efficient. 5. **Cost-Effectiveness:** While initial setup costs for digital systems might be higher due to hardware and software requirements, they often become more cost-effective in the long run. Digital technology benefits from economies of scale and ongoing improvements in manufacturing processes, making it more affordable over time. 6. **Complex Processing Capabilities:** Digital processing enables complex algorithms and computations that might be impractical or impossible in analog systems. This capability is particularly valuable in applications such as image processing, data analysis, and communications. 7. **Ease of Integration:** Digital systems can be easily integrated with other digital devices and systems, facilitating compatibility and interoperability across a wide range of technologies. 8. **Ease of Modification and Upgrade:** Digital systems can be modified or upgraded through software changes, avoiding the need for extensive hardware alterations. This ease of upgrade can extend the lifespan of devices and systems. **----(each 1 of 1M)**	U/BTETC502.2	**05**

B.	Find the DTFT of an exponential sequence: x[n] = a^n u[n] where | a |< 1 $X(\omega) = DTFT\{x[n]\} = \sum_{n=-\infty}^{\infty} x[n]e^{-j\omega n}$ Given signal is, x[n] = α^n u[n] $X(\omega) = \sum_{n=-\infty}^{\infty} \alpha^n u[n]e^{-j\omega n}$ $= \sum_{n=0}^{\infty} \left(\alpha e^{-j\omega}\right)^n$ $= \frac{1}{1-\alpha e^{-j\omega}}$ ---(each step 1M)	Ap/BTETC502.2	05
C.	Determine 4 point DFT of a signal x(n)={1, 1} using standard formula and sketch its magnitude & Phase. Let us assume $N = L = 4$. We have $X(k) = \sum_{n=0}^{N-1} x(n)e^{-j2\pi nk/N} \quad k = 0, 1, \cdots, N-1$ $X(0) = \sum_{n=0}^{3} x(n) = x(0) + x(1) + x(2) + x(3)$ $= 1 + 1 + 0 + 0 = 2$ $X(1) = \sum_{n=0}^{3} x(n)e^{-j\pi n/2} = x(0) + x(1)e^{-j\pi/2} + x(2)e^{-j\pi} + x(3)e^{-j3\pi/2}$ $= 1 + \cos\frac{\pi}{2} - j\sin\frac{\pi}{2}$ $= 1 - j$ $X(2) = \sum_{n=0}^{3} x(n)e^{-j\pi n} = x(0) + x(1)e^{-j\pi} + x(2)e^{-j2\pi} + x(3)e^{-j3\pi}$ $= 1 + \cos\pi - j\sin\pi$ $= 1 - 1 = 0$ $X(3) = \sum_{n=0}^{3} x(n)e^{-j3\pi n/2} = x(0) + x(1)e^{-j3\pi/2} + x(2)e^{-j3\pi} + x(3)e^{-j9\pi/2}$ $= 1 + \cos\frac{3\pi}{2} - j\sin\frac{3\pi}{2}$ $= 1 + j$ $X(k) = \{2, 1-j, 0, 1+j\}$ ---(each step 1M)	An/BTETC502.2	05

D. Define Twiddle Factor. Explain Properties of twiddle factor & compute the DFT of 4 point sequence x(n)={0,1, 2, 3} using matrix form.

Ap/BTETC502.1

05

Twiddle Factor

It is denoted as W_N and defined as $W_N = e^{-j2\pi/N}$. Its magnitude is always maintained at unity. Phase of $W_N = -2\pi/N$. It is a vector on unit circle and is used for computational convenience. Mathematically, it can be shown as –

$$W_N^r = W_N^{r \pm N} = W_N^{r \pm 2N} = \dots$$ ---(1M)

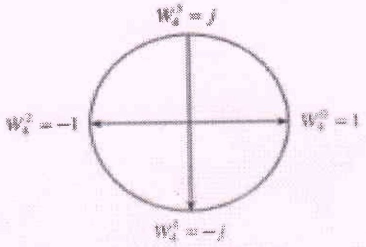
1. $W_N^{k+\frac{N}{2}} = e^{-\frac{j2\pi k}{N}} e^{-j\pi} = -W_N^k$ **(Symmetry Property)**
2. $W_N^{k+N} = e^{-\frac{j2\pi k}{N}} e^{-j2\pi} = W_N^k$ **(periodicity property)** --(1M)

Solution The first step is to determine the matrix $\mathbf{W}_4$. By exploiting the periodicity property of $\mathbf{W}_4$ and the symmetry property

$$W_N^{k+N/2} = -W_N^k$$

the matrix $\mathbf{W}_4$ may be expressed as

$$\mathbf{W}_4 = \begin{bmatrix} W_4^0 & W_4^0 & W_4^0 & W_4^0 \\ W_4^0 & W_4^1 & W_4^2 & W_4^3 \\ W_4^0 & W_4^2 & W_4^4 & W_4^6 \\ W_4^0 & W_4^3 & W_4^6 & W_4^9 \end{bmatrix} = \begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & W_4^1 & W_4^2 & W_4^3 \\ 1 & W_4^2 & W_4^0 & W_4^2 \\ 1 & W_4^3 & W_4^2 & W_4^1 \end{bmatrix}$$



(a) 4-point DFT

$$= \begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & -j & -1 & j \\ 1 & -1 & 1 & -1 \\ 1 & j & -1 & -j \end{bmatrix}$$

Then

$$\mathbf{X}_4 = \mathbf{W}_4\mathbf{x}_4 = \begin{bmatrix} 6 \\ -2+2j \\ -2 \\ -2-2j \end{bmatrix}$$

---(each step 1M)

Shri Balasaheb Mane Shikshan Prasarak Mandal, Ambap's
Ashokrao Mane Group of Institutions,Faculty of Engineering
Vathar Tarf Vadgaon- 416112

Exam: CA-I **Branch:** E&TC Engg. **Time:** 12.30-1.30

Subject: DSP. (Digital Signal Processing). **Date:** 14/09/2023

Roll No.	Name of student	Sign	Marks( )
01	Bhosale Dhairyashil Pratap	Dhairyashil	03+05=08
02	Chougule Suyog Rajkumar	SRChougule	04+04=08
03	Pandurang Namdev Gopane		03+06=09
04	Geeta Chandrakant Jagtap	GJagtap	02+10=12
05	Rushikesh Ramesh Kumbhar		04+06=10
06	Sakshi Sachin Lambe	SLambe	04+09=13
07	Shreeyansh Sunil Kininge	SKininge	03+05=08
08	Diksha Dhananjay Mane	Dmane.	04+13=17
09	Sakshi Ananda Mutnale	SMutnale.	04+11=15
10	Aditi Raosaheb Patil	ARPatil	03+13=16
11	Patil Akhay Dilip	A D Patil	05+04=09
12	Aniket Vishwanath Patil		04+06=10
13	AYUSH Subhash Patil	Spatil	05+05=10
14	Ketan Krushnat Patil	K.K.P	04+05=09
15	Pratik Dattatray Patil	Patil	04+06=10
16	Rohan Shivaji Patil	PSPatil	04+04=08
17	Rohini Bharma Patil	Patil.	04+09=13
18	Sakshi madhukar Patil	SmPatil	04+10=14
19	Patil Vrushabh	VPatil.	05+04=09
20	Pranita Shrikant Pawar	Pranita	05+05=10
21	Poojakumari N. Rajput	~~Rajput~~	04+09=13
22	Sonamkumari N. Rajput	SonamR	04+06=10
23	Ritesh S. Patil.		04+12=16
24	Arati Ramchandra Salunkhe	Salunkhe	04+13=17
25	Shubham M. Shinde.		03+05=08
26	Shirish . Y . Shipekar		04+04=08
27	Kajal Mahadev Shirke		03+12=15
28	Vaishnavi Vishwas Yadav-Patil.	VYPatil.	03+07=10
29	Prachi Raghunath Yadav	PYadav.	04+08=12
30	Suyash Sanjay Desai	Desai.	04+09=13
31	Pooja M. Pawar	Pawar	05+13=18
32	Sarthak Sachin Jadhav	Sarthak	03+05=08

