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K. C. College of Engineering & Management Studies & Research

Mith Bunder Road, Kopri, Thane (E)

Cycle – 2 NAAC Accreditation 2024

Criteria 2: Teaching- Learning and Evaluation

2.6.2 Attainment of POs and COs are evaluated.

Submitted to

National Assessment and Accreditation Council

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Mith Bunder Road, Near Hume Pipe ,Kopri,Thane E-400603

Assessment processes used to gather the data upon which the evaluation of Course Outcome is based

The course outcomes for every course are defined as per syllabus and mapped with programme outcomes. The course outcomes are assessed and evaluated using direct and indirect methods and various tools are used for data collection. At the end of the course, attainment of course outcome is calculated and programme outcome is evaluated.

Method	Assessment Tools		WEIGHTAGE	WEIGHTAGE
Direct	Internal Assessment	Internal Assessment test(Theory)	Direct Assessment 'X'= (80% ESE) + (20%IA	Final Final Attainment= (80% 'X') + (20% 'Y')
		Assignments		
		Laboratory Experiment		
		Mini Project		
		Major Project		
	End semester Examination(Theory and practical/ oral Exam)			
Indirect		Course exit survey	Indirect Assessment 'Y'	

Table : Assessment Process

A) Direct Assessment Tool

I) Internal Term Test

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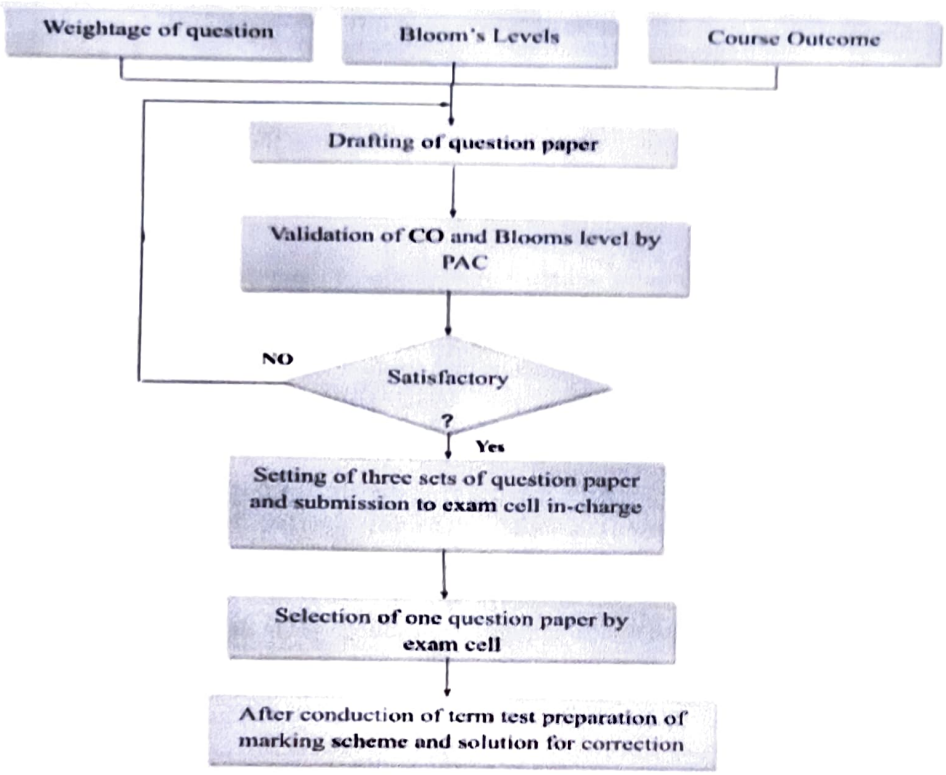

Fig Flowchart of conduction of Internal Term Test theory exam

Assessment Tools	Frequency	Assessment Process
Internal Term Test	Twice per semester	Two term tests are conducted in a semester as per University of Mumbai guidelines . A faculty prepares 3 sets of the Question papers for the given subject and submitted them to the IA coordinator. A faculties s Marking Scheme and solutions for question paper and evaluates the performance of students as per the Marking scheme The Internal Assessment marks are based on average of score of two tests conducted

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Record the Attainment of Course Outcomes of all Courses with Respect to Set Attainment Levels

Institute is following below guidelines for setting of CO target for the Given Subject

1. Basis of CO target is

- Trends (Previous result of same subject of passed one / two years)
- Students intelligence (Pre-requisite subject result of same batch)

2. Methodology

- To calculate the trends , % of students * getting more than 60% marks.* is taken
- To calculate pre-requisite, % of students *getting more than 60% marks.*is taken

3. Take the average of student % from both the procedure and round it off to the higher 0 value.

e.g. if 35% round it off to 40%

Example : CO Target setting for A.Y. 2019-20.(Infrastructure Security) for University Examination.

As the subject is newly introduced in the syllabus the previous result of the same subject is not available so only student intelligence is considered for target setting.

Prerequisite mentioned in the syllabus -_Cryptography and Network Security, Computer Network

1) Cryptography and Network Security (2018-19)
   Total no. of students = 64
   Passing = 32 Marks (40 %) = 29 students = 45.31 %
   Above 48 Marks (60%) = 31 students = 48.43%

2) Computer Network (2017-18)
   Total no. of students = 69
   Passing = 32 Marks (40 %) = 51 students = 73.91 %
   Above 48 Marks (60%) = 6 students = 8.69 %
3) Average = (48.43 + 8.69) = 28.56 % rounded off to 30%
4) Set Target will be

- 30% of students getting more than 60 % marks level 1*
- 40% of students getting more than 60 % marks level 2*
- 50% of students getting more than 60 % marks level 3*

5) For Internal Assessment target is increased by 10% or any level appropriately decided.

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Attainment Levels Versus Target (IT)

CO Attainment Method	Attainment Level		
	1	2	3
University Examination	*30% student scoring more than or equal to 60% marks in the final examination*	*40% student scoring more than or equal to 60% marks in the final examination*	*50% student scoring more than or equal to 60% marks in the final examination*
Internal Assessment	*40% students score more than or equal to 60% marks in the internal assessment*	*50% students score more than or equal to 60% marks in the internal assessment*	*60% students score more than or equal to 60% marks in the internal assessment*
Course Exit Survey	*50% weightage in course exit analysis*	*55% weightage in course exit analysis*	*60% weightage in course exit analysis*

Indirect Assessment Tools:

Table :Indirect Assessment Tools (Process of Measuring Attainment of each PO & PSO's)

Sr.No	Assessment Tool	Frequency	Assessment Process
1	Course Exit Survey	At the end of semester for every course.	Course Exit Surveys are conducted at the end of semester for each course by every subject teacher to evaluate the outcome of teaching learning. The level of attainment of COs and the mapped POs are calculated using Course Exit Survey as a tool. .
2	Program Exit Survey	At the end of graduation	Program Exit Survey is taken for final year students to assess graduate attributes at the end of 8th semester.
3	Employer's Feedback Form	Once in a year	Collect the information about the graduates' and skills, capabilities and opportunities available

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4	Content Beyond Syllabus Activity	After each activity	Collect the information about the outcome of the event.
5	Rotaract Club Activities	After each activity	Collect the information about the outcome of the event.
6	Gender Equity Cell		
7	Professional Body event survey		
8	NSS Activities		
9	YRC Club		
10	Eco Club		

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COURSE FILE

ACADEMIC YEAR	2022-23	CLASS	T.E.	SEM	V
NAME OF FACULTY	Dr. Aarti Bakshi				
DESIGNATION	Assistant Professor				
DEPARTMENT	Electronics and Telecommunication				
COURSE CODE	ECC502				
NAME OF SUBJECT	Discrete Time Signal Processing				

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Cover Page

Prepared by:

Name: Dr. Aarti Bakshi

Sign: Bakshi

Designation: Assistant Professor

Date: 24/02/2023

Verified by:

Name: AVISHEK RAY

Sign: alay

Designation: ASSOCIATE PROF.

Date: 16/9/23

Approved by:

Name: Dr R N Duche

Sign:

Designation: Professor & HOD - EXTC, KCOE

Date: 16/9/2023

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Department of Electronics & Telecommunication

Institute Vision & Mission

Vision

To be an organization with potential for excellence in engineering and management for the advancement of society and human kind.

Mission

- To excel in academics, practical engineering, management and to commence research endeavours.
- To prepare students for future opportunities.
- To nurture students with social and ethical responsibilities

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Department Vision & Mission

Vision

To shape Electronics & Telecommunication engineers to be professionally and socially competent.

Mission

- To aim for excellence in teaching learning process and analytical thinking.
- To conduct skill development programs in order to become industry ready.
- To impart students with social and moral education

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Program outcomes

Engineering Graduates will be able to:

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

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PEO

PEO1-

Apply engineering knowledge and skills to meet the requirements of present and emerging technological needs (skill).

PEO2-

Inculcate life-long learning in electronics & telecommunication for developing modernized projects, technologies and services (Professional development)

PEO3 -

Actively involved in socially relevant projects for electronics in the context of developments and services (ethics).

PEO4-

Communicate effectively and operate in cross functional domains. (Communication and teamwork)

PSOs

PSO1:

Knowledge in Communication Engineering Technologies for application in areas of image processing, signal processing, wireless communication.

PSO2:

Apply Hardware & software tools in domains of analog & digital electronic system design

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC502	Discrete-Time Signal Processing	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme						
		Theory Marks				Exam Duration (Hrs.)	Term Work	and Oral
		Internal Assessment			End Sem. Exam.			
		Test1	Test2	Avg.				
ECC502	Discrete-Time Signal Processing	20	20	20	80	03	--	--

Course Pre-requisite:

ECC404 Signals & Systems

Course Objectives:

1. To develop a thorough understanding of discrete Fourier transform and its use in spectral analysis and frequency domain filter designing.
2. To design and realize IIR filters and FIR filters, gain an appreciation for the tradeoffs necessary in the filter design and to evaluate the effects of finite word lengths on the filters.
3. To introduce applications of digital signal processing in the field of biomedical and audio signal processing.

Course Outcomes:

After successful completion of the course student will be able to:

1. Recall the system representations and understand the relation between different transforms.
2. Understand the concepts of discrete-time Fourier transform, fast Fourier transform and apply in system analysis.
3. Design digital IIR and FIR filters to satisfy the given specifications and evaluate the frequency response and pole-zero representations to choose a particular filter for the given application.
4. Interpret the different realization structures of Digital IIR and FIR filters.
5. Analyze the impact of hardware limitations on the performance of digital filters.
6. Apply signal processing concepts, algorithms in applications related to the field of biomedical and audio signal processing.

Module No.	Unit No.	Topics	Hrs.
1.0		**Discrete Fourier Transform & Fast Fourier Transform**	08
	1.1	Discrete Fourier transform (DFT), DFT as a linear transformation, Properties of the DFT, Relationship of the DFT to other transforms, Filtering of long data sequences: Overlap-Save and Overlap-Add Method	05
	1.2	Fast Fourier Transform: Radix-2 Fast Fourier Transforms (FFT), Radix-2 decimation in time and decimation in frequency FFT algorithms, Inverse FFT	03
2.0		**IIR Digital filters**	08
	2.1	LTI systems as frequency-selective filters like low pass, high pass, band pass, notch, comb, all-pass filters, and digital resonators, Analog filter approximations: Butterworth, Chebyshev I, Elliptic	03
	2.2	Mapping from s-plane to the z-plane - impulse invariant and bilinear transformation, Design of IIR digital filters (Butterworth and Chebyshev-I) from analog filters using impulse invariant and bilinear transformation techniques, Analog and digital frequency transformations	05
3.0		**FIR Digital Filters**	09
	3.1	Characteristics of linear phase FIR digital filters, Symmetric and antisymmetric FIR filter, Location of the zeros of linear phase FIR filters, Minimum, maximum and mixed phase systems	04
	3.2	Design of FIR filters using Window techniques (Rectangular, Hamming, Hanning, Blackman, Bartlett), Design of FIR filters using Frequency Sampling Technique – Type I low pass filter design, Comparison of IIR and FIR filters	05
4.0		**Digital Filter Structures**	05
	4.1	Realization structures for FIR systems: Cascade form, Frequency sampling structure, Lattice structure, Computational complexities for N length filter	02
	4.2	Realization structures for IIR systems: Cascade form and parallel form structures, Lattice Ladder structure, Computational complexities for N order filter	03
5.0		**Finite Word Length Effects in Digital Filters**	05
	4.1	Rounding and truncation errors, Quantization error, Output noise power from a digital system	02
	4.2	Product quantization, Noise model for direct form and cascaded IIR structure (first order), Coefficient quantization error and zero input limit cycle	03
6.0		**Applications of Digital Signal Processing**	04
	6.1	Application of DSP for ECG and EEG signals analysis.	02
	6.2	Application of DSP for echo cancellation and sub-band coding of speech signal	02
		Total	39

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Text Books:

1. Proakis J., Manolakis D., "*Digital Signal Processing*", 4th Edition, Pearson Education.
2. Emmanuel C. Ifeachor, Barrie W. Jervis," Digital Signal Processing", A Practical Approach", Pearson Education
3. A Nagoor Kani "Digital Signal Processing", 2nd Edition. Tata Mc Graw Hill Education Private Limited

Reference books

1. Sanjit K. Mitra, "Digital Signal Processing – A Computer Based Approach ", 4th Edition McGraw Hill Education (India) Private Limited, 2013
2. Oppenheim A., Schafer R., Buck J., "Discrete Time Signal Processing", 2nd Edition, Pearson Education, 3rd Edition, 2010
3. L. R. Rabiner and B. Gold, "Theory and Applications of Digital Signal Processing", Prentice-Hall of India, 2006.
4. S Salivahan, C Gnanapriya, "Digital Signal Processing", Mc Graw Hill Education (India) limited, 4th Edition, 2015
5. Monson H Hayes, "Digital Signal Processing", Schaum's Outline Series, 2nd Edition, 2011
6. Rangaraj M. Rangayyan, "Biomedical Signal Analysis- A Case Study Approach",Wiley 2002.

NPTEL / Swayam Course:

1. Course: Digital Signal Processing By Prof. S.C Dutta Roy, IIT Delhi
   http://www.nptelvideos.in/2012/12/digital-signal-processing.html
2. Course: Digital Signal Processing By Prof. V. M. Gadre , IIT Bombay
   https://nptel.ac.in/courses/108/101/108101174/
3. Course: Digital Signal Processing By Prof. T. K. Basu , IIT Kharagpur
   https://nptel.ac.in/courses/108/105/108105055/

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. **Total 04 questions** need to be attempted.

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Course Objective

1. To develop a thorough understanding of discrete Fourier transform and its use in spectral analysis and frequency domain filter designing.
2. To design and realize IIR filters and FIR filters, gain an appreciation for the tradeoffs nec the filter design and to evaluate the effects of finite word lengths on the filters.
3. To introduce applications of digital signal processing in the field of biomedical and audio signal processing.

Course Outcome

Course code	Course outcome	Bloom Taxonomy Level
	At the end of the course student will be able to	
ECC502.1	Understand the relation between different transforms	Understanding
ECC502.2	Understand the concepts of discrete-time Fourier transform, fast Fourier transform and apply in system analysis	Applying
ECC502.3	Design digital IIR and FIR filters to satisfy the given specifications and evaluate the frequency response and pole zero representations	Applying
ECC502.4	Interpret the different realization structures of Digital IIR and FIR filters.	Applying
ECC502.5	Analyze the impact of hardware limitations on the performance of digital filters	Applying
ECC502.6	Apply signal processing concepts, algorithms in applications related to the field of biomedical and audio signal processing	Applying

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Bloom Taxonomy Level

Bloom's Taxonomy level	Keywords	Activities
Remembering	Define, Duplicate, List, Memorize, Recall, Repeat, State	Television Shows, Magazine articles, Reading
Understanding	Classify, Describe, Discuss, Explain ,Identify, Locate, Recognize, Report, Select, Translate, Paraphrase	Diagram, Speech(Seminar),Graph, Outline
Applying	Choose, Demonstrate, Dramatize, Employ, Illustrate, Interpret, Operate, Schedule, Sketch, Solve, Use, Write	Mini Project, Quiz
Analyzing	Appraise, Compare, Contrast, Criticize, Differentiate, Discriminate, Distinguish, Examine, Experiment, Question, Test	Survey, Conclusion, Report, Questionnaire
Evaluating	Appraise, Argue, Defend, Judge, Select, Support, Value(Output), Evaluate	Group Discussion, Self evaluation, Recommendation
Creating	Assemble, Construct, Create, Design, Develop, Formulate, Write	Experiment, Simulation, major project

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CO – PO Matrix

Class: T.E

Sem:V

DTSP

Year:2022-23

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
ECC502.1	3	3	2											2
ECC502.2	3	3	2										3	2
ECC502.3	3	3											3	2
ECC502.4	3	3	2										3	2
ECC502.5	3	3											3	3
ECC502.6	3	3	2							3		2	3	2
Average	3	3	2							3		2	3	2.1

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Year: TE **LESSON PLAN - Discrete Time Signal Processing** **Semester: V**

Academic Year :2022-23

Sr. No.	Planned Date	Topic	Module	No. of hours required	Knowledge Dimension	Cognition Dimension	Instructional Mode	Assessment Mode	Assessment Type			Actual Date of Conduction
									Direct	Indirect	Rubrics	
1	11-Jul-22	DFT as a linear transformation, Properties of the DFT	1	1	Conceptual Knowledge	Applying	PPT, Solved Examples, Black Board	Class Test 1, End Semester Examination, Assignment No. 1	Yes	Yes	Yes	11-Jul-22
2	13-Jul-22	Relationship of the DFT to other transforms, Filtering of long data sequences.	1	1	Conceptual Knowledge	Applying	PPT, Solved Examples, Black Board	Class Test 1, End Semester Examination, Assignment No. 1	Yes	Yes	Yes	13-Jul-22
3	15-Jul-22	Overlap-Save Method	1	1	Conceptual Knowledge	Applying	PPT, Solved Examples, Black Board	Class Test 1, End Semester Examination,Assignment No.1	Yes	Yes	Yes	18-Jul-22
	18-Jul-22	Overlap-Add Method	1	1	Conceptual Knowledge	Applying	PPT, Solved Examples, Black Board	Class Test 1, End Semester Examination,Assignment No.1	Yes	Yes	Yes	20-Jul-22