Total No. of Present Student: 36
Total No. of Absent Student: 01
Total No. of Student: 37

14/9 (D.J. Pawar)
Jr.Supervisor Name & Sign

Shri Balasaheb Mane Shikshan Prasarak Mandal, Ambap's

Ashokrao Mane Group of Institutions,Faculty of Engineering

Vathar Tarf Vadgaon- 416112

Exam: **Branch:** E&TC Engg. **Time:**

Subject: **Date:**

Roll No.	Name of student	Sign	Marks( )
33	Shriya Wayangankar	Shriya	04+14 =18
34	Manasi Sannaki	Mgs.	02+13 =15
35	Anjali Patil		03+09 =12
36	snehjeet. Chougule.		03+09=12
37	Pathan Umar		Ab
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Total No. of Present Student:

Total No. of Absent Student:

Total No. of Student:

14/9

Jr.Supervisor Name & Sign

Dr. Babasaheb Ambedkar Technological University, Lonere
ASHOKRAO MANE GROUP OF INSTITUTIONS
Vathar Tarf Vadgaon, Tal. Hatkanangale, Dist. Kolhapur. (M.S.) Pin 416 112.

(To be filled by the Candidate) Sr. No. 022704

Mid Sem Exam./Unit Test-I/Unit Test-II/POE

Course: TY- BTech **Exam Seat No.:** - - - - 3 3

Subject: DSP **Code:**

Semester: V **Examination Seat No.**

Center: Vathar, AMGOI

Date: 14-9-2023 **Time:** 12:30 to 1:30 pm

Name of the Supervisor *Signature of the Supervisor*

(To be filled in by the examiner)

Q. No.	1	2	3	4	5	6	7	8	Total Marks In Fig.	Signature
	04	14							18	

(Start writing from here)

00 A. Convolution

01 B. ~~300πt~~ 400πt

01 C. $X(k) = \frac{1}{N} \sum_{n=0}^{N-1} x(n) W_N^{-nk}$

01 D. N^2, $N \times (N-1)$

01 E. W_N^{nk}, ~~$e^{-j2\pi nk/N}$~~ $= e^{-j\frac{2\pi}{N}}$

Q. 2

A) 1] Digital signal can convey information with less noise, distortion & interface

2] Digital signal can reproduced easily in mass quantities at comparetively lower cost.

3] Digital signal can easily Stored in any magnetic media or optical media using Semiconductor chip.

4] Digital systems are more accurate and probability of error occurance can be reduced by employing error detector and corrector codes.

5] Digital signal processor is more flexible because DSP operations can be altereted using digitally programable system.

6] Digital signal can be transmitted over long distances.

04

c) Given : $x(n) = \{1, 1\}$

$x(n) = \{1,1,0,0\}$ ⟶ Padding (N-L) zeros in $x(n$

$N = 4 , L = 2$

$$x(k) = \sum_{n=0}^{N-1} x(n) e^{-j2\pi \frac{kn}{N}} \quad k = 0,1,2 \cdots N-1$$

$$x(k) = \sum_{n=0}^{N-1} x(n) e^{-j2\pi kn/4} \quad k = 0,1,2,3$$

for $k = 0$

$x(0) = 1 + 1 + 0 + 0 = 2$

for k = 1

$x(1) = 1 + e^{-j2\pi(1)/4} + 0 + 0$

$= 1 + \cos\pi/2 - j\sin\pi/2$

$x(1) = 1 - j$

~~k~~ for k = 2

$x(2) = 1 + e^{-j2\pi(2)/4}$

$= 1 + e^{-j\pi} = 1 - 1$

$x(2) = 0$

for k = 3

$x(3) = 1 + e^{-j2\pi(3)/4}$

$= 1 + e^{-j3\pi/2}$

$x(3) = 1 + j$

$x(n) = \{2, 1-j, 0, 1+j\}$

$|x(k)| = \sqrt{(Re)^2 + (Im)^2}$

$2 = \sqrt{(2)^2 + (0)^2} = 2$

$1-j = \sqrt{(1)^2 + (-j)^2} = \sqrt{2}$

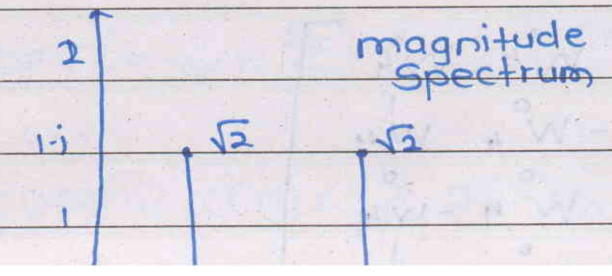
$0 = 0$

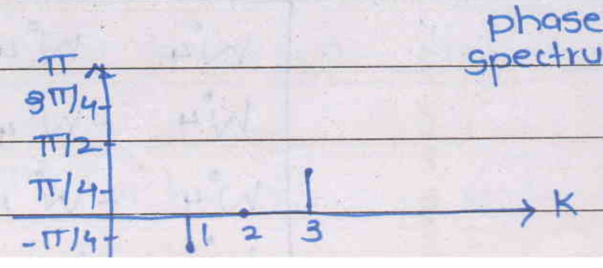
$1+j = \sqrt{(1)^2 + (j)^2} = \sqrt{2}$

$|x(k)| = \{2, \sqrt{2}, 0, \sqrt{2}\}$

Q5

$\angle x(k) = \tan^{-1}\left(\frac{Im}{Re}\right) = \{0, \frac{-\pi}{4}, 0, \frac{\pi}{4}\}$





B] $x[n] = a^n u[n]$

$$X(j\omega) = \sum_{n=-\infty}^{\infty} x(n)\, e^{-j\omega n}$$

$$= \sum_{n=0}^{\infty} a^n \cdot 1\, e^{-j\omega n}$$

$$= \sum_{n=0}^{\infty} (a \cdot e^{-j\omega})^n$$

$$= \sum_{n=0}^{\infty} e^{-an} \cdot e^{j\omega n}$$

$$= \sum_{n=0}^{\infty} \left[e^{-(a+j\omega)}\right]^n$$

$$= \frac{1}{1 - e^{-a(j\omega)}}$$

03

$$X(j\omega) = \frac{1}{1 - a \cdot e^{-j\omega}}, \quad |a \cdot e^{-j\omega}| < 1$$

D] $x(n) = \{0, 1, 2, 3\}$

$N = 4$

$$X_N = W_n \, x_n$$

$$\begin{bmatrix} X(0) \\ X(1) \\ X(2) \\ X(3) \end{bmatrix} = \begin{array}{c|cccc} & 0 & 1 & 2 & 3 \\ \hline 0 & W_4^0 & W_4^0 & W_4^0 & W_4^0 \\ 1 & W_4^0 & W_4^1 & W_4^2 & W_4^3 \\ 2 & W_4^0 & W_4^2 & W_4^4 & W_4^6 \\ 3 & W_4^0 & W_4^3 & W_4^6 & W_4^9 \end{array} \begin{bmatrix} x(0) \\ x(1) \\ x(2) \\ x(3) \end{bmatrix}$$

By using twiddle factor matrix becomes

$$\begin{bmatrix} W_4^0 & W_4^0 & W_4^0 & W_4^0 \\ W_4^0 & -W_4^1 & -W_4^0 & W_4^1 \\ W_4^0 & -W_4^0 & W_4^0 & -W_4^0 \end{bmatrix}$$

$$W^0_N = \left(e^{-j\frac{2\pi n}{N}}\right)^0 = e^0 = 1$$

$$W^1_4 = \left(e^{-j2\frac{\pi}{4}}\right)^1 = e^{-j\frac{\pi}{2}} = \cos\frac{\pi}{2} - j\sin\frac{\pi}{2} = 0 - j = -j$$

$$W^2_4 = \left(e^{-j2\frac{\pi}{4}}\right)^2 = e^{-j\pi} = \cos\pi - j\sin\pi = -1 - j(0) = -1$$

$$W^3_4 = \left(e^{-j2\frac{\pi}{4}}\right)^3 = e^{-j3\frac{\pi}{2}} = \cos 3\frac{\pi}{2} - j\sin 3\frac{\pi}{2} = 0 - j(-1) = j$$

$$W^4_4 = \left(e^{-j2\frac{\pi}{4}}\right)^4 = e^{-j2\pi} = \cos 2\pi - j\sin 2\pi = 1 - 0 = 1$$

$$W^6_4 = \left(e^{-j2\frac{\pi}{4}}\right)^6 = e^{-j3\pi} = \cos 3\pi - j\sin 3\pi = -1 - j(0) = -1$$

$$W^9_4 = \left(e^{-j2\frac{\pi}{4}}\right)^9 = e^{-j9\frac{\pi}{2}} = \cos 9\frac{\pi}{2} - j\sin 9\frac{\pi}{2} = 0 - (j) = -j$$

$X_N \quad = W_n \quad x_n$

$$\begin{bmatrix} X(0) \\ X(1) \\ X(2) \\ X(3) \end{bmatrix} = \begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & -j & -1 & j \\ 1 & -1 & 1 & -1 \\ 1 & j & -1 & -j \end{bmatrix} \begin{bmatrix} 0 \\ 1 \\ 2 \\ 3 \end{bmatrix}$$

$x(0) = 0 + 1 + 2 + 3 = 6$

$x(1) = 0 + (-j) + (-2) + 3j = -2 - 2j$

$x(2) = 0 + (-1) + (2) + (-3) = -2$

$x(3) = 0 + j + (-2) + (-3j) = -2 + 3j$

$x(k) = \{6, -2-2j, -2, -2+3j\}$

Twiddle factor :

Twiddle factor are set of values that are used in fast fourier transform to speed up the operations of DTF & IDTF

It is denoted as $W_N^{nk} = e^{\frac{-j2\pi nk}{N}}$

DFT $= x(k) = \sum_{n=0}^{N-1} x(n) W_N^{nk}$ for $k = 0, 1, 2 \cdots N-1$

$\sum^{N-1} x(k)$ ${}^{-nk}$

Properties of twiddle factor:

① Periodicity Property: $W_N^{nk+N} = W_N^{nk}$

where N is a complete periodic cycle.

N = 8 then

$W^{0}_{8} = W^{8}_{8} = W^{16}_{8} = 1$

② Symmetric Property : $W_N^{nk+\frac{N}{2}} = Wn^{k}$

If N = 8 then the values are symmetric in that periodic cycle.

$W^{0}_{8} = 1 \quad W^{4}_{8} = -1$

05

$W^{1}_{8} = \frac{1}{\sqrt{2}} - j\frac{1}{\sqrt{2}}$; $W^{5} = \frac{-1}{\sqrt{2}} + j\frac{1}{\sqrt{2}}$

ASHOKRAO MANE GROUP OF INSTITUTIONS, VATHAR.
Faculty of Engineering

CIRCULAR/NOTICE

Doc. No.: AMGOI -FRM-03
Rev. No.: 00
Rev. Dt: 04/07/2013

Date-07/10/2023

All the students are hereby informed that, departmental MSE Semester Exam is scheduled from **11/10/2023** to **13/10/2023** of **20 marks**. The details of the schedule are as follows.

DATE	TIME	SY	TY	B. Tech
11/10/2023	10.15.am to11.15 am	EMI	DSP	FOC
11/10/2023	03.00pm to 04.00pm	EDC	AC	ME
12/10/2023	10.15.am to11.15 am	M III	ACOM	MCOM
12/ 10/2023	03.00pm to 04.00pm	DE	EFT	ED
13/ 10/2023	10.15.am to11.15 am		CSE	EEFM

7/10/23

Mr. S. A. Bhosale
Exam coordinator

Mrs. S. S. Patil
H.O.D

HOD
Electronics & Telecommunication Engg.
Ashokrao Mane Group of Institutions
Vathar Tarf Vadagaon.

E & Tc. Engg.

DR. BABASAHEBAMBEDKAR TECHNOLOGICAL UNIVERSITY, LONERE
Mid Semester Examination-Marking scheme with solution—Oct., 2023
Course: **B. Tech in Electronics & Telecommunication Engineering** Sem: **V**
Subject Name: **Digital Signal Processing** Subject Code: **BTETC502**
Max Marks: **20** Date: **11/ 10 /2023** Duration: **1 Hr.**

		(Level/CO)	Marks
Q. 1	**Fill in the blank**	05*01M	
A.	How many complex multiplications are need to be performed for each FFT algorithm? a) (N/2)logN b) N $\log_2N$ c) **$(N/2)\log_2N$** d) N^2	U/BTETC502.2	01
B.	How many no. of stages required to compute 16 point DFT using DIF FFT algorithm. a) 2 b) 3 c) **4** d) 8	U/BTETC502.2	01
C.	For a decimation-in-time FFT algorithm, which of the following is true? a) Both input and output are in order b) Both input and output are shuffled c) **Input is shuffled and output is in order** d) Input is in order and output is shuffled	U/BTETC502.2	01
D.	4-point DFT of a real time discrete signal x[n] of length 4 is given by X(k) ; k = 0, 1, 2, 3. It is given that X(0) = 5; X(1) =1+ j1 ; X(2) = 0.5 & X(3)=_____ a) -0.5 b) -1-j1 c) **1-j1** d) -5	A/BTETC502.2	01
E.	Multiplying sequence x(n) by $e^{j\omega 0}$ in time domain corresponds to frequency shift by 'ω0' in frequency domain this is called as a) Time shifting property b) Periodicity Property c) **Frequency shifting property** d) Correlation theorem	U/BTETC502.2	01
Q.2	Solve **any Three** of the following.	03*05 M	
A.	Determine Output response y(n) if h(n)={1,1,1} and x(n)={1,2,3,4} by using i) Circular convolution ii) circular convolution using linear convolution. Write comment on result. **Ans:** i) y(n)={8,7,6,9}--------(2M) ii)y(n)={1,3,6,9,7,4}----(2M) **comment:** In circular convolution first 2 points are result of overlapping of first and last 2 points from linear convolution i.e In circular convolution aliasing effect takes place. -------------------------(1M)	A/BTETC502.2	05
B.	Explain any four properties of DFT. Each property statement & proof ----------------(1.25M)	U/BTETC502.2	05
C.	Compute the FFT of a sequence x(n)=n+1 where N=4 using 'Decimation in Time' algorithm. **Ans:** 1st stage calculations and flow diagram -----------(2M) 2nd stage calculations and flow diagram-----------(2M) X(k)={10, -2+2j, -2, -2-2j} -------------------------- (1M)	A/BTETC502.2	05
D.	Compute the FFT of a sequence x(n)={1,-1,1,-1} where N=4 using 'Decimation in Frequency' algorithm. **Ans:** 1st stage calculations and flow diagram -----------(2M) 2nd stage calculations and flow diagram-----------(2M) X(k)={0,0,4,0} ---------------------------- (1M)	A/BTETC502.2	05