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5	20-Jul-22	DIT FFT	1	1	Conceptual Knowledge	Applying	PPT, Solved Examples, Black Board	Class Test 1, End Semester Examination, Assignment No.1	Yes	Yes	Yes	22-Jul-22
6	22-Jul-22	DIF FFT	1	1	Conceptual Knowledge	Applying	PPT, Solved Examples, Black Board	Class Test 1, End Semester Examination, Assignment No.1	Yes	Yes	Yes	22-Jul-22
7	25-Jul-22	Inverse FFT	1	1	Conceptual Knowledge	Applying	PPT, Solved Examples, Black Board	Class Test 1, End Semester Examination,Assignment 1	Yes	Yes	Yes	25-Jul-22
8	27-Jul-22	DIT IFFT	1	1	Conceptual Knowledge	Applying	PPT, Solved Examples, Black Board	Class Test 1, End Semester Examination,Assignment No.1	Yes	Yes	Yes	27-Jul-22
9	29-Jul-22	DIF IFFT	1	1	Conceptual Knowledge	Applying	PPT, Solved Examples, Black Board	Class Test 1, End Semester Examination,Assignment 1	Yes	Yes	Yes	29-Jul-22
10	1-Aug-22	LTI systems as frequency-selective filters like low pass, high pass, band pass, notch	2	1	Conceptual Knowledge	Applying	PPT, Solved Examples, Black Board	Class Test 1, End Semester Examination,Assignment No.1	Yes	Yes	Yes	29-Jul-22

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11	3-Aug-22	Butterworth, Chebyshev I, Elliptic	2	1	Conceptual Knowledge	Applying	PPT, Solved Examples, Black Board	Class Test 1, End Semester Examination,Assignment No.1	Yes	Yes	Yes	1-Aug-22
12	5-Aug-22	Mapping from s-plane to the z-plane - impulse invariant	2	1	Conceptual Knowledge	Applying	PPT, Solved Examples, Black Board	Class Test 1, End Semester Examination, Assignment No.1	Yes	Yes	Yes	3-Aug-22
13	8-Aug-22	Bilinear transformation	2	2	Conceptual Knowledge	Applying	PPT, Solved Examples, Black Board	Class Test 1, End Semester Examination, Assignment No. 1	Yes	Yes	Yes	5-Aug-22
14	10-Aug-22	Design of IIR digital filters Butterworth using impulse invariant and bilinear transformation techniques	2	1	Conceptual Knowledge	Applying	PPT, Solved Examples, Black Board	Class Test 1, End Semester Examination, Assignment No. 2	Yes	Yes	Yes	8-Aug-22
15	12-Aug-22	Design of IIR digital filters Chebeysev -I using impulse invariant and bilinear transformation techniques	2	1	Conceptual Knowledge	Applying	PPT, Solved Examples, Black Board	Class Test 1, End Semester Examination, Assignment No.2	Yes	Yes	Yes	8-Aug-22
16	12-Aug-22	Problem Solving	2	1	Conceptual Knowledge	Applying	PPT, Solved Examples, Black Board	Class Test 1, End Semester Examination, Assignment No.2	Yes	Yes	Yes	10-Aug-22

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17	24-Aug-22	Problem Solving	2	1	Conceptual Knowledge	Applying	PPT, Solved Examples, Black Board	Class Test 1, End Semester Examination, AssignmentNo. 2	Yes	Yes	Yes	22-Aug-22
18	26-Aug-22	Problem Solving	2	1	Conceptual Knowledge	Applying	PPT, Solved Examples, Black Board	Class Test 1, End Semester Examination, Assignment No.2	Yes	Yes	Yes	24-Aug-22
19	5-Sep-22	Characteristics of linear phase FIR digital filters	3	1	Conceptual Knowledge	Applying	PPT, Solved Examples, Black Board	Class Test 1, End Semester Examination, Assignment No.2	Yes	Yes	Yes	26-Aug-22
20	7-Sep-22	Symmetric and antisymmetric FIR filter	3	1	Conceptual Knowledge	Applying	PPT, Solved Examples, Black Board	Class Test 1, End Semester Examination, Assignment No.2	Yes	Yes	Yes	12/09/20222
21	12-Sep-22	Location of the zeros of linear phase FIR filters	3	1	Conceptual Knowledge	Applying	PPT, Solved Examples, Black Board	Class Test 1, End Semester Examination, Assignment No.2	Yes	Yes	Yes	14-Sep-22
22	14-Sep-22	Minimum, maximum and mixed phase systems	3	1	Conceptual Knowledge	Applying	PPT, Solved Examples, Black Board	Class Test 1, End Semester Examination, Assignment No. 2	Yes	Yes	Yes	19-Sep-22

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17	24-Aug-22	Problem Solving	2	1	Conceptual Knowledge	Applying	PPT, Solved Examples, Black Board	Class Test 1, End Semester Examination, AssignmentNo. 2	Yes	Yes	Yes	22-Aug-22
18	26-Aug-22	Problem Solving	2	1	Conceptual Knowledge	Applying	PPT, Solved Examples, Black Board	Class Test 1, End Semester Examination, Assignment No.2	Yes	Yes	Yes	24-Aug-22
19	5-Sep-22	Characteristics of linear phase FIR digital filters	3	1	Conceptual Knowledge	Applying	PPT, Solved Examples, Black Board	Class Test 1, End Semester Examination, Assignment No.2	Yes	Yes	Yes	26-Aug-22
20	7-Sep-22	Symmetric and antisymmetric FIR filter	3	1	Conceptual Knowledge	Applying	PPT, Solved Examples, Black Board	Class Test 1, End Semester Examination, Assignment No.2	Yes	Yes	Yes	12/09/20222
21	12-Sep-22	Location of the zeros of linear phase FIR filters	3	1	Conceptual Knowledge	Applying	PPT, Solved Examples, Black Board	Class Test 1, End Semester Examination, Assignment No.2	Yes	Yes	Yes	14-Sep-22
22	14-Sep-22	Minimum, maximum and mixed phase systems	3	1	Conceptual Knowledge	Applying	PPT, Solved Examples, Black Board	Class Test 1, End Semester Examination, Assignment No. 2	Yes	Yes	Yes	19-Sep-22

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23	16-Sep-22	Design of FIR filters using Window techniques	3	1	Conceptual Knowledge	Applying	PPT, Solved Examples, Black Board	Class Test 1, End Semester Examination, Assignment No.2	Yes	Yes	Yes	21-Sep-22
24	19-Sep-22	Rectangular, Hamming, Hanning, Blackman, Bartlett	3	1	Conceptual Knowledge	Applying	PPT, Solved Examples, Black Board	Class Test 1, End Semester Examination, Assignment No.2	Yes	Yes	Yes	23-Sep-22
25	21-Sep-22	Problem Solving	3	1	Conceptual Knowledge	Applying	PPT, Solved Examples, Black Board	Class Test 1, End Semester Examination, Assignment No.2	Yes	Yes	Yes	23-Sep-22
26	23-Sep-22	Design of FIR filters using Frequency Sampling Technique Type I low pass filter design,	4	1	Conceptual Knowledge	Applying	PPT, Solved Examples, Black Board	Class Test 1, End Semester Examination, Assignment No.2	Yes	Yes	Yes	26-Sep-22
27	26-Sep-22	Realization structures for FIR systems: Cascade form, Frequency sampling structure	4	1	Conceptual Knowledge	Applying	PPT, Solved Examples, Black Board	Class Test 1, End Semester Examination, Assignment No.2	Yes	Yes	Yes	26-Sep-22
28	28-Sep-22	Lattice structure, Computational complexities for N length filter	4	1	Conceptual Knowledge	Applying	PPT, Solved Examples, Black Board	Class Test 1, End Semester Examination, Assignment No. 2	Yes	Yes	Yes	26-Sep-22

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29	30-Sep-22	Realization structures for IIR systems: Cascade form and parallel form structures	4	1	Conceptual Knowledge	Applying	PPT, Solved Examples, Black Board	Class Test 1, End Semester Examination, Assignment 2	Yes	Yes	Yes	26-Sep-22
30	3-Oct-22	Lattice Ladder structure	4	1	Conceptual Knowledge	Applying	PPT, Solved Examples, Black Board	Class Test 1, End Semester Examination, Assignment No. 2	Yes	Yes	Yes	3-Oct-22
31	7-Oct-22	Computational complexities for N order filter	4	1	Conceptual Knowledge	Applying	PPT, Solved Examples, Black Board	Class Test 1, End Semester Examination, Assignment No.2	Yes	Yes	Yes	7-Oct-22
32	10-Oct-22	Rounding and truncation errors, Quantization error	5	1	Conceptual Knowledge	Applying	PPT, Solved Examples, Black Board	Class Test 2, End Semester Examination , Assignment No.3	Yes	Yes	Yes	08/10/202
33	12-Oct-22	Output noise power from a digital system	5	1	Conceptual Knowledge	Applying	PPT, Solved Examples, Black Board	Class Test 2, End Semester Examination , Assignment No.3	Yes	Yes	Yes	8-Oct-22
34	14-Oct-22	Product quantization, Noise model for direct form	5	2	Conceptual Knowledge	Applying	PPT, Solved Examples, Black Board	Class Test 2, End Semester Examination , Assignment No2	Yes	Yes	Yes	10-Oct-22

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29	30-Sep-22	Realization structures for IIR systems: Cascade form and parallel form structures	4	1	Conceptual Knowledge	Applying	PPT, Solved Examples, Black Board	Class Test 1, End Semester Examination, Assignment 2	Yes	Yes	Yes	26-Sep-22
30	3-Oct-22	Lattice Ladder structure	4	1	Conceptual Knowledge	Applying	PPT, Solved Examples, Black Board	Class Test 1, End Semester Examination, Assignment No. 2	Yes	Yes	Yes	3-Oct-22
31	7-Oct-22	Computational complexities for N order filter	4	1	Conceptual Knowledge	Applying	PPT, Solved Examples, Black Board	Class Test 1, End Semester Examination, Assignment No.2	Yes	Yes	Yes	7-Oct-22
32	10-Oct-22	Rounding and truncation errors, Quantization error	5	1	Conceptual Knowledge	Applying	PPT, Solved Examples, Black Board	Class Test 2, End Semester Examination , Assignment No.3	Yes	Yes	Yes	08/10/202
33	12-Oct-22	Output noise power from a digital system	5	1	Conceptual Knowledge	Applying	PPT, Solved Examples, Black Board	Class Test 2, End Semester Examination , Assignment No.3	Yes	Yes	Yes	8-Oct-22
34	14-Oct-22	Product quantization, Noise model for direct form	5	2	Conceptual Knowledge	Applying	PPT, Solved Examples, Black Board	Class Test 2, End Semester Examination , Assignment No2	Yes	Yes	Yes	10-Oct-22

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35	14/10/200	Cascaded IIR structure (first order)	5	1	Conceptual Knowledge	Applying	PPT, Solved Examples, Black Board	Class Test 2, End Semester Examination , Assignment No.3	Yes	Yes	Yes	10-Oct-22
36	16-Oct-22	Application of DSP for ECG signals analysis.	6	1	Conceptual Knowledge	Applying	PPT, Solved Examples, Black Board	Class Test 2, End Semester Examination , Assignment No.3	Yes	Yes	Yes	11-Oct-22
37	16-Oct-22	Application of DSP for EEG signals analysis.	6	1	Conceptual Knowledge	Applying	PPT, Solved Examples, Black Board	Class Test 2, End Semester Examination , Assignment No.3	Yes	Yes	Yes	12-Oct-22
38	17-Oct-22	Application of DSP for echo cancellation	6	1	Conceptual Knowledge	Applying	PPT, Solved Examples, Black Board	Class Test 2, End Semester Examination , Assignment No.3	Yes	Yes	Yes	13-Oct-22
39	17-Oct-22	Sub-band coding of speech signal	6	1	Conceptual Knowledge	Applying	PPT, Solved Examples, Black Board	Class Test 2, End Semester Examination , Assignment No.3	Yes	Yes	Yes	17-Oct-22

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Modes of Content Delivery

I	Class Room Teaching	V	Case Study	ix	Seminar
I i	Power Point Presentation	Vi	Expert Lecture	x	Remedial Lecture
I ii	Tutorial	Vii	Simulation/ Demonstration	xi	Lab Experiment
I v	Group Discussion	viii	Industry Visit		

Sr. No	Course Outcome	Mode of Delivery										
		i	Ii	Iii	Iv	V	vi	vii	viii	ix	x	xi
1	ECC502.1	✓	✓								✓	
2	ECC502.2	✓	✓								✓	
3	ECC502.3	✓	✓								✓	
4	ECC502.4	✓	✓								✓	
5	ECC502.5	✓	✓								✓	
6	ECC502.6	✓	✓								✓	

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Date of display: 18/08/2022 **Date of submission: 23/08/2022**

Assignment No: 1 (2022-23)

Subject: DTSP

Semester: V **Class: TE (EXTC)**

Q No.	Question	Bloom's Taxonomy Level	Course Outcomes
1.	Derive relation between DFT and Z transform	Applying	ECC502.1
2.	Derive relationship to thee Fourier series coefficients of an aperiodic signal	Applying	ECC502.1
3.	$x[n] = \begin{cases} 1 & 0 \le n \le 3 \\ 0 & 4 \le n \le 7 \end{cases}$ i) Find DFT of X(k) ii) Using the result obtained in (i) find DFT of the following sequence $x_1 = \begin{cases} 1 & n = 0 \\ 0 & 1 \le n \le 4 \\ 1 & 5 \le n \le 7 \end{cases}$ And $x_2 = \begin{cases} 0 & 0 \le n \le 1 \\ 1 & 2 \le n \le 5 \\ 0 & 6 \le n \le 7 \end{cases}$	Applying	ECC502.2
4.	Using DFT method , obtain the circular convolution of the following: x_1 = [1 2 1 -2] x_2 = [3 -2 1 -3]	Applying	ECC502.2
5.	Compute the DFT of $(n) = 2\delta(n) + 3\delta(n-1) + 4\delta(n-2) + 5\delta(n-3)$. Use DIF FFT	Applying	ECC502.2
6.	An eight point sequence x(n) is given by $x_1(n)$ = {1 2 3 4 5 6 7 8} i) Find DFT of $x_1(n)$	Applying	ECC502.2

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Date of display: 19/09/2022 **Date of submission: 23/09/2022**

Assignment No: 2 (2022-23)

Subject: DTSP

Semester: V **Class: TE (EXTC)**

Q No.	Question	Bloom's Taxonomy Level	Course Outcomes
1.	The system function of analog filter is given by $H(s) = \frac{s+0.1}{(s+0.1)^2+9}$. Design IIR filter using impulse invariance method.	Applying	ECC502.3
2.	The system transfer function of analog filter is given by $H(s) = \frac{2}{(s+1)(s+2)}$. Obtain the system transfer function of digital filter using BLT with $T_s = 1$ sec.	Applying	ECC502.3
3.	Design a digital Butterworth filter for following specifications using Bilinear transformations Attenuation in passband = 1.93dB Passband edge frequency = 0.2π Attenuation in stopband = 13.97dB Stopband edge frequency = 0.6π	Creating	ECC502.3
4.	Design a Chebyshev filter with a maximum pass band attenuation of 2.5dB and $\Omega_p = 20$ rad/sec and stopband attenuation of 30 dB and $\Omega_s = 50$ rad/sec.	Creating	ECC502.3
5.	A high pass filter is to be designed with following desired frequency response $H_d(e^{jw}) = 0 \quad \frac{-\pi}{4} \le w \le \frac{\pi}{4}$ $H_d(e^{jw}) = e^{-j2w} \quad \frac{\pi}{4} \le w \le \pi$ Determine the filter coefficients h(n) if the window function is defined as w(n) = 1 $0 \le n \le 4$ = 0 otherwise	Creating	ECC502.3
6.	Design a linear phase FIR low pass filter of length seven with cut off frequency 1 rad/sec. Using rectangular window.	Creating	ECC502.3

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Date of display: 03/10/2022 **Date of submission: 07/10/2022**

Assignment No: 3 (2022-23)

Subject: DTSP

Semester: V **Class: TE (EXTC)**

Q No.	Question	Bloom's Taxonomy Level	Course Outcomes
1.	Consider a LTI system, initially at the rest , described by the difference equation $y(n) = \frac{1}{4} y(n-2) + x(n)$ i) Determine impulse response h (n) of the system. ii) Determine direct form II , parallel form and cascade form of realization of this system.	Applying	ECC502.4
2.	Realize a linear phase FIR filter with following impulse response. Give necessary equation. $H(z) = \frac{2}{3}z + 1 + \frac{2}{3}z^{-1}$	Applying	ECC502.4
3.	Perform 4 bit quantization using truncation and rounding of decimal number 0.484375	Applying	ECC502.5
4.	What is the effect of coefficient quantization on a seconder order IIR filter? When it is realized in Direct form I and cascade form. $H(z) = \frac{1}{1 - 0.9z^{-1} + 0.2z^{-2}}$	Applying	ECC502.5
5.	Explain how DTSP is useful in interference cancellation in ECG.	Understanding	ECC502.6
6.	How DTSP is useful in speech processing. Explain any application of speech processing using DTSP	Understanding	ECC502.6

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Rubrics for Assignment

Applicable / Not Applicable

Rubrics Description	Maximum Marks Weight	Excellent (05)	Good (04 – 03)	Fair (02-00)
Understanding	**2.5**	An in-depth understanding of the relevant concepts, theories and issues related are addressed. Appropriate solution is recommended after analysis of relevant constraints. **(2.5)**	A thorough grasp of the subject matter is demonstrated. Solution is included with minor procedural or conceptual errors. **(2.0 –1.5)**	A basic grasp of the subject matter is demonstrated. Solution included is inappropriate or less accurate with major procedural or conceptual errors. **(01-00)**
Presentation	**1.5**	The wordings are precise and unambiguous. Sentence structure is consistently clear and lucid. Paper is clean and appropriately formatted. There are virtually no spelling or grammatical errors. **(1.5)**	The most part precisely worded and unambiguous. Sentence structure is mostly clear. There are a few minor spelling or grammatical errors. **(01)**	Wordings imprecise ambiguous often. Sentence structure is often confusing. There are several spelling and grammatical errors. **(0.5-00)**
Punctuality	**01**	Submission is within a week or in timely manner as directed by the teacher. **(01)**	Submission is after a week beyond the submission date. **(01-0.5)**	Submission is after 2 weeks or beyond the submission date. **(0.5-00)**