Shri Balasaheb Mane Shikshan Prasarak Mandal, Ambap's
Ashokrao Mane Group of Institutions,Faculty of Engineering
Vathar Tarf Vadgaon- 416112

Exam: Mid Sem **Branch:** E&TC Engg. **Time:** 10:30 to 11:30

Subject: Digital signal processing **Date:** 11/10/2023

Roll No.	Name of student	Sign	Marks( )
01	Bhosale Dhairyashil Pratap	Dhairyashil	04+05=09
02	Chougule Suyog Rajkumar	SChougule	03+05 =08
03	Pandurang Namadev Gopane		05+08 =13
04	Geeta Chandrakant Jagtap	GJagtap	04+11 =15
05	Rushikesh Ramesh Kumbhar		04+10 =14
06	Sakshi Sachin Lambe	SLambe	04 +11=15
07	Shreyansh Sunil Kiningé.	SKinge.	04+07=11
08	Diksha D Mane	DMane	05+13 =18
09	Sakshi A. Mutnale	SMutnale.	05+11 =16
10	Aditi Raosaheb patil	ARPatil.	04+12 =16
11	Patil Akshay Dilip	A.D.Patil.	05+05=10
12	Aniket Vishwanath Patil		04+08 =12
13	AYUSH Subhash patil	Patil	04+07=11
14	Ketan Krushnat Patil	K.K.Patil	04+06 =10
15	Pratik Dattatray Patil	Patil	04+06=10
16	Rohan Shivaji Patil	PSPatil	05+05 =10
17	Rohini Bharama Patil	Patil	04+10=14
18	Sakshi Madhukar Patil	SPatil	04+10= 14
19	Vrushabh Babaso Patil	Bapu	04+04=08
20	Pranita Shrikant Pawar.	Pranita.	03 +11=14
21	Poojakumari N. Rajput		03+12 =15
22	Sonamkumari N. Rajput	Sonam	03+ 10 =13
23	Ritesh Shashikant Patil		04+10=14
24	Arati Ramchandra Salunkhe	Salunkhe	04+14=18
25	Shubham Maruti Shinde.		00+08=08
26	Shirish . Y. Shipekar		05+07=12
27	Kajal Mahadev Shirke.		05+10 =15
28	Vaishnavi Vishwas Yadav-Patil	VPatil.	04+10=14
29	Prachi Raghunath Yadav	Pyadav.	05+11 = 16
30	Suyash Sanjay Desai		03+10 =13
31	Pooja M. Pawar	PPawar	04+14 =18
32	Sarthak Sachin Jadhav.	Sarthak.	03+07 =10

Total No. of Present Student: 36
Total No. of Absent Student: 01
Total No. of Student: 37

Mali
Jr.Supervisor Name & Sign

Shri Balasaheb Mane Shikshan Prasarak Mandal, Ambap's

Ashokrao Mane Group of Institutions,Faculty of Engineering

Vathar Tarf Vadgaon- 416112

Exam: Mid sem **Branch:** E&TC Engg. **Time:** 10:30 to 11:30

Subject: Digital signal processing **Date:** 11/10/2023

Roll No.	Name of student	Sign	Marks( )
33	Shriya R. Wayangankar		04+12=16
34	Manasi Sannaki	mgs	04+12=16
35	Anjali Patil		03+09=12
36	snehjeet chougule.		03+06=09
37	Pathan Umar		
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Total No. of Present Student: 36

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Jr.Supervisor Name & Sign

Dr. Babasaheb Ambedkar Technological University, Lonere
ASHOKRAO MANE GROUP OF INSTITUTIONS
Vathar Tarf Vadgaon, Tal. Hatkanangale, Dist. Kolhapur. (M.S.) Pin 416 112.

(To be filled by the Candidate) Sr. No. 022395

[✓ Mid Sem Exam.]/~~Unit Test-I/Unit Test-II/POE~~

Course: TY BTech

Exam Seat No.: 08

Subject: DSP

Code:

Semester: V

Examination Seat No.:

Center: AMGOI, Vathar

Date: 11/10/23

Time:

Prof D.M.Mali

Name of the Supervisor

Mali 11/10/23

Signature of the Supervisor

(To be filled in by the examiner)

Q. No.	1	2	3	4	5	6	7	8	Total Marks In Fig.	Signature
	05	13							18	

(Start writing from here)

Q. 1

01 A ~~d) N/2~~ c) $(N/2) \log_2 N$

01 B c) 4

01 C c) i/p is shuffled & o/p is in order

01 D c) 1-j1

01 E c) freq^n shifting prop.

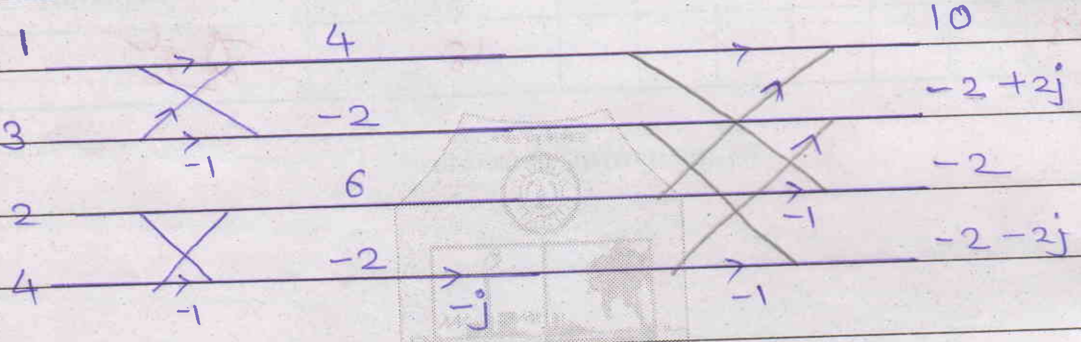
Q.2 c) $x(n) = n+1$ $N=4$

$\therefore x(n) = \{1, 2, 3, 4\}$

DIT-FFT

- Bit Reversal

00 →	00	$x(0)$	= 1
01 →	10	$x(2)$	= 3
10 →	01	$x(1)$	= 2
11 →	11	$x(3)$	= 4



05

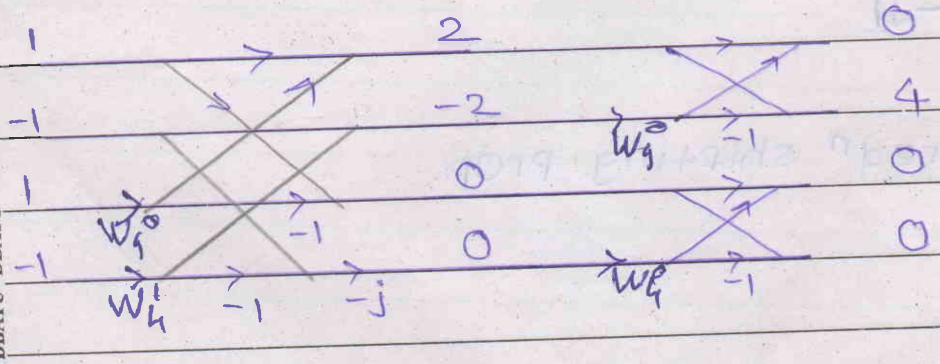
show calculations of each stage along with twiddle factor

we get,

$\therefore X(k) = \{10, -2+2j, -2, -2-2j\}$

Q.2 d) $x(n) = \{1, -1, 1, -1\}$ $N=4$

DIF-FFT



04

$\therefore X(k) = \{0, 4, 0, 0\}$

Padding

Q.2

A. $x(n) = \{1, 2, 3, 4\}$ $h(n) = \{1, 1, 1\}$ $h(n) = \{1, 1, 1, 0\}$

$$y(n) = x(n) * h(n) = \sum_{k=0}^{N-1} x(k) \cdot h(n-k)$$

i> circular convolution:

$$[y_n] = \begin{bmatrix} 1 & 0 & 1 & 1 \\ 1 & 1 & 0 & 1 \\ 1 & 1 & 1 & 0 \\ 0 & 1 & 1 & 1 \end{bmatrix} \begin{bmatrix} 1 \\ 2 \\ 3 \\ 4 \end{bmatrix}$$

$$y_n = \begin{bmatrix} 1+0+3+4 \\ 1+2+0+4 \\ 1+2+3+0 \\ 0+2+3+4 \end{bmatrix}$$

$$\therefore \begin{bmatrix} y(0) \\ y(1) \\ y(2) \\ y(3) \end{bmatrix} = \begin{bmatrix} 8 \\ 7 \\ 6 \\ 9 \end{bmatrix}$$

$\therefore y(n) = \{8, 7, 6, 9\}$

ii> circular convolution using linear convolution

- Linear

h(n) \ x(n)	1	2	3	4
1	1	2	3	4
1	1	2	3	4
1	1	2	3	4

$\therefore y(n) = \{1, 3, 6, 9, 7, 4\}$

Length of $x(n)$ $L = 4$

length of $h(n)$ $M = 3$

$\therefore$ Length of $y(n) = L+M-1 = 4+3-1 = 6$

- circular convolution using Linear

  $\therefore$ padding zeros

$x(n) = \{1, 2, 3, 4, 0, 0\}$

$h(n) = \{1, 1, 1, 0, 0, 0\}$

$$\therefore y_n = \xcancel{\begin{bmatrix} 1 & 0 & 0 & 1 & 1 & 1 \\ 1 & 1 & 0 & 0 & 1 & 1 \\ 1 & 1 & 1 & 0 & 0 & 1 \\ 0 & 1 & 1 & 1 & 0 & 0 \\ 0 & 0 & 1 & 1 & 1 & 0 \end{bmatrix}}$$

$$y_n = \begin{bmatrix} 1 & 0 & 0 & 0 & 1 & 1 \\ 1 & 1 & 0 & 0 & 0 & 1 \\ 1 & 1 & 1 & 0 & 0 & 0 \\ 0 & 1 & 1 & 1 & 0 & 0 \\ 0 & 0 & 1 & 1 & 1 & 0 \\ 0 & 0 & 0 & 1 & 1 & 1 \end{bmatrix} \begin{bmatrix} 1 \\ 2 \\ 3 \\ 4 \\ 0 \\ 0 \end{bmatrix}$$

$$y_n = \begin{bmatrix} 1+0+0+0+0+0 \\ 1+2+0+0+0+0 \\ 1+2+3+0 \end{bmatrix}$$

$$\therefore \begin{bmatrix} y(0) \\ y(1) \\ y(2) \\ y(3) \\ y(4) \\ y(5) \end{bmatrix} = \begin{bmatrix} 1 \\ 3 \\ 6 \\ 9 \\ 7 \\ 4 \end{bmatrix}$$

04

$$\therefore y(n) = \{1, 3, 6, 9, 7, 4\}$$

ASHOKRAO MANE GROUP OF INSTITUTIONS, VATHAR.
Faculty of Engineering

CIRCULAR/NOTICE

Doc. No.: AMGOI -FRM-03
Rev. No.: 00
Rev. Dt: 04/07/2013

Date-28/11/2023

All the students are hereby informed that, departmental CA-II Semester Exam is scheduled from **01/12/2023** to **02/12/2023** of **20 marks**. The details of the schedule are as follows.

DATE	TIME	SY	TY	B.Tech
01/12/2023	10.15.am to11.15am	M III	EFT	FOC
01/12/2023	12.30pm to 01.30pm	EDC	DSP	ED
01/12/2023	02.30pm to 03.30pm	-	ACOM	MCOM
02/ 12/2023	10.15.am to11.15am	DE	AC	ME
02/ 12/2023	12.30pm to 01.30pm	EMI	CSE	EEFM

28/11

Mr. S. A. Bhosale
Exam coordinator

Mrs. S. S. Patil
H.O.D

HOD
Electronics & Telecommunication Engg.
Ashokrao Mane Group of Institutions
Vathar Tarf Vadagaon.

E & Tc. Engg.

DR. BABASAHEBAMBEDKAR TECHNOLOGICAL UNIVERSITY, LONERE

Continuous Assessment-II DEC., 2023

Course: **B. Tech in Electronics & Telecommunication Engineering** Sem: **V**
Subject Name: **Digital Signal Processing** Subject Code: **BTETC502**
Max Marks: **20** Date: **01/11/2023** Duration: **1 Hr.**

Instructions to the Students:

1. **Solve all questions .**
2. Assume suitable data if required.
3. Use of non-programmable scientific calculator is allowed.

		(Level/CO)	Marks
Q. 1	**Fill in the blank**		**05*01M**
A.	The magnitude response of Butterworth filter has a) Flat pass band and Flat stop band b) Flat pass band and Tapering stop band c) Tapering pass band and Flat stop band d) Tapering pass band and Tapering stop band	R/BTETC502.6	01
B.	The transformation technique in which there is one to one mapping from s-domain to z-domain is__ a) Approximation of derivatives b) Impulse invariance method c) Bilinear transformation method d) Backward difference for the derivative	R/BTETC502.6	01
C.	Stable poles from s- plane maps- a) Inside unit circle in z-plane b) Outside unit circle in z-plane c) On unit circle in z-plane d) None of the above	U/BTETC502.6	01
D.	Consider the assertions given below. Which among them is an advantage of FIR Filter? a) Necessity of computational techniques for filter implementation b) Requirement of large storage c) Incapability of simulating prototype analog filters d) Presence of linear phase response	R/BTETC502.6	01
E.	In FIR filter design, which among the following parameters is/are separately controlled by using Kaiser window? a) Order of filter b) Transition width of main lobe c) Both a) and b) d) None of the above	R/BTETC502.6	01
Q.2	Solve **any Three** of the following.		**03*05 M**
A.	For analog transfer function $H(s) =1/s^2+3s+2$, Determine H(z) using impulse invariant technique.	A/BTETC502.3	05
B.	What is bilinear transformation? Explain frequency warping effect & prewarping procedure in BLT method.	U/BTETC502.3	05
C.	Design the second order low pass digital Butterworth filter with following specifications, Cutoff frequency=1KHz Sampling frequency=104 sps $H(s)= 1/s2+\sqrt{2}\ s+1$	A/BTETC502.3	05
D.	Obtain following realizations of system functions: i) $H(z)= (1+2z^{-1}-z^{-2})\ (1+z^{-1}-z^{-2})$ --cascade realization ii) $y(n)=2r\cos w_0\ y(n-1)-r^2y(n-2)+x(n)-r\cos w_0\ x(n-1)$—direct form-I	A/BTETC502.6	05