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Department of Electronics and Telecommunication

CLASS TEST I (2022-23)

Semester: V **Class: TE** **Date:** 29/08/2022

Marks: 20 **Subject: Discrete Time Signal Processing** **Duration: 1hr**

Question No.	Question	Marks	Bloom Taxonomy Level	Course outcome
Q.1. OR	a. Derive relation between DFT and Z transform	03	Applying	ECC502.1
	b. Compute DFT of a sequence $x_1(n)$= {1, 2, 4, 2}using property and not otherwise compute DFT of $x_2(n)$= {1+j, 2+2j, 4+4j, 2+2j}	03	Applying	ECC502.2
Q.2	a. Derive relationship to the Fourier series coefficients of a periodic signal	03	Applying	ECC502.1
	b. First five DFT points of real and even sequences x (n) of length eight are given below. Find the remaining points. X(k) = {5, 1, 0, 2, 3-,-,-}	03	Applying	ECC502.2
Q.3 OR	Given x (n) = 2^n. Find X (k) using DIT FFT algorithm. Assume x (n) length is 8.	08	Applying	ECC
Q.4	Given x (n) = n+1 and N = 8, Find DFT X (k) using DIF FFT.	08	Applying	ECC502.2
Q.5 OR	Obtain digital filter transfer function by applying impulse invariance function $H(s) = \frac{0.5(s+4)}{(s+5)(s+2)}$. If T_s = 1 sec.	06	Applying	ECC502.3
Q.6	The system transfer function of analog filter is given by $H(s) = \frac{2}{(S+1)(s+2)}$. Obtain the system transfer function of digital filter using BLT with T_s = 1 sec	06	Applying	ECC502.3

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Department of Electronics and Telecommunication
CLASS TEST I (2022-23)

Semester: V **Class: TE** **Date:** 29/08/2022

Marks: 20 **Subject: Discrete Time Signal Processing** **Duration: 1hr**

Question No.	Question	Marks	Bloom Taxonomy Level	Course outcome
Q.1. OR	a. Derive relation between DFT and Z transform	03	Applying	ECC502.1
	b. Compute DFT of a sequence $x_1(n)$= {1, 2, 4, 2}using property and not otherwise compute DFT of $x_2(n)$= {1+j, 2+2j, 4+4j, 2+2j}	03	Applying	ECC502.2
Q.2	a. Derive relationship to the Fourier series coefficients of a periodic signal	03	Applying	ECC502.1
	b. First five DFT points of real and even sequences x (n) of length eight are given below. Find the remaining points. X(k) = {5, 1, 0, 2, 3-,-,-}	03	Applying	ECC502.2
Q.3 OR	Given x (n) = 2^n. Find X (k) using DIT FFT algorithm. Assume x (n) length is 8.	08	Applying	ECC502.2
Q.4	Given x (n) = n+1 and N = 8, Find DFT X(k) using DIF FFT.	08	Applying	ECC502.2
Q.5 OR	Obtain digital filter transfer function by applying impulse invariance function $(s) = \frac{s}{(s+5)(s+2)}$. If T_s = 0.1 sec.	06	Applying	ECC502.3
Q.6	The system transfer function of analog filter is given by $H(s) = \frac{s+0.1}{(s+0.1)^2+16}$. Obtain the system transfer function of digital filter using BLT which is resonance at $w_r = \frac{\pi}{2}$	06	Applying	ECC502.3

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CLASS TEST I (2022-23)

Semester: V **Class: TE** **Date:** 29/08/2022

Marks: 20 **Subject: Discrete Time Signal Processing** **Duration: 1hr**

Question No.	Question	Marks	Bloom Taxonomy Level	Course outcome
Q.1. OR	a. Derive relation between DFT and Z transform	03	Applying	ECC502.1
	b. Compute DFT of a sequence $x_1(n)$= {1, 2, 4, 2}using property and not otherwise compute DFT of $x_2(n)$= {1+j, 2+2j, 4+4j, 2+2j}	03	Applying	ECC502.2
Q.2	a. Derive relationship to the Fourier series coefficients of a periodic signal	03	Applying	ECC502.1
	b. First five DFT points of real and even sequences x (n) of length eight are given below. Find the remaining points. X(k) = {5, 1, 0, 2, 3-,-,-}	03	Applying	ECC502.2
Q.3 OR	Given x (n) = 2^n. Find X (k) using DIT FFT algorithm. Assume x (n) length is 8.	08	Applying	ECC502.2
Q.4	Given x (n) = n+1 and N = 8, Find DFT X (k) using DIF FFT.	08	Applying	ECC502.2
Q.5 OR	Obtain digital filter transfer function by applying impulse invariance function $(s) = \frac{s}{(s+5)(s+2)}$. If T_s = 0.1 sec.	06	Applying	ECC502.3
Q.6	The system transfer function of analog filter is given by $H(s) = \frac{2}{(S+1)(s+2)}$. Obtain the system transfer function of digital filter using BLT with T_s = 1 sec.	06	Applying	ECC502.3

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CLASS TEST I (2022-23)

Semester: V **Class: TE** **Date:** 29/08/2022

Marks: 20 **Subject: Discrete Time Signal Processing** **Duration: 1hr**

Question No.	Question	Marks
Q.1.	a. Derive relation between DFT and Z transform	Each step = 01 mark
OR	b. Compute DFT of a sequence $x_1(n)$= {1, 2, 4, 2}using property and not otherwise compute DFT of $x_2(n)$= {1+j, 2+2j, 4+4j, 2+2j}	Each step = 01 mark
Q.2	a. Derive relationship to the Fourier series coefficients of a periodic signal	Each step = 01 mark
	b. First five DFT points of real and even sequences x (n) of length eight are given below. Find the remaining points. X(k) = {5, 1, 0, 2, 3-,-,-}	Each step = 01 mark
Q.3 OR	Given x (n) = 2^n . Find X (k) using DIT FFT algorithm. Assume x (n) length is 8.	Butterfly Diagram = 01mark Calculation of Twiddle Factor = 01 mark Each Stage Calculation = 02 marks
Q.4	Given x (n) = n+1 and N = 8, Find DFT X(k) using DIF FFT.	Butterfly Diagram = 01mark Calculation of Twiddle Factor = 01 mark Each Stage Calculation = 02 marks
Q.5 OR	Obtain digital filter transfer function by applying impulse invariance function $(s) = \frac{s}{(s+5)(s+2)}$. If $T_s = 0.1$ sec.	Formula = 01 mark Each step = 01mark
Q.6	The system transfer function of analog filter is given by $H(s) = \frac{s+0.1}{(s+0.1)^2+16}$. Obtain the system transfer function of digital filter using BLT which is resonance at $w_r = \frac{\pi}{2}$	Formula = 01 mark Each step = 01mark

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Class Test II

Sub: DSP

Sem :- V TE EXTC 29/08/2022

Q.1 a) Relation both DFT & z transform

$$X(z) = \sum_{n=0}^{\infty} x(n) \cdot z^{-n}$$

$$z^k = e^{j2\pi k/N} \quad k = 0, 1 \cdots N-1$$

$$X(z)\Big|_{z_k = e^{j2\pi k}} = \sum_{n=0}^{\infty} x(n) \cdot e^{-j2\pi kn/N}$$

$x(n)$ is causual sequence & has 'N' no. of samples

$$X(z)\Big|_{z_k = e^{j2\pi k/N}} = \sum_{n=0}^{N-1} x(n) \cdot e^{-j2\pi kn/N}$$

$$x(k) = X(z)\Big|_{z_k = e^{j2\pi kn/N}}$$

Q.1 b) $x_1(n) = \{1\ 2\ 4\ 2\}$

$$x_1(k) = [W_4]\, x_1(n)$$

$$x_1(k) = \begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & -j & -1 & j \\ 1 & -1 & 1 & -1 \\ 1 & j & -1 & -j \end{bmatrix} \begin{bmatrix} 1 \\ 2 \\ 4 \\ 2 \end{bmatrix}$$

$$x_1(k) = \begin{bmatrix} 9 \\ 1-3j \\ -1 \\ 1+3j \end{bmatrix}$$

$x_1(k) = \{9, -3, 1, -3\}$

$x_2(n) = \{1+j^0, 2+2j^0, 4+4j^0, 2+2j^0\}$

$x_2(n) = x_1(n) + j^0 x_1(n)$

$x_2(k) = x_1(k) + j^0 x_2(k)$

$x_2(k) = \{9+9j^0, -3-3j^0, 1+j^0, -3-3j^0\}$

9.2 a) Relationship to the Fourier series coefficients

$x_p(n)$ = Periodic sequence

$$x_p(n) = \sum_{k=0}^{N-1} C_k e^{j^0 2\pi kn/N} \quad -\infty < n < \infty$$

$$C_k = \frac{1}{N} \sum_{N=0}^{N-1} (x_p) e^{-j^0 2\pi nk/N}$$

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

$$x(n) = \frac{1}{N} \sum_{K=0}^{N-1} X(k) e^{-j^0 2\pi kn/N} \quad n = 0, 1, \dots N-1$$

If $x_n = x_p(n) \quad 0 \le n \le N-1$

$X(k) = NC_k$

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Q.2b) $x(0) = 5$ $\quad x(3) = 2$

$x(1) = 1$ $\quad x(4) = 3$

$x(2) = 0$

$x^*(k) = x(N-k)$

$x(k) = x^*(N-k)$

$N = 8$

$x(5) = x^*(8-5) = x^*(3)$

$x(5) = 2$

$x(6) = x^*(8-6) = x^*(2)$

$x(6) = 0$

$x(7) = x^*(8-7) = x^*(1)$

$x(7) = 1$

$x(k) = \{5, 1, 0, 2, 3, 2, 0, 1\}$

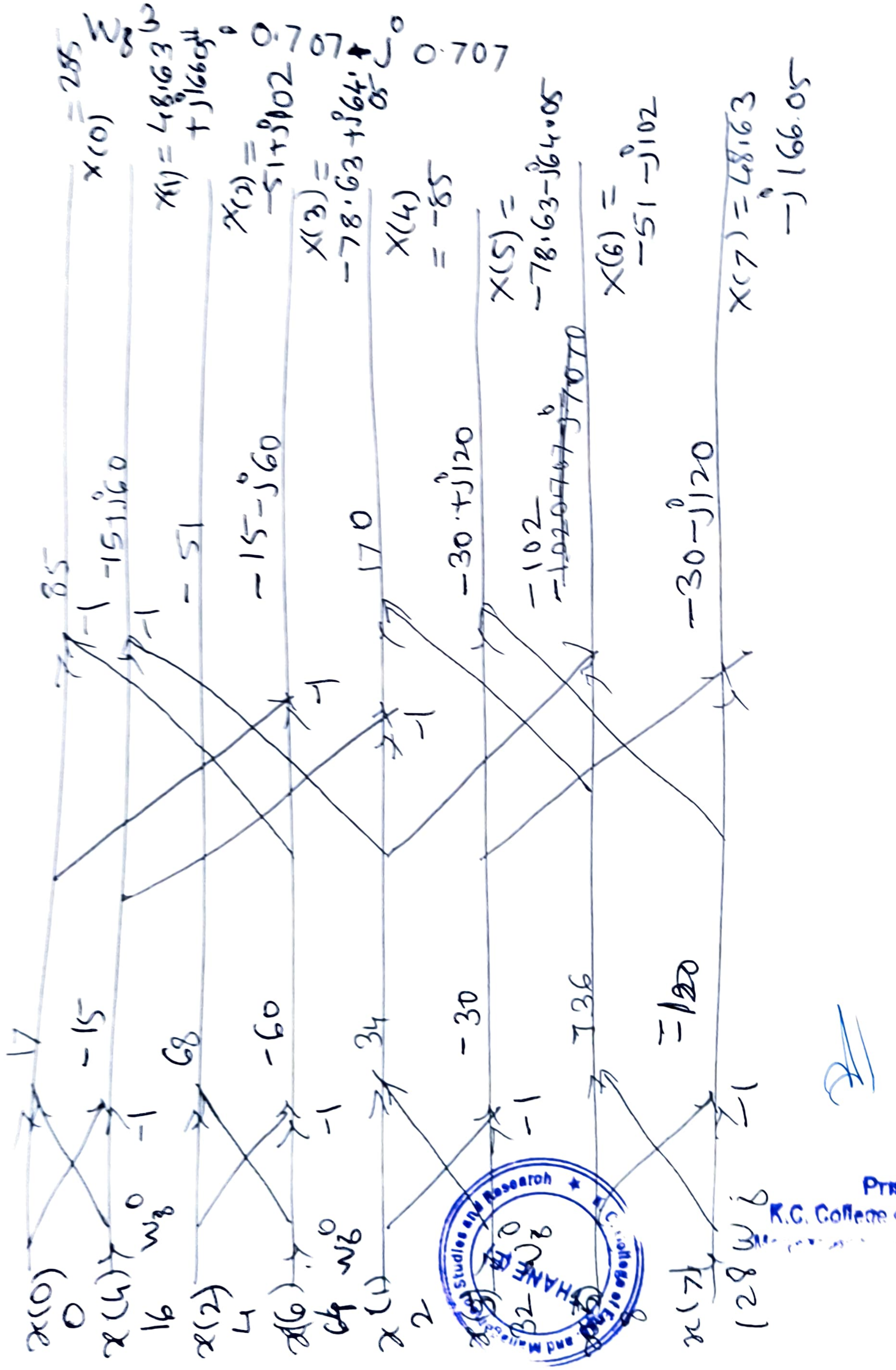
Q.3 $x(n) = 2^n$ $N = 8$

$x(0) = 1$ $x(1) = 2$ $x(2) = 4$ $x(3) = 8$

$x(4) = 16$ $x(5) = 32$ $x(6) = 64$ $x(7) = 128$

$W_8^0 = 1$ $W_8^1 = 0.707 - j\,0.707$ $W_8^2 = -j$

$W_8^3 = 0.707 + j\,0.707$



Q.4

$x(0) = 1$	6	16	36
$x(1) = 2$	8	20	-4
$x(2) = 3$	10	-4	$-4+j4$
$x(3) = 4$	12	$j4$	$-4-j4$
$x(4) = 5$	-4	$-4+j4$	$-4+j9.65$
$x(5) = 6$	$-2.828+j2.828$	$j5.656$	$-4+j11.656$
$x(6) = 7$	$j4$	$-4-j4$	$-4+j11.65$
$x(7) = 8$	$2.828+j2.828$	$j5.656$	$-4-j9.65$

Q.5 Impulse variance function

$$(S) = \frac{5}{(S+5)(S+2)} \quad T_S = 0.1 \text{ sec.}$$

$$\frac{A_1}{S+5} + \frac{A_2}{S+2}$$

$$A_1 = \frac{5}{(S+5)(S+2)}(S+5)\Big|_{S=-5} = 1.66$$

$$A_2 = \frac{5}{(S+5)(S+2)}(S+2)\Big|_{S=-2} = 0.66$$

$$H(s) = \frac{1.66}{S+5} - \frac{0.66}{S+2}$$

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$$\frac{1.66}{s+5} \Rightarrow \frac{1.66}{1-e^{-5T_s}z^{-1}}$$

$$\frac{0.66}{s+2} \rightarrow \frac{0.66}{1-e^{-2T_s}z^{-1}}$$

$$T_s = 0.1 \text{ sec.}$$

$$H(z) = \frac{1.66}{1-e^{-0.5}z^{-1}} - \frac{0.66}{1-e^{-0.2}z^{-1}}$$

$$e^{-0.5} = 0.606 \quad e^{-0.4} = 0.818$$

$$H(z) = \frac{1 - 0.9z^{-1}}{1 - 1.42z^{-1} + 0.49z^{-2}}$$

Q.6 $$H(s) = \frac{s+0.1}{(s+0.1)^2 + 16}$$

$$H(s) = \frac{s+0.1}{(s+0.1)^2 + 4^2}$$

$$\Omega = 4$$

$$\Omega = \frac{2}{T_s}\tan(\omega/2)$$

$$4 = \frac{2}{T_s}\left(\frac{\pi}{2}\right) \quad \omega = \pi/2$$

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$$4 = \frac{2}{4}\tan(\pi/4)$$

$$T_s = 0.5$$

$$s = \frac{2}{T_s}\left[\frac{z-1}{z+1}\right]$$

$$s = 4\left[\frac{z-1}{z+1}\right]$$

$$H(z) = \frac{4\left[\frac{z-1}{z+1}\right]+0.1}{\left(4\left[\frac{z-1}{z+1}\right]+0.1\right)^2}$$

$$H(z) = \frac{4.1z^2+0.2z-3.9}{32.81z^2+0.027z+31.21}$$

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Department of Electronics and Telecommunication
CLASS TEST II (2022-23)

Semester: V **Class: TE** **Date:** 19/10/2022

Marks: 20 **Subject: Discrete Time Signal Processing** **Duration: 1hr**

Question No.	Question	Marks	Bloom Taxonomy Level	Course outcome
Q.1.	Given the difference equation $y(n) = -0.1\,y(n-1) + 0.2\,y(n-1) + 3\,x(n) + 3.6\,x(n-1) + 0.6\,x(n-2)$	08	Applying	ECC502.4
OR	Draw Direct form I and II, cascade and parallel realization of the system.			
Q.2	Obtain FIR linear phase and cascade form realizations for system function $H(z) = (1 + \frac{1}{2}z^{-1} + z^{-2})(1 + \frac{1}{4}z^{-1} + z^{-2})$	08	Applying	ECC502.4
Q.3	Consider a IIR filter transfer function $H(z) = \frac{1}{1-095z^{-1}+0.225z^{-2}}$. What will be the effect of coefficient quantization on the transfer function for 1. Direct form 2. Cascade form. Assume number of quantization bits b = 3 bits	08	Applying	ECC502.5
OR				
Q.4	A second order IIR filter has a transfer function $(z) = \frac{1}{(1-0.3z^{-1})(1-0.35z^{-1})}$. Find the effect of quantization on the location of poles of this filter and Cascade form. Use 3 bits after the decimal point.	08	Applying	ECC502.5
Q.5	What are different types of inference occurring in the measurement of ECG signal?	04	Understanding	ECC502.6
OR				
Q.6	Write a short note on speech noise reduction	04	Understanding	ECC502.6