DR. BABASAHEBAMBEDKAR TECHNOLOGICAL UNIVERSITY, LONERE

Continuous Assessment-II DEC., 2023

Course: **B. Tech in Electronics & Telecommunication Engineering** Sem: **V**
Subject Name: **Digital Signal Processing** Subject Code: **BTETC502**
Max Marks: **20** Date: **01/11/2023** Duration: **1 Hr.**

		(Level/CO)	Marks
Q. 1	**Fill in the blank**		**05*01M**
A.	The magnitude response of Butterworth filter has a) Flat pass band and Flat stop band b) **Flat pass band and Tapering stop band** c) Tapering pass band and Flat stop band d) Tapering pass band and Tapering stop band	**R/BTETC502.6**	**01**
B.	The transformation technique in which there is one to one mapping from s-domain to z-domain is__ a) Approximation of derivatives b) Impulse invariance method c) **Bilinear transformation method** d) Backward difference for the derivative	**R/BTETC502.6**	**01**
C.	Stable poles from s- plane maps- a) **Inside unit circle in z-plane** b) Outside unit circle in z-plane c) On unit circle in z-plane d) None of the above	**U/BTETC502.6**	**01**
D.	Consider the assertions given below. Which among them is an advantage of FIR Filter? a) Necessity of computational techniques for filter implementation b) Requirement of large storage c) Incapability of simulating prototype analog filters d) **Presence of linear phase response**	**R/BTETC502.6**	**01**
E.	In FIR filter design, which among the following parameters is/are separately controlled by using Kaiser window? a) Order of filter b) Transition width of main lobe c) **Both a) and b)** d) None of the above	**R/BTETC502.6**	**01**
Q.2	Solve **any Three** of the following.		**03*05 M**
A.	For analog transfer function $H(s) =1/s^2+3s+2$, Determine H(z) using impulse invariant technique.	**A/BTETC502.3**	**05**

Solution

Given that, $H(s) = \frac{2}{s^2+3s+2} = \frac{2}{(s+1)(s+2)}$

By partial fraction expansion technique we can write,

$$H(s) = \frac{2}{(s+1)(s+2)} = \frac{A}{s+1} + \frac{B}{s+2}$$

$$A = \frac{2}{\cancel{(s+1)}(s+2)} \times \cancel{(s+1)}\Big|_{s=-1} = \frac{2}{-1+2} = 2$$

$$B = \frac{2}{(s+1)\cancel{(s+2)}} \times \cancel{(s+2)}\Big|_{s=-2} = \frac{2}{-2+1} = -2$$

The roots of quadratic $s^2+3s+2=0$ are,

$$s = \frac{-3 \pm \sqrt{3^2 - 4 \times 2}}{2}$$

$$= \frac{-3 \pm 1}{2} = -1, -2$$

---(2M)

$$\therefore H(s) = \frac{2}{s+1} + \frac{2}{s+2}$$

By impulse invariant transformation we know that,

$$\boxed{\frac{A_i}{s+p_i} \xrightarrow{\text{(is transformed to)}} \frac{A_i}{1-e^{-p_iT}z^{-1}}}$$

$$\therefore H(z) = \frac{2}{1-e^{-p_1T}z^{-1}} + \frac{-2}{1-e^{-p_2T}z^{-1}} \quad \text{where } p_1 = 1 \text{ and } p_2 = 2$$

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

When T = 1 second

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

$$H(z) = \frac{2}{1-0.3679z^{-1}} + \frac{-2}{1-0.1353z^{-1}} = \frac{2(1-0.1353z^{-1}) - 2(1-0.3679z^{-1})}{(1-0.3679z^{-1})(1-0.1353z^{-1})}$$

$$= \frac{2-0.2706z^{-1}-2+0.7358z^{-1}}{1-0.1353z^{-1}-0.3679z^{-1}+0.0498z^{-2}} = \frac{0.4652z^{-1}}{1-0.5032z^{-1}+0.0498z^{-2}}$$

---(3M)

B. What is bilinear transformation? Explain frequency warping effect & prewarping procedure in BLT method. U/BTETC502.3 05

The Bilinear transformation is a mapping that transforms the left half of S-plane into the unit circle in the Z-plane only once, thus avoiding aliasing of frequency components.

The mapping from the S-plane to the Z-plane is in bilinear transformation is $S=2/T(1-Z^{-1}/1+Z^{-1})$

The mapping is highly non-linear producing frequency, compression at high frequencies. Neither the impulse response nor the phase response of the analog filter is preserved in a digital filter obtained by bilinear transformation ---(2M)

Frequency warping effect:

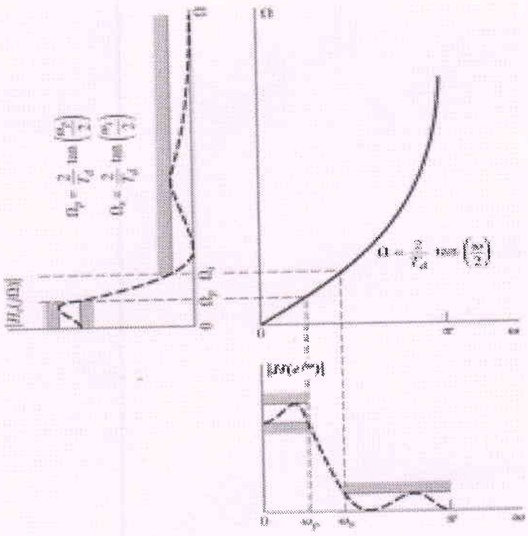
The mapping of frequency from Ω to ω is approximately linear for small value of Ω & ω. For the higher frequencies, however the relation between Ω & ω becomes highly non-linear. This introduces the distortion in the frequency scale of digital filter relative to analog filter. This effect is known as warping effect. ---(1M)

Prewarping procedure:

For large frequency values the non linear compression that occurs in the mapping of Ω to ω is more apparent .This compression causes the transfer function at high Ω frequency to be highly distorted when it is translate to the w domain. This compression is being compensated by introducing a prescaling or prewarpping to Ω frequency scale.