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Department of Electronics and Telecommunication

CLASS TEST II (2022-23)

Semester: V **Class: TE** **Date:** 19/10/2022

Marks: 20 **Subject: Discrete Time Signal Processing** **Duration: 1hr**

Question No.	Question	Marks	Bloom Taxonomy Level	Course outcome
Q.1. OR	Given the difference equation $y(n) = -0.1\,y(n-1) + 0.2\,y(n-1) + 3\,x(n) + 3.6\,x(n-1) + 0.6\,x(n-2)$ Draw Direct form I and II, cascade and parallel realization of the system.	08	Applying	ECC502.4
Q.2	Obtain FIR linear phase and cascade form realizations for system function $H(z) = (1 + \frac{1}{2}z^{-1} + z^{-2})(1 + \frac{1}{4}z^{-1} + z^{-2})$	08	Applying	ECC502.4
Q.3 OR	Consider a IIR filter transfer function $H(z) = \frac{1}{1-095z^{-1}+0.225z^{-2}}$. What will be the effect of coefficient quantization on the transfer function for 1. Direct form 2. Cascade form. Assume number of quantization bits b = 3 bits	08	Applying	ECC502.5
Q.4	A second order IIR filter has a transfer function $(z) = \frac{1}{(1-0.3z^{-1})(1-0.35z^{-1})}$. Find the effect of quantization on the location of poles of this filter and Cascade form. Use 3 bits after the decimal point.	08	Applying	ECC502.5
Q.5 OR	What are different types of inference occurring in the measurement of ECG signal?	04	Understanding	ECC502.6
Q.6	Write a short note on two band digital crossover	04	Understanding	ECC502.6

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Department of Electronics and Telecommunication
CLASS TEST II (2022-23)

Semester: V **Class: TE** **Date:** 19.10.2022

Marks: 20 **Subject: Discrete Time Signal Processing** **Duration: 1hr**

Question No	Question	Marks	Bloom Taxonomy Level	Course outcome
Q.1	Given the difference equation $y(n) = -0.1\,y(n-1) + 0.2\,y(n-1) + 3\,x(n) + 3.6\,x(n-1) + 0.6\,x(n-2)$	08	Applying	ECC502.4
OR	Draw Direct form I and II, cascade and parallel realization of the system.			
Q.2	Obtain FIR linear phase and cascade form realizations for system function $H(z) = (1 + \frac{1}{2}z^{-1} + z^{-2})(1 + \frac{1}{4}z^{-1} + z^{-2})$	08	Applying	ECC502.4
Q.3	Consider a IIR filter transfer function $H(z) = \frac{1}{1-0.95z^{-1}+0.225z^{-2}}$. What will be the effect of coefficient quantization on the transfer function for 1. Direct form 2. Cascade form. Assume number of quantization bits b = 3 bits	08	Applying	ECC502.5
OR				
Q.4	A second order IIR filter has a transfer function $(z) = \frac{1}{(1-0.3z^{-1})(1-0.35z^{-1})}$. Find the effect of quantization on the location of poles of this filter and Cascade form. Use 3 bits after the decimal point.	08	Applying	ECC502.5
Q.5	Write a short note on speech noise reduction	04	Understanding	ECC502.6
OR				
Q.6	Write a short note on two band digital crossover	04	Understanding	ECC502.6

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CLASS TEST II (2022-23)

Semester: V **Class: TE** **Date:** 19/10/2022

Marks: 20 **Subject: Discrete Time Signal Processing** **Duration: 1hr**

Question No.	Question	Marks
Q.1. OR	Given the difference equation $y(n) = -0.1\,y(n-1) + 0.2\,y(n-1) + 3\,x(n) + 3.6\,x(n-1) + 0.6\,x(n-2)$ Draw Direct form I and II, cascade and parallel realization of the system.	Direct form I =02 marks II= 02 marks, cascade= 02 marks parallel realization =02 marks
Q.2	Obtain FIR linear phase and cascade form realizations for system function $H(z) = (1 + \frac{1}{2}z^{-1} + z^{-2})(1 + \frac{1}{4}z^{-1} + z^{-2})$	Linear phase = 02 marks Cascade form = 02 marks
Q.3 OR	Consider a IIR filter transfer function $H(z) = \frac{1}{1-095z^{-1}+0.225z^{-2}}$. What will be the effect of coefficient quantization on the transfer function for 1. Direct form 2. Cascade form. Assume number of quantization bits b = 3 bits	Direct form = 04 marks Cascade form = 04 marks
Q.4	A second order IIR filter has a transfer function $(z) = \frac{1}{(1-0.3z^{-1})(1-0.35z^{-1})}$. Find the effect of quantization on the location of poles of this filter and Cascade form. Use 3 bits after the decimal point.	Location of pole = 03 marks Cascade form = 05 marks
Q.5 OR	What are different types of inference occurring in the measurement of ECG signal?	Valid Points =04 marks
Q.6	Write a short note on speech noise reduction	Valid Points =04 marks

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Class Test II

Sub: DTSP

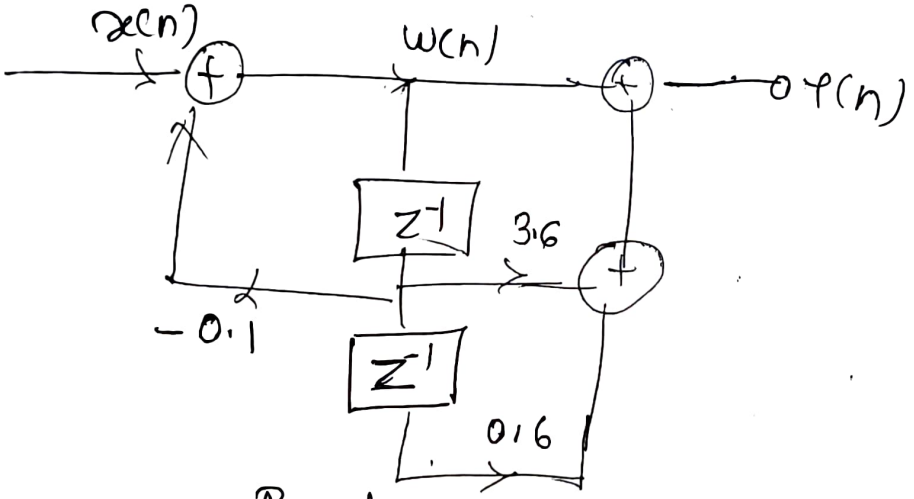
Sem: V

Date: 19/10/2022

Q. 1) $y(n) = -0.1y(n-1) + 0.2y(n-2) + 3x(n) + 3.6x(n-1) + 0.16x(n-2)$

$= -0.1 z^{-1} Y(z) + 0.2 z^{-1} Y(z) + 3X(z) + 3.6 X(z) z^{-1} + 0.16 z^{-2} X(z)$

$$H(z) = \frac{Y(z)}{X(z)} = \frac{3 + 3.6z^{-1} + 0.16z^{-2}}{1 - 0.1z^{-1}}$$

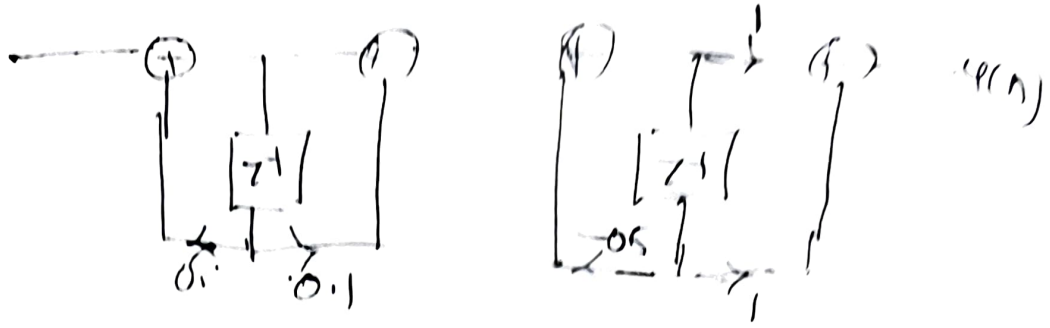


Parallel

Parallel cascade $H(z) = \frac{3 + 3.6z^{-1} + 0.16z^{-2}}{z^2 - 0.1z}$

$= \frac{3 + 3.6z^{-1} + 0.16z^{-2}}{[z \cdot (z - 0.1)]}$

$= \frac{3(z + 0.2)(z + 1)}{(z - 0.1)}$



Q.2 $\left(1+\frac{1}{2}z^{-1}+z^{-2}\right)\left(1+\frac{1}{4}z^{-1}+z^{-2}\right)$

$$H_1(z) = \frac{W(z)}{X(z)} = 1+\frac{1}{2}z^{-1}+z^{-2}$$

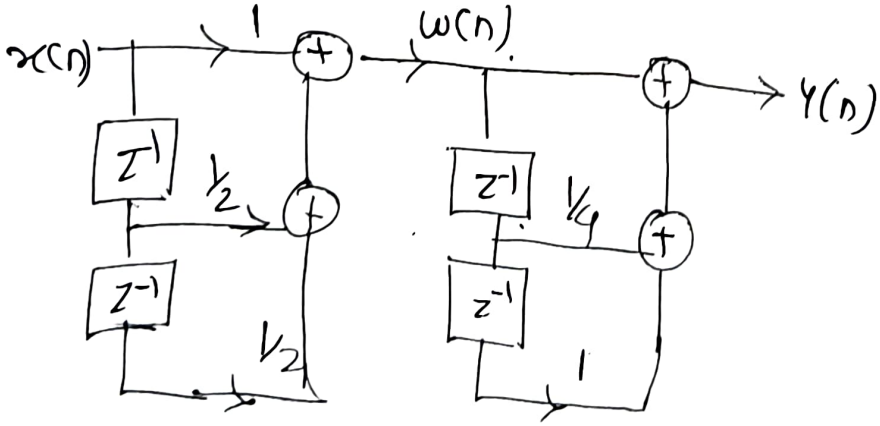
$$H_2(z) = \frac{Y(z)}{W(z)} = 1+\frac{1}{4}z^{-1}+z^{-2}$$

$$W(z) = X(z) + \frac{1}{2}X(z)z^{-1} + z^{-2}$$

$$w(n) = x(n) + \frac{1}{2}x(n-1) + \frac{1}{2}x(n-2)$$

$$Y(z) = W(z) + \frac{1}{4}z^{-1}W(z) + z^{-2}W(z)$$

$$Y(n) = w(n) + \frac{1}{4}w(n-1) + w(n-2)$$



Q.3 $(0.95) = (0.1111001)_2$

$(-0.95) = (1.0000111)_2$

$(0.25) = (0.0100000)_2$

$(-0.95)_2 \xrightarrow{\text{quantized}} (1.111)_2$

$(0.225)_2 \xrightarrow{\text{quantized}} (0.001)_2$

$(1.111)_2 = (-0.875)_{10}$

$(0.001)_2 = (0.125)_{10}$

$$H(z) = \frac{1}{1 - 0.875z^{-1} + 0.125z^{-2}}$$

Cascade : $H(z) = \frac{1}{(1-0.5z^{-1})(1-0.45z^{-2})}$

$(0.5)_{10} = (0.1000)_2$

$(-0.5)_{10} = (1.1000)_2$

$(+0.45)_{10} = (0.1110001)_2$

$(-0.45)_{10} = (1.1110001)_2$

$(1.100)_2 = (-0.5)_{10}$

$(1.0011)_2 = (-0.375)_{10}$

$$H(z) = \frac{1}{(1-0.5z^{-1})(1-0.375z^{-1})}$$

Q.4 $H(z) = \frac{1}{(1-0.3z^{-1})(1-0.35z^{-1})}$

$(0.65)_{10} = (0.1010011)_2$

$(-0.65)_{10} = (1.1010011)_2$

$(0.101)_2 = 1 \times 2^{-1}$

$= 0.5 + 0.125$

$(0.101)_2 = (0.625)_{10}$

quant $(-0.625)_{10} = (-0.625)_{10}$

$(0.105)_{10} = (0.000011)_2$

$(0.105)_{10} = (0)_{10}$

$$H(z) = \frac{1}{1 - 0.625 z^{-1}} \qquad z = 0.625$$

$$H(z) = \frac{1}{(1 - 0.3z^{-1})(1 - 0.35z^{-2})}$$

$(0.3)_{10} = (0.010)_2$

$(-0.3)_{10} = (1.010)_2$

$(1.0.10)_2 = (-0.25)_{10}$

$(-0.35)_{10} = (0.010110)_2$

$= (0.010)_2$

$(-0.35)_{10} = (1.010)_2$

$= (-0.25)_{10}$

$$H(z) = \frac{1}{(1 - 0.25z^{-1})(1 - 0.25z^{-1})}$$

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Department of Electronics & Telecommunication

Student Roll No

Sr. no	Name of the student
1	Abhishek Kumar
2	Chandorkar Aayush Maheshwar
3	Bandi SwathiSampath
4	Dhondu Naresh Narsingh
5	Gadkar Om Sanjay
6	Girase Devendra Ravindra
7	Jadhav Chinmay Prasanna
8	Jadhav Siddhesh Abhay
9	Jumde Nikhil Tulsiram
10	Kanthe Tanya Amol
11	Katkar Parth Devendra
12	Khade Harshada Shahaji
13	Kharbe Yusuf Farooque
14	Kolhe Harshal Jitendra
15	Kulkarni Rohan Rupesh
16	Kumawat Bhakti Ramavatar
17	Maity Soumyadip Swapan
18	Malaye Mayur Uttam
19	Mishra Akshat Gyanprakash
20	More Snehal Maruti

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22	Panchal Sahilkumar Keshav
23	Panpatil Om Mangesh
24	Parkar Kunal Santosh
25	Patade Saurabh Sanjay
27	Phadke Taraka Pravin
28	Pol Chaitanya Bharat
29	Rajak Avinash Sunil
30	Rane Dhaval Vinayak
31	Raorane Shivani Sandesh
32	Sabbani Shrikant Narender
33	Sable Ruchita Vinay
34	Salvi Atharva Harshal
35	Salvi Swaraj Vilas
36	Shetty Ananya Umesh
37	Shinde Aryan Vilas
38	Singh Shraddha Harishankar
39	Tarmale Adesh Pandurang
40	Walimbe Rohan Anil
42	Bamne Niraj Dilip
44	Bhoir Aniket Prabhakar
45	Dixit Pawan Rajkumar
46	Gawai Gayatri Yuvraj

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47	Ghegad Vaibhav Ramesh
48	Gujare Chinmay Mahendra
50	Gurjar Aryan Sanjay
51	Kamble Aniket Tanaji
52	Karangutkar Akshay
53	Lawand Vrushali Sanjay
54	Malekar Tejas Prakash
55	Mhatre Purva Sanjay
56	Pandey Abhishek Achutanand
57	Rai Rupesh
58	Ramanna Shrinivas Baburao
59	Rane Aniket Vinayak
60	Raut Tanmayee Sudhakar
61	Riddhi Sudhir
62	Sagvekar Jayshree Yashvant
63	Salve Pawan Balasaheb
64	Sayyed Adnan Zahid
65	Shaikh Mehrajuddin Faiji
66	Shaikh Murtuza Farooq
67	Sharma Amitkumar Vinodkumar

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68	Shejwal Pratham Sanjay
69	Shinde Snehal Shivnath
70	Solapure Raj Balaji
71	Surve Pritesh Pravin
72	Sutar Harshwardhan Tushar
73	Swami Vedant Virbhadra
74	Talawdekar Vaibhavi Laxman
75	Tiwari Pratham Pramod
76	Undage Abodh Ravindra
77	Yadav Chandan Sheshram
78	Utekar Swapnil

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Student Analysis-Intelligent Test Report

Type of students	Count
Bright	5
Slow learner	8
Total	13

Assessment Tools:

1. Test on current subject (after 3 weeks)

2. ESE (pre- semester)

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Activities

I. Activities (Quiz/Seminar/Group Discussion/ Industrial Visit/Mini Project/Industry Interaction or any other (If Any)

Academically Bright Students: Screen Casting

Sr. No.	Name of Student	Roll No	Remedial Activity taken by teacher
1	Pol Chaitanya Bharat	28	
2	Rajak Avinash Sunil	29	Screen Casting
3	Shetty Ananya Umesh	36	
4	Singh Shraddha Harishankar	38	
5	Ramanna Shrinivas Baburao	58	

II. Remedial Activity for academically weak students

Sr. No.	Name of Student	Roll No	Remedial Activity taken by teacher
1	Panchal Sahilkumar Keshav	22	Remedial lecture, Extra question Solving
2	Gujare Chinmay Mahendra	48	Remedial lecture, Extra question Solving
3	Rane Aniket Vinayak	59	Remedial lecture, Extra question Solving
4	Shaikh Mehrajuddin Jalil	65	Remedial lecture, Extra question Solving
5	Solapure Raj Balaji	70	Remedial lecture, Extra question Solving
6	Surve Pritesh Pravin	71	Remedial lecture, Extra question Solving

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Department of Electronics and Telecommunication

Class: TE (EXTC) **SEM:** V

Subject: Discrete Time Signal Processing

Subject Incharge: Dr. Aarti Bakshi

Activity: Screen Casting

Activity Report: Screen Casting is to create instructional videos. These videos enable students to learn at their own pace, wherever they prefer. Screencasts can provide learners a student-centered and engaging learning experience in both distance and traditional learning settings.

Academically bright student solved discrete time signal processing different module numerical problems and recorded video to summarize it in their own words. These videos are uploaded on Google classroom. This helps the other students to learn and practice the numerical problems whenever they prefer.

Outcome: Students learned to create video. These videos help the students to learn the concept.