For bilinear transform Ω scale is converted into Ω* scale

(i.e) $\Omega^* = 2/T_s \tan(\Omega T_s/2)$ (prewarped frequency)



we have to account for frequency warping when we start from a discrete-time filter specification. $\Omega p = (2/T_s)\tan(\omega_p/2)$ and $\Omega s = (2/T_s)\tan(\omega_s/2)$ ---

(2M)

C. Design the second order low pass digital Butterworth filter with following specifications, — A/BTETC502.3 — 05

Cutoff frequency=1KHz

Sampling frequency=104 sps

$H(s)= 1/s2+\sqrt{2} s+1$

Shri Balasaheb Mane Shikshan Prasarak Mandal, Ambap's
Ashokrao Mane Group of Institutions,Faculty of Engineering
Vathar Tarf Vadgaon- 416112

Exam: CA-II **Branch:** E&TC Engg. **Time:** 10:35 to 11:15

Subject: Digital Signal Processing (DSP) **Date:** 01/12/23

Roll No.	Name of student	Sign	Marks( )
01	Bhosale Dhairyashil Pratap		04+04=08
02	Chougule Suyog Rajkumar	SChougule	03+05=08
03	Pandurang Namadev Gopane		05+04=09
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18	Sakshi Madhukar Patil	SmPatil	03+13=16
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21	Pooja N. Rajput		05+13=18
22	Sonamkumari N. Rajput	Sonam	04+13=17
23	Ritesh S. Patil.		03+09=12
24	Arati Ramchandra Salunkhe	Salunkhe.	05+11=16
25	-Shinde Shubham Maruti	SShinde	04+04=08
26	Shirishkumar . Y. Shipekar	Shipekar	04+05=09
27	Kajal Mahadev Shirke		05+13=18
28	Vaishnavi Vishwas Yadav-Patil.	VYPatil.	05+11=16
29	Prachi Raghunath Yadav	PYadav.	05+12=17
30	Suyash Sanjay Desai		05+06=11
31	Pooja M. Powar		05+13=18
32	Jadhav Sarthak Sachin	Sarthak	03+05=08

Total No. of Present Student: 36
Total No. of Absent Student: 01
Total No. of Student: 37

Jr.Supervisor Name & Sign

Shri Balasaheb Mane Shikshan Prasarak Mandal, Ambap's
Ashokrao Mane Group of Institutions,Faculty of Engineering
Vathar Tarf Vadgaon- 416112

Exam: Branch: E&TC Engg. Time:

Subject: Date:

Roll No.	Name of student	Sign	Marks( )
33	Shriya Wayangankar	Shreya	05+13=18
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35	Anjali Patil		05+12=17
36	Snehjeet Chougule		05+05=10
37	Pathan Umar	-	Ab
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Jr.Supervisor Name & Sign

Dr. Babasaheb Ambedkar Technological University, Lonere

ASHOKRAO MANE GROUP OF INSTITUTIONS

Vathar Tarf Vadgaon, Tal. Hatkanangale, Dist. Kolhapur. (M.S.) Pin 416 112.

(To be filled by the Candidate) Sr. No. 030690

~~Mid Sem Exam./Unit Test-I/~~Unit Test-II/~~POE~~

Course: TY BTech **Exam Seat No.:** 0 8

Subject: DSP **Code:**

Semester: V

Examination Seat No.

Center: AMGOI, Vathar

Date: 04/12/23 **Time:**

prof. S.A. Bhosale

Name of the Supervisor

4/12

Signature of the Supervisor

(To be filled in by the examiner)

Q. No.	1	2	3	4	5	6	7	8	Total Marks In Fig.	Signature
	05	14							19	

(Start writing from here)

Q.1

01 1) b) Flat pass band & Tapering stop band.

01 2) c) Bilinear transfomation method

01 3) a) Inside unit circle in z-plane

01 4) d) presence of linear phase response

01 5) c) Both a) and b)

Q.2

c) Given: Cut-off freqn $(f_c) = 1\,kHz$

sampling freqn $(f_s) = 10^4$ sps $= 10^4$ ~~K~~Hz

The T.F. of Low pass butterworth filter is

$$H(s) = \frac{1}{s^2+\sqrt{2}s+1}$$

$$\therefore \omega_c = 2\pi\left(\frac{f_c}{f_s}\right) = 2\pi\left(\frac{1k}{10k}\right)$$

$$= 2\pi(0.1) = 0.2\pi \text{ rad/sec}$$

Pre-warping,

$$\Omega_c = \frac{2}{T}\tan\left(\frac{\omega_c}{2}\right)$$

$$= \frac{2}{1}\tan\left(\frac{0.2\pi}{2}\right) \text{ --- } (\because T=1)$$

$$= 2\tan(0.1\pi)$$

$$\therefore \Omega_c = 0.0109$$

Now, Replace $s \rightarrow s/\Omega_c$

$$\therefore H_a(s) = \frac{1}{\left(\frac{s}{\Omega_c}\right)^2 + \frac{\sqrt{2}}{\Omega_c}s + 1}$$

$$= \frac{1}{\frac{s^2}{(0.01)^2} + \frac{\sqrt{2}}{0.01}s + 1}$$

$$\therefore Ha(s) = \frac{0.0001}{s^2 + (0.0001)(141.42)s + 0.0001}$$

$$\therefore Ha(s) = \frac{0.0001}{s^2 + 0.014 s + 0.0001}$$

TO get Butterworth Low pass filter,

$$\therefore H(z) = Ha(s)\Big|_{s \to \frac{2}{T}\left(\frac{1-z^{-1}}{1+z^{-1}}\right)} \leftarrow T=1$$

$$\therefore H(z) = \frac{0.0001}{\left(\frac{2(1-z^{-1})}{1+z^{-1}}\right)^2 + 0.014\left(\frac{2(1-z^{-1})}{(1+z^{-1})}\right) + 0.0001}$$

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is required T.F. of LP Butterworth filter.

Q.2.A

$$H(s) = \frac{1}{s^2 + 3s + 2}$$

$2s^2$
$\wedge$
$+2 \; +1$

$$\therefore H(s) = \frac{1}{(s+2)(s+1)}$$

By PFE,

$$H(s) = \frac{1}{(s+2)(s+1)} = \frac{A_1}{s+2} + \frac{A_2}{s+1} \quad \text{———} ①$$

$$\therefore A_1 = \frac{1}{-2+1} = -1$$

$$\& \; A_2 = (s+1) \frac{1}{(s+2)(s+1)} \Bigg|_{s=-1}$$

$$\therefore A_2 = 1$$

eqn ① becomes,

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

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

i.e. in the form,

$$H(s) = \frac{C_1}{s-P_1} + \frac{C_2}{s-P_2}$$

$$\therefore C_1 = 1, \; C_2 = -1, \; P_1 = -1, \; P_2 = -2$$

By impulse invariance technique,

$$H(z) = \sum_{k=1}^{N} \frac{T.C_k}{1-e^{P_k T} z^{-1}} \quad \because T=1$$

Q4

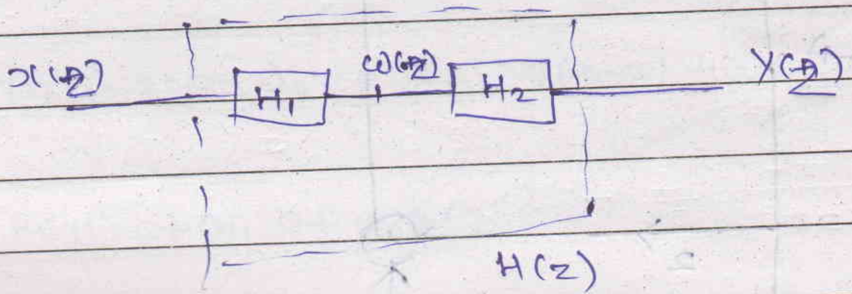
$$\therefore H(z) = \frac{1}{1-e^{-1}z^{-1}} - \frac{1}{1-e^{-2}z^{-1}}$$

Q.2

D. i) $H(z) = (1+2z^{-1}-z^{-2})(1+z^{-1}-z^{-2})$ ①

Cascade Realization.

consider $H(z) = H_1(z) \cdot H_2(z)$



$$\therefore \quad H_1(z) = \frac{\omega(z)}{x(z)}$$

$$\therefore \quad 1+2z^{-1}-z^{-2} = \omega(z) \cdot x(z)$$

$$\therefore \quad \omega(z) = x(z) + 2x(z)z^{-1} - x(z)z^{-2}$$

Taking IZT on b.s.