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Department of Electronics & Telecommunication

Remedial / Makeup/ Gate Coaching Attendance

Subject: DTSP
Semester: V

Date: 13/10/2022
Class: TE

Subject Teacher: Dr. Aarti Bakshi

Topic covered: Revision of DIT & DIF FFT

Roll Number	Name of students	Sign
58	Shrinivas Bommu	
22	Panchal Shailkumar	Shailkumar
25	Patade Surabh	
48.	Gujare Chinmay	
26	Patel Rizwan	AB
53	Lawand Vrushali	
71	Surve Ritesh	
72.	Sufar Harshwardhan	Sufar
75	Pratham Tiwari	Pratham
59	Rane Aniket	AB
65	Shaikh Mehraj	

Subject Incharge Sign: -

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Dr. Rajiv Iyer
H.o.D.EXTC

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Department of Electronics & Telecommunication

Remedial / Makeup/ Gate Coaching Attendance

Subject: DTSP

Semester: V

Date: 14/10/2022

Class: TE

Subject Teacher: Dr. Aarti Bakshi

Topic covered:

Revision of FIR & IIR filters

Roll Number	Name of students	Sign
76	Abodh Undage	Undage
55	Purva Mhatre	Mhatre
22	Panchal Shailkumar	Shailkumar
25	Patade Surabh	
48	Gujare Chinmay	
53	Lawand Vrushali	
70	Surve Pritesh	
72.	Sufar Harshwardhan	Sufar
26	Patel Rizwan	AB
75	Pratham Tiwari	Pratham
65	Shaikh Mehraj	
59	Rane Aniket	AB

Subject Incharge Sign: -

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Dr. Rajiv Iyer
H.o.D. EXTC

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Name - Vaishali Lawand
DTSP
Roll no - 53

Q.1] Design an FIR digital filter to approximate an ideal LPF with passband gain of unity, cut off frequency 850 Hz & working at sampling frequency of 5000 Hz. The length of impulse response should be 5. Use rectangular & hamming window.

Ans- We begin by drawing the digital filter frequency response.

We know π corresponds to $\frac{F_s}{2} = \frac{2500\,Hz}{2}$

i.e 2500 Hz $\longrightarrow \pi$

$\therefore$ 850 Hz $\longrightarrow \frac{850}{2500}\pi = 0.34\pi$

$\therefore$ 850 Hz corresponds to 0.34π as shown in P.T.S.1, Hence $\omega_c = 0.34\pi$

We use the I-DTFT formula to compute the desired impulse response.

$$h_d(n) = \frac{1}{2\pi}\int_{-\pi}^{+\pi} H(\omega)\, e^{+j\omega n}\, d\omega : -\infty \leq n \leq +\infty$$

$$h_d(n) = \frac{1}{2\pi}\int_{-0.34\pi}^{0+0.34\pi} 1 \cdot e^{j\omega n}\, d\omega$$

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The generalized solution of this integral is,

$$h_d(n) = \frac{\sin \omega_c n}{\pi n}; \quad -\infty \leq n \leq +\infty$$

Sin we

$$\omega_c = 0.34\pi$$

∴ we use eqn (2).

$$h_d(0) = \frac{1}{2\pi} \int_{-0.34\pi}^{+0.34\pi} e^0 \, dw$$

$$= \frac{1}{2\pi} [w]_{-0.34\pi}^{+0.34\pi}$$

$$= \frac{1}{2\pi} [0.34\pi - (-0.34\pi)]$$

$$h_d(0) = 0.34$$

$$\therefore h_d(n) = \begin{cases} \frac{\sin 0.34\pi n}{\pi n}; & -\infty \leq n \leq +\infty \\ \text{except } n=0 \quad . \quad \text{for } n=0 \end{cases}$$

Since $M = 5$, we shift this impulse response by $\frac{M-1}{2} = \frac{5-1}{2} = 2$

This is done by replacing n by $(n-2)$

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Hence we have

$$h_d(n) = \begin{cases} \dfrac{\sin 0.34\pi(n-2)}{\pi(n-2)}, & 0 \le n \le 4 \\ 0.34; & n = 2 \end{cases}$$

Rectangular window,

$$w(n) = \begin{cases} 1; & 0 \le n \le 4 \\ 0; & \text{otherwise} \end{cases}$$

The final impulse response is given by the formula,

$$h(n) = h_d(n) \times w(n) \quad 0 \le n \le 4 \quad \cdots (1)$$

we form a Table

Value of n	$h_d n$	wn	$h(n) = h_d(n) \times w(n)$
0	$h_d(0) = \dfrac{\sin 0.34\pi(-2)}{\pi(-2)} = 0.13$	1	0.13
1.	$h_d(1) = \dfrac{\sin 0.34\pi(-1)}{\pi(-1)}$	1	0.28
2.	$h_d(2) = 0.324$	1	~~0.28~~ 0.34
3.	$h_d(3) = \dfrac{\sin 0.34\pi(1)}{\pi(1)}$	1	0.28
4.	$h_d(4) = \dfrac{\sin}{\pi(2)}$ $= 0.13$	1	0.13

Hence the impulse response of the low pass filter using rectangular window is

$$h(n) = \{0.13, 0.28, 0.54, 0.28, 0.13\}$$

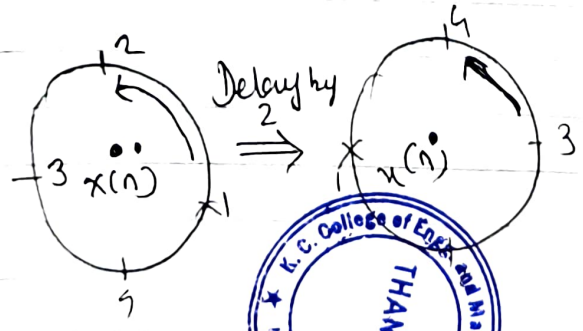
Hamming window :

The Hamming window is given by

$$w(n) = \begin{cases} 0.54 - 0.46\cos\left(\frac{2\pi n}{M-1}\right); & 0 \leq n \leq M-1 \\ 0; & \text{otherwise.} \end{cases}$$

Q2) For a ~~distance~~ discrete time sequence $x(n) = \{1, 2, 3, 4\}$, DFT is given by $X(k) = \{0, -2, +2j, -2, -2j\}$. Compute the DFT of $x(n) = \{3, 4, 12\}$ using circular time.

Ans $x(n) = \{1, 2, 3, 4\}$ & $x^1(n) = \{3, 4, 12\}$



$\therefore x^{\wedge}[n] = x(n-2)$

if $x(n) \xleftrightarrow{DFT} X(k)$

then $x[n-m]_N \xleftrightarrow{DFT} X(k)e^{-}$.

Here $m = 2$ & $N = 4$

$\therefore x^{\wedge}(n) = x(n-2)]_4 \longleftrightarrow X(k) \cdot e$

Given, $X(k) = \{10, -2, +j2, -2, -2, -j2\}$

for $k = 0 \Rightarrow X^{\wedge}(0) = x(0)e^{0} = x(0) = 10$

for $k = 1 \Rightarrow X^{\wedge}(1) = X(1)\, e^{-j\frac{2\pi}{4}}$

$= (-2 + j2)(\cos\pi - j\sin\pi)$

$= (-2 + j2)(-1) = 2 - j2$

for $k = 2 \Rightarrow X^{\wedge}(2) = X[2]\, e^{-j2\pi}$

$= -2(\cos 2\pi - j\sin 2\pi) = -2$

for $k = 3 \Rightarrow X^{3}[3] = X[3]\, e^{-2j2}$

$= -2[\cos 2\pi - j\sin 2\pi] = -2$

for $= 3 = 3^{A}[3] = X[3]\, e^{-j3\pi}$

$= [-2 - j2][\cos 3\pi - j\sin 3\pi]$

$= [-2 - j2)(-1] = 2 + j2$

$\therefore X^{\wedge}[k] = \{10, 2, -j2, -2, 2, +j2\}$.

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Extra question DTSP

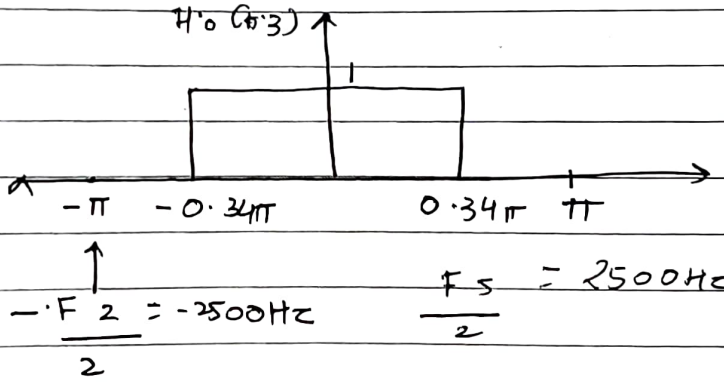
1)

We know π corresponds to $\frac{F_s}{2} = 2500$ Hz

i.e 2500 Hz $\rightarrow \pi$

$\therefore$ 850 Hz $\rightarrow \frac{850}{2500}\pi = 0.34\pi$

$\therefore$ 850 Hz corresponds to 0.34π as shown in the



We use the I-DTFT formula to compute the desired impulse response.

$$h_d(n) = \frac{1}{2\pi} \int_{-\pi}^{+\pi} H(\omega) e^{+j\omega n} d\omega \quad :-\infty \le n \le +\infty$$

$$h_d(n) = \frac{1}{2\pi} \int_{-0.34\pi}^{+0.34\pi} 1 \cdot e^{j\omega n} d\omega$$

∴ We use equation (2)

$$\therefore h_d[0] = \frac{1}{2\pi} \int_{-0.34\pi}^{+0.34\pi} e^{0} \, dw$$

$$= \frac{1}{2\pi} [w]_{-0.34\pi}^{+0.34\pi}$$

$$= \frac{1}{2\pi} [0.34\pi - [0.34\pi)]$$

$$h_d[0] = 0.34$$

$$\therefore h_d[n] = \left\{ \frac{\sin 0.34\pi n}{\pi n} ; \quad -\infty \le n \le +\infty \right.$$

Hence we have

$$h_d(n) = \left\{ \frac{\sin 0.34\pi (n-2)}{\pi (n-2)} \right. \quad 0 \le n \le 4$$

Rectangular window

$$w(n) = \begin{cases} 1 : 0 \le n \le 4 \\ 0, \text{ otherwise.} \end{cases}$$

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Hence the impulse response

$$h(n) = \{0.15, 0.28, 0.34, 0.28, 0.135\}$$

The Hamming window is given by the formula

$$w(n) = \begin{cases} 0.54 - 0.46\cos\left(\frac{2\pi n}{m-1}\right) \\ 0 \text{ ; otherwise} \end{cases}$$

i.e $w(n) = \begin{cases} 0.54 - 0.46\cos\left(\frac{2\pi n}{4}\right) \\ 0, \text{ otherwise} \end{cases}$

Q2) $x(n) = \{1, 2, 2, 1, 0\}$
$\uparrow$

If $x(n) \xleftrightarrow{DFT} X(k)$

$x((n-m))_N \xleftrightarrow{DFT} X(k)e$

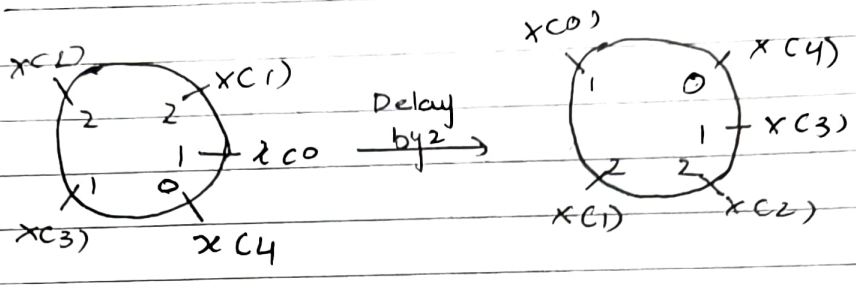
Here $N = 5$

$\therefore x((n-m))_5 \xleftrightarrow{DFT} X(k)e$

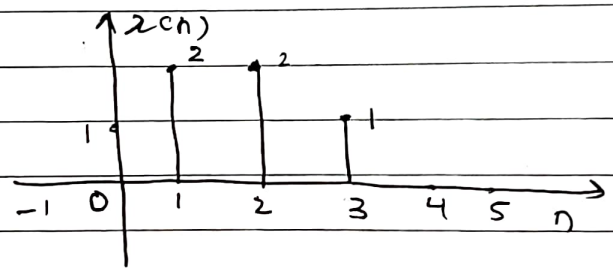
$Y(k) = e^{\cdots} X(k)$

Comparing equations ① & ② we note that

$y(n) = x(n-2)_5$



$\therefore y(n) = \{1, 0, 1, 2, 2\}$



Hence this $y(n)$ will be the sequence which will have a DFT whic is equal to $e^{\frac{-j4\pi k}{5}} X(k)$.

Teacher's Signature:

Course Exit Survey Analysis

Class: TE **Sub: DTSP**

Sem : V **Year: 2022-23**

Timestamp	Email Address	First Name	Surname	Roll Number	Are you able to recall the system representations and understand the relation between different transforms?	Do you understand the concepts of discrete-time Fourier transform, fast Fourier transform and apply in system analysis?	Are you able to design digital IIR and FIR filters to satisfy the given specifications and evaluate the frequency response and pole zero representations to choose a particular filter for the given application ?	Are you able to interpret the different realization structures of Digital IIR and FIR filters?	Are you able to analyze the impact of hardware limitations on the performance of digital filters?	Are you able to apply signal processing concepts, algorithms in applications related to the field of biomedical and audio signal processing?
10/14/2022 18 52 37	rupeshrai.2021@kcc	Rupesh	Rai	57	High	High	Medium	High	High	High
10/14/2022 18 59 58	chinmayjadhav@kcc	Chinmay	Jadhav	7	High	High	High	High	High	High
10/14/2022 18 26 53	yusufkharbe@kccem	Yusuf	Kharbe	13	Medium	Medium	Medium	Medium	Medium	Medium
10/14/2022 22 45 09	swarajsalvi@kccems	Swaraj	Salvi	35	High	High	High	High	High	High
10/14/2022 15 52 11	dhavalrane@kccems	Dhaval	Rane	30	Medium	Medium	Medium	Medium	Medium	Medium
10/14/2022 16 13 34	rohankulkarni@kcce	Rohan	Kulkarni	15	Medium	Medium	Medium	Medium	Medium	Medium
10/14/2022 16 15 22	tarakaphadke@kccem	Taraka	Phadke	27	High	High	High	Medium	Medium	High
10/14/2022 16 21 21	swathibandi@kccem	Swathi	Bandi	3	Medium	Low	Medium	Medium	Low	Low
10/15/2022 16 51 17	snehalmore@kccems	Snehal	More	20	High	Medium	High	Medium	Low	High
10/15/2022 19 04 38	aniketbhoir.2021@k	Aniket	Bhoir	44	Medium	Medium	Medium	Medium	Medium	Medium
10/16/2022 11 11 10	akshatmishra@kccem	AKSHAT	MISHRA	19	Medium	Medium	Medium	Medium	Medium	Medium
10/16/2022 17 18 40	parthkatkar@kccems	Parth	Katkar	11	High	High	High	High	High	High
10/16/2022 17 53 11	vrushalilawand.2021	Vrushali Sanjay Law	Lawand	53	Medium	Medium	Medium	Medium	Medium	Medium
10/16/2022 18 51 35	harshalkolhe@kccem	Harshal	Kolhe	14	High	Medium	High	Medium	High	Medium
10/16/2022 22 10 00	saurabhpatade@kcc	saurabh	patade	25	High	High	High	High	High	High
10/17/2022 18 08 40	shrikantsabbani@kcc	SHRIKANT	SABBANI	32	High	High	High	High	High	High
10/17/2022 21 00 40	adnansayyed.2021@	Adnan Zahid	Sayyed	64	High	Medium	High	Medium	High	Medium
10/27/2022 12 33 10	avinashrajak@kccem	Avinash	Rajak	29	High	Medium	Medium	High	High	Medium
10/27/2022 12 41 50	anamyashetty@kccem	Anamya	Shetty	36	Medium	Medium	High	Medium	Medium	High
10/28/2022 0 15 14	kunalparkar@kccem	Kunal	Parkar	24	Medium	Medium	Medium	Medium	Medium	Medium
10/28/2022 0 55 15	harshadakhade@kcc	harshada	khade	12	Medium	Medium	Medium	Medium	Medium	Medium
10/28/2022 10 17 14	siddheshjadhav@kcc	Siddhesh	Jadhav	8	Medium	Medium	Medium	Medium	Medium	Medium
10/28/2022 11 11 12	devendragurase@kcc	Devendra	Gurase	6	High	Medium	High	Medium	High	High
10/29/2022 0 33 07	abodhundage.2021@	Abodh	Undage	76	High	Medium	Medium	Medium	Medium	High
10/29/2022 10 06 04	soumyadipmaity@kcc	Soumyadip	Maity	17	High	High	High	High	High	High
10/29/2022 12 53 00	aniketkamble.2021@	Aniket	Kamble	51	Medium	Medium	Medium	Medium	Medium	Medium
10/29/2022 16 15 57	shivaniraorane@kcc	Shivani	Raorane	31	Medium	Medium	Medium	Medium	Medium	Medium
10/30/2022 10 29 27	jayshreesagvekar.202	Jayshree	Sagvekar	62	High	Medium	Medium	Medium	High	High
10/30/2022 12 50 04	tanmayeeraut.2021@	Tanmayee	Raut	60	Medium	Medium	Medium	Medium	Medium	Medium
10/30/2022 15 43 25	bhakukumawat@kcc	Bhaku	Kumawat	16	Medium	Medium	Medium	Medium	Medium	Medium