$$\therefore \omega(n) = x(n) + 2x(n-1) - x(n-2) \quad ②$$

Now, $H_2(z) = \frac{Y(z)}{\omega(z)}$

$$\therefore \quad 1+z^{-1}-z^{-2} = \frac{Y(z)}{\omega(z)}$$

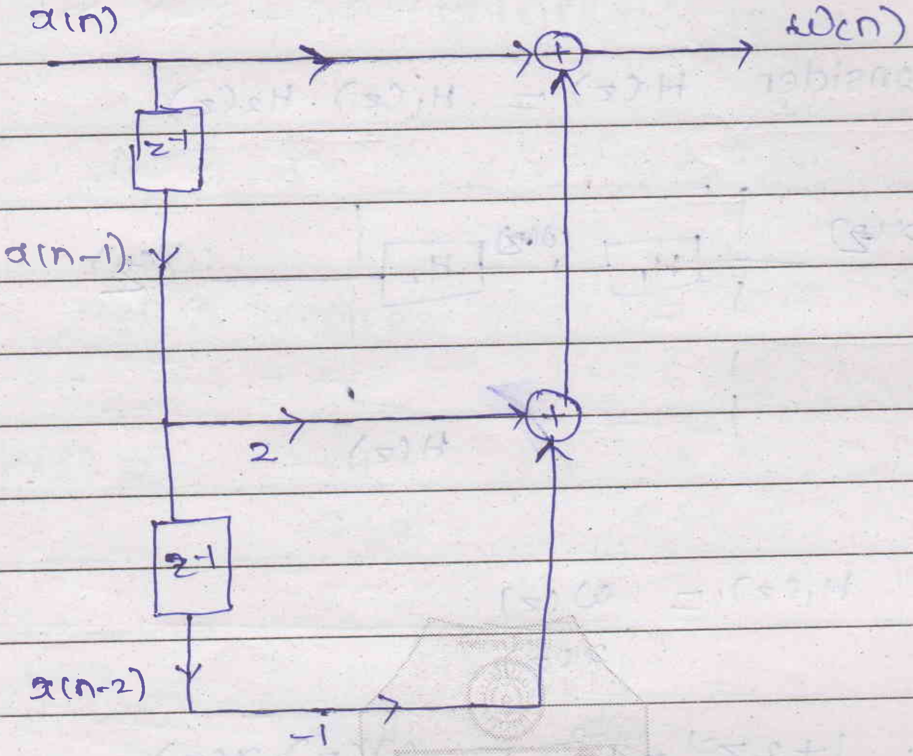
$$\therefore \quad y(z) = \omega(z) + \omega(z)z^{-1} - \omega(z)z^{-2}$$

Taking I.Z.T on b.s.

$$\therefore y(n) = \omega(n) + \omega(n-1) - \omega(n-2) \quad ②$$

cascade Realization of eqn ① is -

$$\omega_n = x(n) + 2x(n-1) - x(n-2)$$



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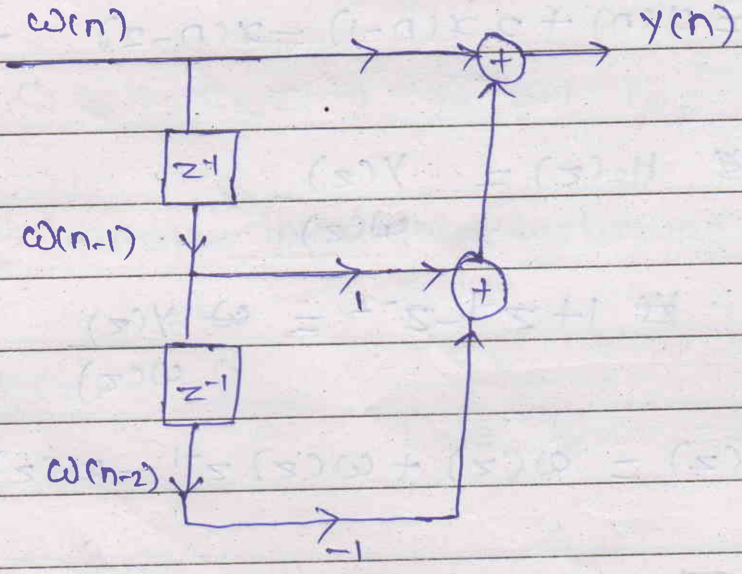
cascade Ralization of eqn ②,

$$y(n) = \omega(n) + \omega(n-1) - \omega(n-2)$$



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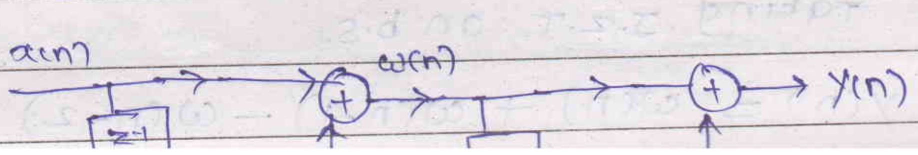


D. ii) $y(n) = 2r\cos\omega_0 y(n-1) - r^2 y(n-2) + x(n) - r\cos\omega_0 x(n-1)$

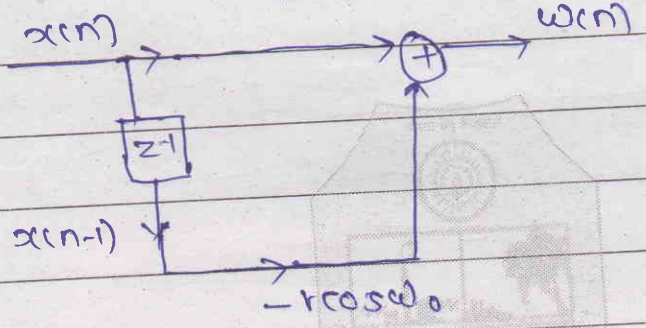
By Direct form-I,

consider,

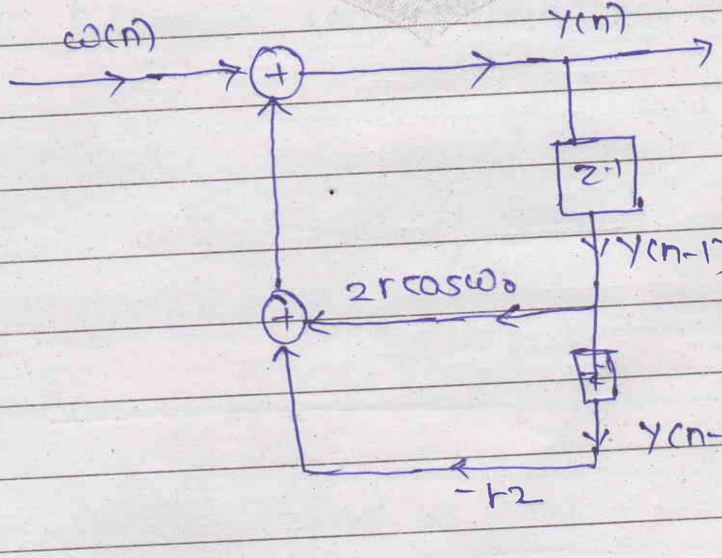
$\omega(n) = x(n) - r\cos\omega_0 x(n-1)$ ——— ①

$\therefore y(n) = 2r\cos\omega_0 y(n-1) - r^2 y(n-2) + \omega(n)$ ——— ②

Realization of eqn ① is –



Realization of eqn ②,



Realization of eq^n ① and ②,

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