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10/30/2022 17 16 17	adeshtarmale a kcem	Adesh	Tarmale	39	High	High	High	High	High	High
10/30/2022 17 28 15	kumarabhishek a kcc	Abhishek	Shukla	1	High	High	High	High	High	High
10/30/2022 17 46 25	rohanwalimbe a kcce	Rohan	Walimbe	40	High	High	High	High	High	High
10/30/2022 18 29 20	chantam apol a kcem	chantanya	pol	28	High	Low	Medium	Medium	High	Low
10/30/2022 20 05 18	manurmalave a kcce	Manur	Malave	18	Medium	Medium	Medium	Medium	Medium	Medium
10/31/2022 1 44 30	shrinivasramanna 20	Shrinivas	Ramanna	58	High	High	High	High	High	High
10/31/2022 2 05 02	nirajbamne 2021 a k	NIRAJ	BAMNE	42	High	High	High	High	High	High
10/31/2022 2 51 22	purvamhatre 2021 a	PURVA	MHATRE	55	High	High	Medium	Medium	High	Medium
10/31/2022 11 21 12	shraddhasingh a kcce	Shraddha	Singh	38	High	High	High	High	High	High
10/31/2022 12 03 02	vaibhavtalawdekar 2	Vaibhav	Talawdekar	74	Medium	Medium	Medium	Medium	Medium	Medium
10/31/2022 12 03 51	gavaingawai 2021 a	Gavain	Gawai	46	Medium	Medium	Medium	Medium	Medium	Medium
10/31/2022 16 06 39	tanvakanthe a kcem	Tanva	Kanthe1p	10	High	Medium	Medium	Medium	Medium	Medium
10/31/2022 23 37 55	pniteshsurve 2021 a k	pnitesh	surve	71	High	High	High	High	High	High
11/1/2022 15 08 19	atharvasalvi a kcem	ATHARVA	SALVI	34	High	High	High	High	High	High
11/1/2022 16 21 45	vedantswami 2021 a	Vedant	Swami	73	High	High	High	High	High	High
11/1/2022 19 22 55	arvangurjar 2021 a k	Arvan	Gurjar	50	Medium	High	Medium	High	Low	High
11/1/2022 21 45 17	prathamshejwal 202	Pratham	Shejwal	68	Medium	Medium	Medium	Medium	Medium	Medium
11/2/2022 12 22 19	aayushchandorkar a k	Aayush	Chandorkar	2	Medium	Medium	Medium	Medium	Medium	Medium
11/2/2022 12 58 02	sahilpanchal a kcem	Sahil	Panchal	22	High	High	High	High	High	High
11/2/2022 14 18 29	amitkumarsharma 20	Amitkumar	Sharma	67	Medium	Medium	Medium	Medium	High	High
11/2/2022 14 48 10	ruchitasable a kcem	Ruchita	Sable	33	High	High	High	High	High	High
11/2/2022 15 21 24	abhishekpandey 202	Abhishek	Pandey	56	High	Medium	Medium	Medium	Medium	High
11/2/2022 15 24 07	chandanshesharnyad	Chandan	Yadav	77	Medium	Medium	Medium	Medium	Medium	Medium
11/3/2022 9 15 15	nareshdhondu@kcce	Naresh	Dhondu	4	High	High	Medium	High	Medium	Medium
11/3/2022 11 04 05	omgadkar@kccemsr	Om	gadkar	5	High	High	Medium	Medium	Medium	Medium
11/3/2022 14 10 51	aniketrane 2021 @kc	Aniket	Rane	59	High	High	Medium	Medium	High	High
11/5/2022 13 12 34	snehalshinde 2021 @	Snehal	Shinde	69	High	High	High	High	High	High
11/5/2022 15 07 41	swapnilutekar 2022 @	utekar	swapnil	78	High	Medium	High	Medium	Medium	Low
11/5/2022 23 32 59	tejasmalekar 2021 @	Tejas	Malekar	54	Medium	Medium	Medium	Medium	Medium	Medium
11/7/2022 0 24 19	shaikhsohrabguddmal	Mehra	Shaikh	65	High	High	High	High	High	High
11/7/2022 10 31 50	prathamtiwari 2021 a	Pratham	Tiwari	75	High	High	High	High	High	High

High	Medium	Low	Level	Percentage
37	24	0	2.6	86.88
27	32	2	2.4	80.32
27	34	0	2.44	81.42
24	37	0	2.39	79.78
31	27	3	2.45	81.96
31	27	3	2.45	81.96

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Sem V. R-19
Paper code: 13805

Duration: 3hrs **[Max Marks:80]**

N.B. : (1) Question No 1 is Compulsory.
(2) Attempt any three questions out of the remaining five.
(3) All questions carry equal marks.
(4) Assume suitable data, if required and state it clearly.

1 Attempt any FOUR [20]

a Find the DFT of x[n]={5, 6, 7, 8}. Using answer and not otherwise find DFT of x1[n]={8, 5, 6, 7}.

b Find the impulse response if the frequency response of the system is given as $H(e^{j\omega}) = e^{-j3\omega}(1 + 0.5\cos\omega - 0.95\cos 2\omega)$

c Realize the linear phase FIR filter given as $h[n] = \{1, -0.5, 0, 0.5, -1\}$ using minimum number of multipliers.

d For linear phase FIR filter, one of the zeros is at $0.2e^{j\frac{\pi}{3}}$. Find other compulsory zeros for Odd Symmetric FIR filter. Determine the transfer function.

e Compare FIR filters with IIR filters

2 a Find the DFT of a real sequence x[n] ={1, -2, 3, 5, 1, 3, -4, 2} using DIT FFT. [10]

b The second order IIR filter is defined as [10]

$$H(z) = \frac{1}{(1 - 0.95z^{-1} + 0.225\,z^{-2})}$$

Determine the shift of poles in direct form and cascade form realization if coefficients are represented by 3 bits.

3 a Determine the digital IIR digital filter from analog filter transfer function which is given as $H(s) = \frac{10}{(s^2+7s+15)}$ with T=0.02sec. using impulse invariant transformation method. [10]

b Find DFT of x1[n]={1, 4, 3, -2} and x2[n]={1, -2, 4, 5} using DIF FFT only once. [10]

4 a Design a digital filter with flat passband and flat stopband which satisfies following constraints using bilinear transformation method. Assume Ts=0.1s. [10]

$0.8 \leq |H(e^{j\omega})| \leq 1 \quad 0 \leq \omega \leq 0.25\pi$

$|H(e^{j\omega})| \leq 0.2 \quad 0.65\pi \leq \omega \leq \pi$

b Find the output of the system having impulse response h[n]={2,1,2} for input sequence x[n]={1, -2, 4, 5, 3, 2, 2, 1, 5, 7, -3, -1, 4, 2} using Overlap-save Method (Assume N=6). [10]

5 a Design a digital FIR filter using Hanning window for M=7 for given specifications. [10]

$$H(e^{j\omega}) = \begin{cases} e^{-j3\omega} & ; \ \frac{\pi}{8} \leq |\omega| \leq \frac{\pi}{4} \\ 0 & ; \ \text{otherwise} \end{cases}$$

b Realize the filter function by lattice realization structure. [10]

$$H(z) = 1 + \frac{3}{4}z^{-1} + \frac{1}{2}z^{-2} + \frac{1}{4}z^{-3}$$

6 a Explain group delay and phase delay. [6]

b Explain how DTSP is used in echo cancellation process. [7]

c Write a short note on Limit cycle oscillations [7]

Solution
Subject Code: 32222 Paper code: 13805
Subject: Discrete Time Signal Processing

Q1 a) DFT of x[n]={5,6,7,8}

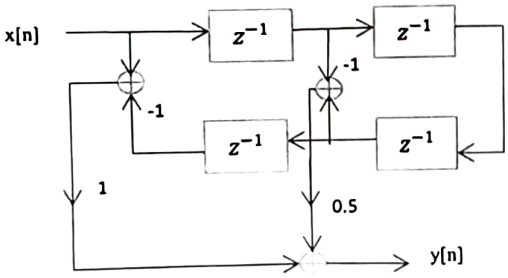
$$\begin{bmatrix}1 & 1 & 1 & 1\\ 1 & -j & -1 & j\\ 1 & -1 & 1 & -1\\ 1 & j & -1 & -j\end{bmatrix}\begin{bmatrix}5\\6\\7\\8\end{bmatrix}=\begin{bmatrix}26\\-2+2j\\-2\\-2-2j\end{bmatrix}$$

x1[n]={8,5,6,7}
Relation between x1[n] and x[n] is x1[n]=x[(n-l)]
l=1
DFT Shifting property
$X1(k) = e^{-j\frac{2\pi lk}{N}}X(k)$
X1(k) ={26, 2+2j, 2, 2-2j}

Q1 b)
$H(e^{j\omega}) = e^{-j3\omega}(1 + 0.5\cos\omega - 0.95\cos 2\omega)$
$H(e^{j\omega}) = e^{-j3\omega}(1 + 0.5\left(\frac{e^{j\omega}+e^{-jw}}{2}\right) - 0.95\cos\left(\frac{e^{j2\omega}+e^{-j2w}}{2}\right))$
$H(e^{j\omega}) = -0.475e^{-j\omega} + 0.25e^{-j2\omega}+e^{-j3\omega}+0.25e^{-j4\omega}-0.475e^{-j5\omega}$

Inverse DTFT
H[n]={0, -0.475, 0.25, 1, 0.25, -0.475, 0}

Q1 c)
h[n]={1, -0.5, 0, 0.5, -1}



Q 1 d) Compulsory zeros for odd symmetric FIR filter

$z_1 = 0.2e^{j\frac{\pi}{3}}$

$z_2 = z_1^* = 0.2e^{-j\frac{\pi}{3}}$

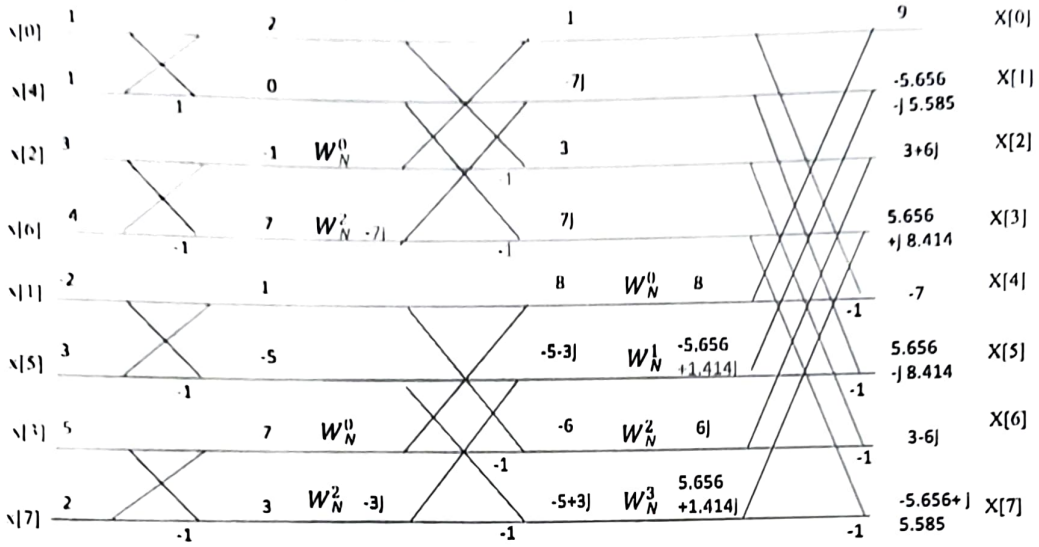
$z_3 = \frac{1}{z_1} = 5e^{-j\frac{\pi}{3}}$

$z_4 = \frac{1}{z_1^*} = 5e^{j\frac{\pi}{3}}$

$H(z) = \frac{(z-0.2e^{j\frac{\pi}{3}})(z-0.2e^{-j\frac{\pi}{3}})(z-5e^{j\frac{\pi}{3}})(z-5e^{-j\frac{\pi}{3}})}{z^4}$

$H(z) = 1 - 5.2z^{-1} + 26.04z^{-2} - [illegible] + z^{-4}$

Q2 a) x[n] = {1, -2, 3, 5, 1, 3, -4, 2}



X(k)={9, -5.656 -j 5.585, 3+6j, 5.656+j 8.414, -7, 5.656- j 8.414, 3- 6j, -5.656+j 5.585}

Q2 b) **Direct Form**

$H(z) = \frac{1}{1-0.95z^{-1}+0.225z^{-2}}$

0.95 x 2= 1.9 --> 1
0.9 x 2 = 1.8 --> 1
0.8 x 2 = 1.6 --> 1
0.6 x 2 = 1.2 --> 1
0.2 x 2 = 0.4 --> 0

(0.95)= 0.1 1 1 1 0.....

3 bit representation
0.111 --> 0.875
New coeff. value = -0.875

0.225 x 2 = 0.45 --> 0
0.45 x 2 = 0.9 --> 0
0.9 x 2 = 1.8 --> 1
0.8 x 2 = 1.6 --> 1
0.6 x 2 = 1.2 --> 1
0.2 x 2 = 0.4 --> 0

(0.225)= 0.0 0 1 1 1 0. ...
3 bit representation
0.001 --> 0.125
New coeff. value = 0.125

Cascade Form:

$H(z) = \frac{1}{1-0.95z^{-1}+0.225z^{-2}}$

$H(z) = \frac{1}{(1-0.5z^{-1})(1-0.45z^{-1})}$

0.5 x 2= 1.0 --> 1
0.0 x 2= 0.0 --> 0

(0.5)= 0.1 0 0 0 ...

3 bit representation
0.100 --> 0.5
New pole location = 0.5

0.45 x 2 = 0.9 --> 0
0.9 x 2 = 1.8 --> 1
0.8 x 2 = 1.6 --> 1
0.6 x 2 = 1.2 --> 1
0.2 x 2 = 0.4 --> 0
(0.225)= 0.0 1 1 1 0 . . .
3 bit representation
0.011 --> 0.375
New pole location = 0.375

Q3 a)

$$H(s) = \frac{10}{s^2+7s+15}$$

$$H(s) = \frac{10}{s^2+7s+12.25+2.75}$$

$$H(s) = \frac{10}{(s+3.5)^2+(1.658)^2}$$

$$H(s) = \frac{10}{1.658}\frac{1.658}{(s+3.5)^2+(1.658)^2} \quad \text{--(1)}$$

Impulse invariant Transformation

$$\frac{b}{(s+a)^2+b^2} \rightarrow \frac{e^{-aT}z^{-1}\sin bT}{1-2e^{-aT}z^{-1}\cos bT+e^{-2aT}z^{-2}} \quad \text{-- (2)}$$

From Equation (1), a=3.5, b=1.658 and T=0.02

Using equation (2) and simplifying

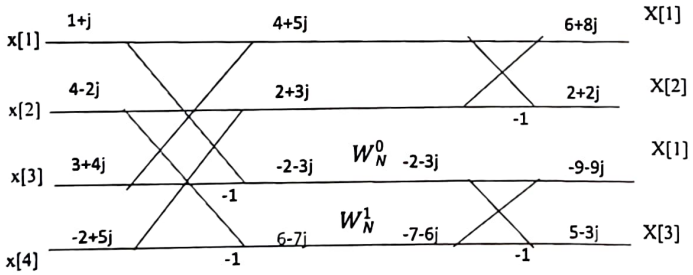
$$H(z) = \frac{0.1789z^{-1}}{1-1.8621z^{-1}+0.869z^{-2}}$$

Q3 b)

x1[n]={1, 4, 3, -2} and x2[n]={1, -2, 4, 5}

x[n]=x1[n]+jx2[n]

x[n]={1+j, 4-2j, 3+4j, -2+5j}



X(k)={6+8j, -9-9j, 2+2j, 5+3j}

$$X^*(-k) = \{6-8j, 5-3j, 2-2j, -9+9j\}$$

$$X1(k) = \frac{X(k)+X^*(-k)}{2} = \{6, -2-6j, 2, -2+6j\}$$

$$X2(k) = \frac{X(k)-X^*(-k)}{2j} = \{8, -3+7j, 2, -3-7j\}$$

Q4 a)

Flat pass band and flat stop band --> Butterworth Filter

Digital Specifications: d1=0.8, d2=0.2, ω1=0.25π, ω2=0.65π

Analog specifications:

Using Bilinear Transformation $\Omega = \frac{2}{T}\tan\frac{\omega}{2}$ and T=0.1s

d1=0.8, d2=0.2, Ω1=2.513 rad/sec, Ω2=6.498 rad/sec

Q3 a)

$$H(s) = \frac{10}{s^2+7s+15}$$

$$H(s) = \frac{10}{s^2+7s+12.25+2.75}$$

$$H(s) = \frac{10}{(s+3.5)^2+(1.658)^2}$$

$$H(s) = \frac{10}{1.658}\frac{1.658}{(s+3.5)^2+(1.658)^2} \quad \text{--(1)}$$

Impulse invariant Transformation

$$\frac{b}{(s+a)^2+b^2} \rightarrow \frac{e^{-aT}z^{-1}\sin bT}{1-2e^{-aT}z^{-1}\cos bT+e^{-2aT}z^{-2}} \quad \text{-- (2)}$$

From Equation (1), a=3.5, b=1.658 and T=0.02

Using equation (2) and simplifying

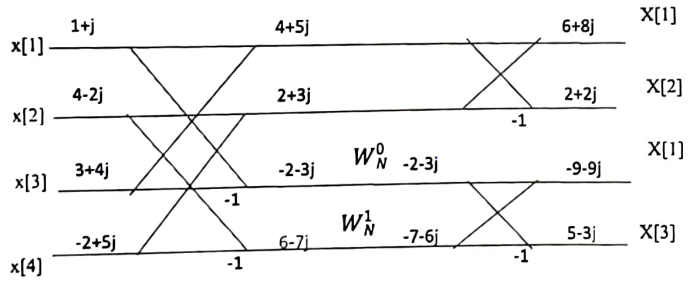
$$H(z) = \frac{0.1789z^{-1}}{1-1.8621z^{-1}+0.869z^{-2}}$$

Q3 b)

x1[n]={1, 4, 3, -2} and x2[n]={1, -2, 4, 5}

x[n]=x1[n]+jx2[n]

x[n]={1+j, 4-2j, 3+4j, -2+5j}



X(k)={6+8j, -9-9j, 2+2j, 5+3j}

$$X^*(-k) = \{6-8j, 5-3j, 2-2j, -9+9j\}$$

$$X1(k) = \frac{X(k)+X^*(-k)}{2} = \{6, -2-6j, 2, -2+6j\}$$

$$X2(k) = \frac{X(k)-X^*(-k)}{2j} = \{8, -3+7j, 2, -3-7j\}$$

Q4 a)

Flat pass band and flat stop band --> Butterworth Filter

Digital Specifications: d1=0.8, d2=0.2, ω1=0.25π, ω2=0.65π

Analog specifications:

Using Bilinear Transformation $\Omega = \frac{2}{T}\tan\frac{\omega}{2}$ and T=0.1s

d1=0.8, d2=0.2, Ω1=2.513 rad/sec, Ω2=6.498 rad/sec

Order of filter and cut off frequency

$$N \geq \frac{1}{2}\frac{\log\left(\frac{\frac{1}{d2^2}-1}{\frac{1}{d1^2}-1}\right)}{\log\left(\frac{\Omega_2}{\Omega_1}\right)} \quad \text{and} \quad \Omega_c = \frac{\Omega_p}{\left[\frac{1}{d1^2}-1\right]^{1/2N}}$$

N=2 and cut off frequency Ωc=2.90 rad/sec

Normalized transfer function

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

Denormalized transfer function

$$H(s) = \hat{H}(s)|s = \frac{s}{\Omega_c}$$

$$H(s) = \frac{8.41}{s^2+4.1s+8.41}$$

Analog to Digital Filter conversion using BLT (T=0.1 sec)

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

$$H(z) = \frac{8.41(z+1)^2}{488.41z^2-783.18z+326.41} \text{ OR}$$

$$H(z) = \frac{0.0172z^2-0.0344z+0.0172}{z^2-1.6035z+0.6683}$$

Q4 b) h[n]={2, 1, 2} --> M=3
x[n]={1, -2, 4, 5, 3, 2, 2, 1, 5, 7, -3, -1, 4, 2}
N=6
N=L+M-1 -- L= 4

h[n]={2, 1, 2, 0, 0, 0}
x1[n]={0, 0, 1, -2, 4, 5}
x2[n]={4, 5, 3, 2, 2, 1}
x3[n]={2, 1, 5, 7, -3, -1}
x4[n]={-3, -1, 4, 2, 0, 0}

Using circular convolution
y1[n]={13, 5, 2, -3, 8, 10}
y2[n]={13, 16, 19, 17, 12, 8}
y3[n]={-3, 2, 15, 21, 11, 9}
y4[n]={-6, -5, 1, 6, 10, 4}

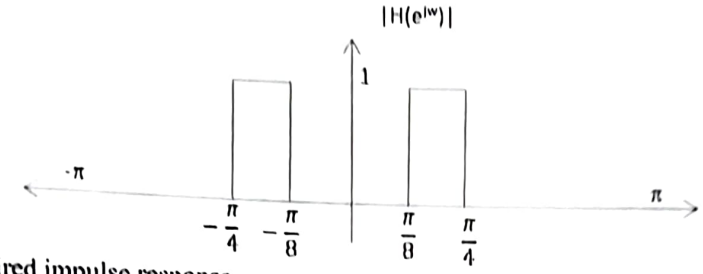
Discard First M-1 samples in each section

13, 5, 2, -3, 8, 10
13, 16, 19, 17, 12, 8
-3, 2, 15, 21, 11, 9
-6, -5, 1, 6, 10, 4

y[n]={ 2, -3, 8, 10, 19, 17, 12, 8, 15, 21, 11, 9, 1, 6, 10, 4 }

Q5 a)

$$H(e^{j\omega}) = \begin{cases} e^{-j3\omega} & : \frac{\pi}{8} \le |\omega| \le \frac{\pi}{4} \\ 0 & : \text{otherwise} \end{cases}$$



Desired impulse response

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

$h_d[n] = \frac{1}{2\pi}\left\{\int_{-\pi/4}^{-\pi/8} H(e^{j\omega})e^{j\omega n}d\omega + \int_{\pi/8}^{\pi/4} H(e^{j\omega})e^{j\omega n}d\omega\right\}$

$$h_d[n] = \begin{cases} \frac{1}{\pi(n-3)}\left[\sin\left(\frac{\pi}{4}(n-3)\right) - \sin\left(\frac{\pi}{8}(n-3)\right)\right] & n \neq 3 \\ 0.125 & n = 3 \end{cases}$$

hd[n]={-0.023, 0.0466,, 0.1032, 0.125, 0.1032, 0.0466, -0.023}

Hanning Window

$$w[n] = \begin{cases} 0.5 - 0.5\cos(\frac{2\pi n}{M-1}) & 0 \le n \le M-1 \\ 0 & \text{Otherwise} \end{cases}$$

w[n] ={0, 0.25, 0.75, 1, 0.75, 0.25, 0}

Impulse response of filter

h[n]=hd[n]. w[n]

h[n] ={0, 0.01165, 0.0774, 0.125, 0.0774, 0.01165, 0}

Q5 b) $H(z) = 1 + \frac{3}{4}z^{-1} + \frac{1}{2}z^{-2} + \frac{1}{4}z^{-3}$

m= 3

$A3(z) = 1 + \frac{3}{4}z^{-1} + \frac{1}{2}z^{-2} + \frac{1}{4}z^{-3}$ k3=1/4

$B_m(z) = z^{-m}A_m(z^{-1})$

$B3(z) = \frac{1}{4} + \frac{1}{2}z^{-1} + \frac{3}{4}z^{-2} + z^{-3}$

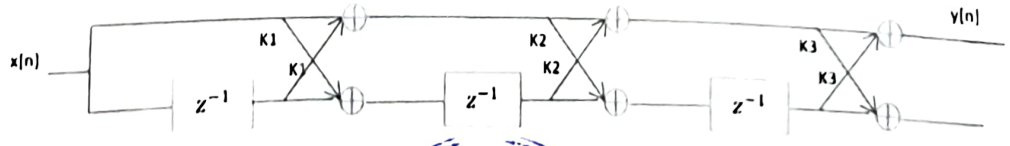
$A_{m-1}(z) = \frac{A_m(z) - k_m B_m(z)}{1 - k_m^2}$

$A2(z) = 1 + \frac{2}{3}z^{-1} + \frac{1}{3}z^{-2}$ k2=1/3

$B2(z) = \frac{1}{3} + \frac{2}{3}z^{-1} + z^{-2}$

$A1(z) = 1 + \frac{1}{2}z^{-1}$ k1=1/2

Lattice Realization Structure



Sem V, R-19
Paper code: 13805

Duration: 3hrs **[Max Marks:80]**

N.B. : (1) Question No 1 is Compulsory.
(2) Attempt any three questions out of the remaining five.
(3) All questions carry equal marks.
(4) Assume suitable data, if required and state it clearly.

1 Attempt any FOUR [20]

a Find the DFT of x[n]={5, 6, 7, 8}. Using answer and not otherwise find DFT of x1[n]={8, 5, 6, 7}.

b Find the impulse response if the frequency response of the system is given as $H(e^{j\omega}) = e^{-j3\omega}(1 + 0.5\cos\omega - 0.95\cos 2\omega)$

c Realize the linear phase FIR filter given as $h[n] = \{1, -0.5, 0, 0.5, -1\}$ using minimum number of multipliers.

d For linear phase FIR filter, one of the zeros is at $0.2e^{j\frac{\pi}{3}}$. Find other compulsory zeros for Odd Symmetric FIR filter. Determine the transfer function.

e Compare FIR filters with IIR filters

2 a Find the DFT of a real sequence x[n] ={1, -2, 3, 5, 1, 3, -4, 2} using DIT FFT. [10]

b The second order IIR filter is defined as [10]

$$H(z) = \frac{1}{(1 - 0.95z^{-1} + 0.225\,z^{-2})}$$

Determine the shift of poles in direct form and cascade form realization if coefficients are represented by 3 bits.

3 a Determine the digital IIR digital filter from analog filter transfer function which is given as $H(s) = \frac{10}{(s^2+7s+15)}$ with T=0.02sec. using impulse invariant transformation method. [10]

b Find DFT of x1[n]={1, 4, 3, -2} and x2[n]={1, -2, 4, 5} using DIF FFT only once. [10]

4 a Design a digital filter with flat passband and flat stopband which satisfies following constraints using bilinear transformation method. Assume Ts=0.1s. [10]

$0.8 \leq |H(e^{j\omega})| \leq 1 \quad 0 \leq \omega \leq 0.25\pi$

$|H(e^{j\omega})| \leq 0.2 \quad 0.65\pi \leq \omega \leq \pi$

b Find the output of the system having impulse response h[n]={2,1,2} for input sequence x[n]={1, -2, 4, 5, 3, 2, 2, 1, 5, 7, -3, -1, 4, 2} using Overlap-save Method (Assume N=6). [10]

5 a Design a digital FIR filter using Hanning window for M=7 for given specifications. [10]

$$H(e^{j\omega}) = \begin{cases} e^{-j3\omega} & ; \ \frac{\pi}{8} \leq |\omega| \leq \frac{\pi}{4} \\ 0 & ; \ \text{otherwise} \end{cases}$$

b Realize the filter function by lattice realization structure. [10]

$H(z) = 1 + \frac{3}{4}z^{-1} + \frac{1}{2}z^{-2} + \frac{1}{4}z^{-3}$

6 a Explain group delay and phase delay. [6]

b Explain how DTSP is used in echo cancellation process. [7]

c Write a short note on Limit cycle oscillations [7]

Aarti Bakshi

Solution
Subject Code: 32222 Paper code: 13805
Subject: Discrete Time Signal Processing

Q1 a) DFT of x[n]={5,6,7,8}

$$\begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & -j & -1 & j \\ 1 & -1 & 1 & -1 \\ 1 & j & -1 & -j \end{bmatrix} \begin{bmatrix} 5 \\ 6 \\ 7 \\ 8 \end{bmatrix} = \begin{bmatrix} 26 \\ -2+2j \\ -2 \\ -2-2j \end{bmatrix}$$

x1[n]={8,5,6,7}
Relation between x1[n] and x[n] is x1[n]=x[(n-1)]
l=1
DFT Shifting property

$X1(k) = e^{-j\frac{2\pi lk}{N}}X(k)$

X1(k) ={26, 2+2j, 2, 2-2j}

Q1 b)

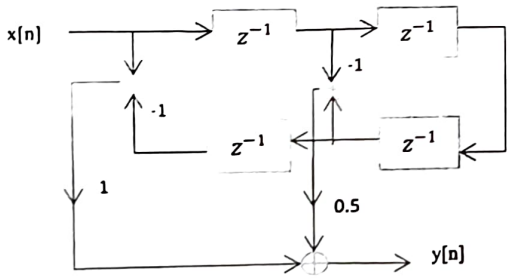
$H(e^{j\omega}) = e^{-j3\omega}(1 + 0.5\cos\omega - 0.95\cos 2\omega)$

$H(e^{j\omega}) = e^{-j3\omega}(1 + 0.5\left(\frac{e^{j\omega}+e^{-jw}}{2}\right) - 0.95\cos\left(\frac{e^{j2\omega}+e^{-j2w}}{2}\right))$

$H(e^{j\omega}) = -0.475e^{-j\omega} + 0.25e^{-j2\omega} + e^{-j3\omega} + 0.25e^{-j4\omega} - 0.475e^{-j5\omega}$

Inverse DTFT
H[n]={0, -0.475, 0.25, 1, 0.25, -0.475, 0}

Q1 c)
h[n]={1, -0.5, 0, 0.5, -1}



Q 1 d) Compulsory zeros for odd symmetric FIR filter

$z_1 = 0.2e^{j\frac{\pi}{3}}$

$z_2 = z_1^* = 0.2e^{-j\frac{\pi}{3}}$

$z_3 = \frac{1}{z_1} = 5e^{-j\frac{\pi}{3}}$

$z_4 = \frac{1}{z_1^*} = 5e^{j\frac{\pi}{3}}$

$H(z) = \frac{(z-0.2e^{j\frac{\pi}{3}})(z-0.2e^{-j\frac{\pi}{3}})(z-5e^{j\frac{\pi}{3}})(z-5e^{-j\frac{\pi}{3}})}{z^4}$

$H(z) = 1 - 5.2z^{-1} + 26.04z^{-2} - 5.2z^{-3} + z^{-4}$

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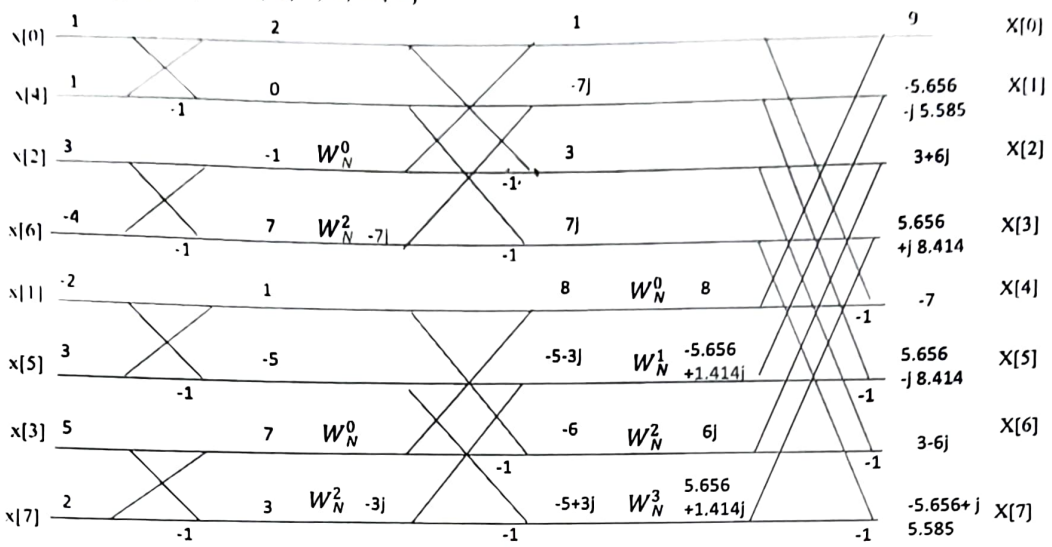
Q2 a) x[n]={1, -2, 3, 5, 1, 3, -4, 2}



X(k)={9, -5.656 -j 5.585, 3+6j, 5.656+j 8.414, -7, 5.656- j 8.414, 3- 6j, -5.656+j 5.585}

Q2 b) **Direct Form**

$H(z) = \frac{1}{1-0.95z^{-1}+0.225z^{-2}}$

0.95 x 2= 1.9 --> 1
0.9 x 2 = 1.8 --> 1
0.8 x 2 = 1.6 --> 1
0.6 x 2 = 1.2 --> 1
0.2 x 2 = 0.4 --> 0

(0.95)= 0.1 1 1 1 0.....

3 bit representation
0.111 --> 0.875
New coeff. value = -0.875

0.225 x 2 = 0.45 --> 0
0.45 x 2 = 0.9 --> 0
0.9 x 2 = 1.8 --> 1
0.8 x 2 = 1.6 --> 1
0.6 x 2 = 1.2 --> 1
0.2 x 2 = 0.4 --> 0

(0.225)= 0.0 0 1 1 1 0. ...
3 bit representation
0.001 --> 0.125
New coeff. value = 0.125

Cascade Form:

$H(z) = \frac{1}{1-0.95z^{-1}+0.225z^{-2}}$

$H(z) = \frac{1}{(1-0.5z^{-1})(1-0.45z^{-1})}$

0.5 x 2= 1.0 --> 1
0.0 x 2= 0.0 --> 0

(0.5)= 0.1 0 0 0 ...

3 bit representation
0.100 --> 0.5
New pole location = 0.5

0.45 x 2 = 0.9 --> 0
0.9 x 2 = 1.8 --> 1
0.8 x 2 = 1.6 --> 1
0.6 x 2 = 1.2 --> 1
0.2 x 2 = 0.4 --> 0
(0.225)= 0.0 1 1 1 0 . . .
3 bit representation
0.011 --> 0.375
New pole location = 0.375

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Q3 a)

$$H(s) = \frac{10}{s^2+7s+15}$$

$$H(s) = \frac{10}{s^2+7s+12.25+2.75}$$

$$H(s) = \frac{10}{(s+3.5)^2+(1.658)^2}$$

$$H(s) = \frac{10}{1.658}\frac{1.658}{(s+3.5)^2+(1.658)^2} \quad --(1)$$

Impulse invariant Transformation

$$\frac{b}{(s+a)^2+b^2} \rightarrow \frac{e^{-aT}z^{-1}\sin bT}{1-2e^{-aT}z^{-1}\cos bT+e^{-2aT}z^{-2}} \quad -- (2)$$

From Equation (1), a=3.5, b=1.658 and T=0.02

Using equation (2) and simplifying

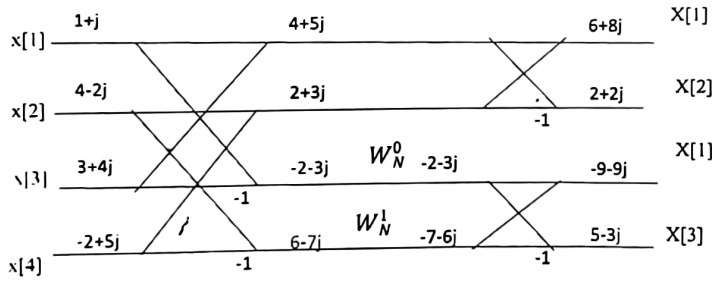
$$H(z) = \frac{0.1789z^{-1}}{1-1.8621z^{-1}+0.869z^{-2}}$$

Q3 b)

x1[n]={1, 4, 3, -2} and x2[n]={1, -2, 4, 5}

x[n]=x1[n]+jx2[n]

x[n]={1+j, 4-2j, 3+4j, -2+5j}



X(k)={6+8j, -9-9j, 2+2j, 5+3j}

$X^*(-k) = \{6-8j, 5-3j, 2-2j, -9+9j\}$

$X1(k) = \frac{X(k)+X^*(-k)}{2}$ ={6, -2-6j, 2, -2+6j}

$X2(k) = \frac{X(k)-X^*(-k)}{2j}$ ={8, -3+7j, 2, -3-7j}

Q4 a)

Flat pass band and flat stop band --> Butterworth Filter

Digital Specifications: d1=0.8, d2=0.2, ω1=0.25π, ω2=0.65π

Analog specifications:

Using Bilinear Transformation $\Omega = \frac{2}{T}\tan\frac{\omega}{2}$ and T=0.1s

d1=0.8, d2=0.2, Ω1=2.513 rad/sec, Ω2=6.738 rad/sec

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Order of filter and cut off frequency

$$N \geq \frac{1}{2}\frac{\log\left(\frac{\frac{1}{d2^2}-1}{\frac{1}{d1^2}-1}\right)}{\log\left(\frac{\Omega_2}{\Omega_1}\right)} \quad \text{and} \quad \Omega_c = \frac{\Omega_p}{\left[\frac{1}{d1^2}-1\right]^{1/2N}}$$

N=2 and cut off frequency Ωc=2.90 rad/sec

Normalized transfer function

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

Denormalized transfer function

$$H(s) = \hat{H}(s)|s = \frac{s}{\Omega_c}$$

$$H(s) = \frac{8.41}{s^2+4.1s+8.41}$$

Analog to Digital Filter conversion using BLT (T=0.1 sec)

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

$$H(z) = \frac{8.41(z+1)^2}{488.41z^2-783.18z+326.41} \text{ OR}$$

$$H(z) = \frac{0.0172z^2-0.0344z+0.0172}{z^2-1.6035z+0.6683}$$

Q4 b) h[n]={2, 1, 2} --> M=3
x[n]={1, -2, 4, 5, 3, 2, 2, 1, 5, 7, -3, -1, 4, 2}
N=6
N=L+M-1 -- L= 4

h[n]={2, 1, 2, 0, 0, 0}
x1[n]={0, 0, 1, -2, 4, 5}
x2[n]={4, 5, 3, 2, 2, 1}
x3[n]={2, 1, 5, 7, -3, -1}
x4[n]={-3, -1, 4, 2, 0, 0}

Using circular convolution
y1[n]={13, 5, 2, -3, 8, 10}
y2[n]={13, 16, 19, 17, 12, 8}
y3[n]={-3, 2, 15, 21, 11, 9}
y4[n]={-6, -5, 1, 6, 10, 4}

Discard First M-1 samples in each section

13, 5, 2, -3, 8, 10
13, 16, 19, 17, 12, 8
-3, 2, 15, 21, 11, 9
-6, -5, 1, 6, 10, 4

y[n]={ 2, -3, 8, 10, 19, 17, 12, 8, 15, 21, 11, 9, 1, 6, 10, 4 }

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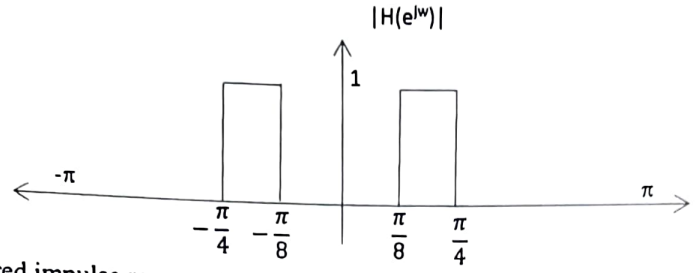
Q5 a)

$$H(e^{j\omega}) = \begin{cases} e^{-|3\omega} & ; \ \frac{\pi}{8} \le |\omega| \le \frac{\pi}{4} \\ 0 & ; \ \text{otherwise} \end{cases}$$



Desired impulse response

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

$h_d[n] = \frac{1}{2\pi}\left\{\int_{-\pi/4}^{-\pi/8} H(e^{j\omega})e^{j\omega n}d\omega + \int_{\pi/8}^{\pi/4} H(e^{j\omega})e^{j\omega n}d\omega\right\}$

$$h_d[n] = \begin{cases} \frac{1}{\pi(n-3)}\left[\sin\left(\frac{\pi}{4}(n-3)\right) - \sin\left(\frac{\pi}{8}(n-3)\right)\right] & n \neq 3 \\ 0.125 & n = 3 \end{cases}$$

hd[n]={-0.023, 0.0466,, 0.1032, 0.125, 0.1032, 0.0466, -0.023}

Hanning Window

$$w[n] = \begin{cases} 0.5 - 0.5\cos(\frac{2\pi n}{M-1}) & 0 \le n \le M-1 \\ 0 & \text{Otherwise} \end{cases}$$

w[n] ={0, 0.25, 0.75, 1, 0.75, 0.25, 0}

Impulse response of filter

h[n]=hd[n]. w[n]

h[n] ={0, 0.01165, 0.0774, 0.125, 0.0774, 0.01165, 0}

Q5 b) $H(z) = 1 + \frac{3}{4}z^{-1} + \frac{1}{2}z^{-2} + \frac{1}{4}z^{-3}$

m= 3

$A3(z) = 1 + \frac{3}{4}z^{-1} + \frac{1}{2}z^{-2} + \frac{1}{4}z^{-3}$ k3=1/4

$B_m(z) = z^{-m}A_m(z^{-1})$

$B3(z) = \frac{1}{4} + \frac{1}{2}z^{-1} + \frac{3}{4}z^{-2} + z^{-3}$

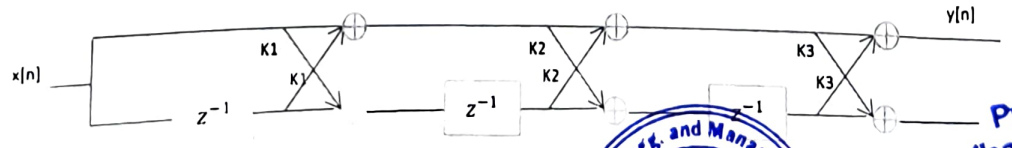
$A_{m-1}(z) = \frac{A_m(z) - k_m B_m(z)}{1 - k_m^2}$

$A2(z) = 1 + \frac{2}{3}z^{-1} + \frac{1}{3}z^{-2}$ k2=1/3

$B2(z) = \frac{1}{3} + \frac{2}{3}z^{-1} + z^{-2}$

$A1(z) = 1 + \frac{1}{2}z^{-1}$ k1=1/2

Lattice Realization Structure



Attainment Levels Versus Target

Class: T.E Sub: DTSP

Sem:V Year: 2022-23

CO Attainment Method	Attainment Level		
	1	2	3
University Examination	60% students scoring more than or equal to 50% marks in the final examination	65% students scoring more than or equal to 50% marks in the final examination	70% students scoring more than or equal to 50% marks in the final examination
Internal Assessment	70% students score more than or equal to 50% marks in the final examination	75% students score more than or equal to 50% marks in the final examination	80% students score more than or equal to 50% marks in the final examination
Course Exit Survey	80% weightage in course exit analysis	85% weightage in course exit analysis	90% weightage in course exit analysis

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Department of Electronics & Telecommunication Enginnering

Calculation for Internal Assessment

CLASS : T.E. SUBJECT : DTSP

SEMESTER : V YEAR : 2022-23

		ECC502.1			ECC502.2					ECC502.3			ECC502.4			ECC502.5			ECC502.6			ESE
		Marks Obtained			Marks Obtained					Marks Obtained			Marks Obtained			Marks Obtained			Marks Obtained			
		Class Test 1 (Q.1) (6 M)	Class Test 1 (Q.2) (6 M)	Assign 1 (5M)	Class Test 1 (Q.3) (8 M)	Class Test 1 (Q.4)(8 M)	Class Test 1 (Q.1) (6 M)	Class Test 1 (Q.2) (6 M)	Assign 1 (5M)	Class Test (Q.5)(6 M)	Class Test (Q.6)(6 M)	Assign 2 (5M)	Class Test 2 (Q.1)(8 M)	Class Test 2 (Q Q.2)(8 M)	Assign 3 (5M)	Class Test 2 (Q.3)(8 M)	Class Test 2 (Q.4)(8 M)	Assign 3(5M)	Class Test 2 (Q.5)(4 M)	Class Test 2 (Q.6)(4 M)	Assign 3 (5M)	(80 M)
1	Abhishek Kumar		5	5		2		5	5		5	5		8	4		5	4		2	4	37
2	Chandorkar Aayush Maheshwar		3	3	3			3	3			3			4	8		4		2	4	17
3	Basak SwathiSampath	1	5	5		0	1	5	5		6	5	4		4			4		3	4	11
4	Dhonde Naresh Narsingh	0	0	2			0	0	2	0		2	0	1	2		0	2			2	6
5	Gadkar Om Sanjay	3	3	5	5		3	3	5			3		4	3	1		3	3		3	5
6	Gurav Devendra Ravindra		3	4	4			3	4	5		5	6		5			5		1	5	18
7	Jadhav Gaurav Prasanna		3	5	4			3	5	4		5	8		5	8		5	1		5	55
8	Jadhav Shubham Abhay		3	5				3	5			5	4		4	4		4		4	4	33
9	Jumde Nikhil Balkishan	2		4	1		2		4			3	4	1	4	5		4	3		4	12
10	Kazmi Yunus Ahmed	5	0	2			5	0	2	1		2	1		2	0		2	4	4	2	6
11	Kolhar Parth Dnyaneshwar	5		5	6		5		5	1		5	2		5	2		5	4		5	0
12	Kunde Harshada Shivaji	1		1		5	1		1	3		1	3		4	6		4		3	4	5
13	Kharbe Yusuf Faheemuddin	3		1		2	3		1	5		1	8		5			5	3		5	32
14	Kolhe Harshal Jagdish	6		5			6		5	2		4	2		5			5			5	10
15	Kulkarni Rohan Rupesh	4		3			4		3	4		3		4	4	0		4		4	4	19
16	Kushwaha Bhakti Ramavatar	5		1	3		5		1	2		1	4		4	3		4	2		4	32
17	Maity Soumyadip Swapan	5		4			5		4	4		4	4		5	3		5	4		5	18
18	Malaye Mayur Uttam		3	5				3	5	2		5	3		5	3		5		4	5	17
19	Mishra Akshay Gyanprakash	3	2	5	6		3	2	5	2	1	5	8	1	5			5	4		5	34
20	More Sachal Maruti	3	6	5	2		3	6	5	3		5	8		5		2	5	2	1	5	13
21	Panchal Sahilkumar Keshav	3		2			3		2		1	2	8	4	2			2		0	2	14
22	Pangani Om Mangesh			4					4			2	1		2	4		2		2	2	24
23	Parkar Kunal Santosh		6	3				6	3	3		3		0	4	2		4	4		4	33
24	Pathak Saurabh Sat		0	2	0		0	0	2		2	2			4			4			4	32
25	Pathak Tanaka Pra		6	5	6			6	5			5	8		5	2		5	4		5	16
26	Pol Dhantanya Bha		6	5	8			6	5	5		5	8		3	7		3	4		3	55
27	Rajak Avinash San	5		3	1		6		3	3		3		0	3	3		3	3	4	3	24
28	Ram Dhaval Vina			5		2			5		3	5	0		5			5		4	5	32
29	Raorane Shivani S	5		5		1	5		5	5		5	1		5			5		4	5	6

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11	Sabbani Shrikant Narender	3	2	3			3	2	3		4	3	2		5	2		5	4		5	34
14	Sable Ruchita Vinay	5		3			5		3	2		3	4		5			5		4	5	35
15	Sahu Atharva Harshal	5		3			5		3	4		3	6		4			4		4	4	26
16	Sahu Swaraj Vilas		2	5		1		2	5		6	4		3	5			5		4	5	32
17	Shetty Ananya Umesh	6		3	4		6		3	4		3			5	2		5			5	32
18	Shinde Aryan Vilas	2	5	3			2	5	3	3		5	6	0	5		3	5		3	5	15
19	Singh Shraddha Harishankar	3	6	5			3	6	5	4		5		4	5		2	5		4	5	11
40	Tarmale Adesh Pandurang	6		4	3		6		4		6	5		6	5	2		5		4	5	24
42	Walimbe Rohan Anil	6		5			6		5	3		5	6		4	2		4		2	4	47
44	Bamne Niraj Dilip	5		3	8		5		3	3		3	3		5		5	5			5	24
45	Bhoir Aniket Prabhakar	3	6	3			3	6	3	6		3	4		4		3	4			4	5
46	Dixit Pawan Rajkumar	3	3	3			3	3	3	4	4	3	3		4			4		2	4	6
47	Gawai Gayatri Yuvraj			2					2			2			2			2		3	2	18
48	Ghogad Vaibhav Ramesh			3	6				3	6		3			3			3		4	3	8
50	Gujare Chinmay Mahendra			3					3	0		4			2			2		4	2	0
51	Gurjar Arvan Sanjay	0		3			0		3			3			4	0		4		3	4	9
52	Kamble Aniket Tanaji	2		5	3		2		5	6		4	8		5	2		5		1	5	17
53	Karangutkar Akshay	3		3	3		3		3	3		3	8		5			5		1	5	9
54	Lawand Vrushali Sanjay		3	2				3	2			2	0		2			2		4	2	20
55	Malekar Tejas Prakash	0		3	2		0		3			3			3	4		3		4	3	3
56	Mhatre Purva Sanjay	2	3	3	3		2	3	3		3	3	6		5		1	5	4		5	19
57	Pandey Abhishek Achutanand	4		5	1		4		5	3		2	2		2	3		2		3	2	19
58	Rai Rupesh	4		5		1	4		5			5	6		5		4	5			5	32
59	Ramgade Shrinivas Baburao	3		5		8	3		5	6		5	8		5	7		5			5	42
60	Rane Kaustubh Vinayak	0		3			0		3			5			5	1		5	2		5	11
61	Rane Tanmayee Sudhakar	0	3	3			0	3	3	1		3			5	1		5	3	1	5	5
62	Ruddhi Sudhir	2		5			2		5	2		5	4	4	4	4		4	1	4	4	35
63	Sagvekar Mayuree Yashwant			5					5			5	6		5	2		5		3	5	9
64	Salve Pawan Balasaheb	2					2			4			0									AB
65	Sayed Adnan Zahir	3		5			3		5	4		5	0		4			4		0	4	10
66	Shaikh Mehrajuddin Ali	3		2			3		2	2		2	4		5	4		5			5	14
	Shaikh Mohammad Farhan	3		3			3		3	4		3			5	5		5	4		5	10
	Sharma Amit Kumar	2	3	3	1		2	3	3	2		3			3	1		3		4	3	13
69	Shewal Pratham Sanjay	2	3	5			2	3	5	2		5			5			5			5	19
70	Shinde Snehal Shrimanti	2	3	2			2	3	2	1		2	0		2		0	2		2	2	6
71	Solapure Raj Balaji	3	3	2			3	3	2			3	0		3			3		2	3	AB
72	Surve Pritesh Pravin	0		3	1		0		3			5	0		5			5		4	5	25
73	Sutar Harshvardhan Tushar	0		1			0		1			1	0		1			1		0	1	0
74	Swamy Venkata Vijendra	0	4	5	1		0	4	5	1		5		2	5	1		5		4	5	25
75	Talavadekar Sabbinani Laxman	3	3	5	1		3	3	5	1		5		7	4	4		4		0	4	12
76	Tiwari Pradeep Prasad	3	3	2			3	3	5	1		5		2	2			2		4	2	17
77	Undage Abodh Ravindra	6		5	1		6		5	1	2	5	6		5	1		5		1	5	32
78	Yadav Chandan Shivaram	5		5	1		5		5		2	5	6		2	3		2		1	2	24
	Utekar Swapnil			2					2	0		2	6		2			2	3		2	5

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Department of Electronics & Telecommunication

Assessment Tools for Course Outcomes : (Direct Methods + Indirect Method) DTSP 2022-23 SEM VI

Course Outcomes	Direct Assessment Tools	Internal Attainment Level of Course Outcomes in %	Internal Attainment Level	Average of Internal Attainment Level	ESE Attainment in %	ESE Attainment in level	X=Total Attainment (Direct) 80% of ESE Attainment Level + 20% of IA level	Indirect Assessment in %	Y=Indirect Assessment Attainment Level	Total Attainment for CO=0.8*x+0.2* y
ECCS02.1	Assignment 1	79%	2.9	2.05	6%	0	0.41%	86.88	2.7	0.868
	Class Test 1 (Q.1 and Q.2)	72.00%	1.2							
ECCS02.2	Assignment 1	79%	3	1.5	6%	0	0.30%	80.32	1	0.44
	Class Test 1 (Q.1, Q.2,Q.3, Q.4)	51%	0							
ECCS02.3	Assignment 2	79%	3	1.5	6%	0	0.30%	81.42	1.1	0.46
	Class Test 1 (Q.5, Q.6)	58%	0							
ECCS02.4	Assignment 3	82.00%	3	1.5	6%	0	0.30%	79.78	1	0.44
	Class Test 1 (Q.1, Q.2)	53%	0							
ECCS02.5.	Assignment 3	82%	3	1.5	6%	0	0.30%	81.96	1.2	0.48
	Class Test 1 (Q.3, Q.4)	34%	0							
ECCS02.6	Assignment 3	82%	3	3	6%	0	0.60%	81.96	1.2	0.72
	Class Test 1 (Q.5, Q.6)	83%	3							

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PO Attainment

Class: T.E
Sem:V

Sub: Discrete Time Signal Processing
Year: 2022-23

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
ECC502.1	0.868	0.868	0.573											0.573
ECC502.2	0.44	0.44	0.29										0.44	0.29
ECC502.3	0.46	0.46											0.46	0.29
ECC502.4	0.44	0.44	0.29										0.44	0.303
ECC502.5	0.48	0.48											0.48	0.317
ECC502.6	0.72	0.72	0.476							0.72		0.476	0.72	0.476
Direct Attainment(x)	**0.568**	**0.568**	**0.40725**							**0.72**		**0.476**	**0.508**	**0.379**

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Observation and Action Taken

Class: T.E **Sub: Discrete Time Signal Processing**
Year: 20222-23

	Target Level	Attainment Level	Observation
PO1	3	0.568	It is a gap of 2.432 due to Some fundamental engineering knowledge of Laplace, Fourier transform, Design of analog filters need to emphasis.
Action	Neet more attention on fumdamentals of signal and system		
PO2	3	0.568	It is a gap of 2.432 due to Some fundamental engineering knowledge of Laplace, Fourier transform, Design of analog filters need to emphasis.
Action	Neet more attention on fumdamentals of signal and system		
PO3	2	0.4073	It is a gap of 1.5927 due to Some fundamental engineering knowledge of Design of analog filters need to emphasis.
Action	More attention should be given on designing of filters.		
PO10	3	0.72	It is gap of 2.28. Design documentation with more case study
Action	Case study activities can be conducted in the class.		
PO12	2	0.476	It is gap of 1.524. In this domain research or technical changes are still going on, which students should be aware about.
Action	Applications can be discuss in the class.		
PSO1	3	0.508	It is a gap of 2.492 due to Some fundamental engineering knowledge of Laplace, Fourier transform, Design of analog filters need to emphasis.
Action	Neet more attention on fumdamentals of signal and system		
PSO2	2	0.379	It is a gap of 1.621 due to Some fundamental engineering knowledge of Laplace, Fourier transform, Design of analog filters need to emphasis.
Action	Neet more attention on fumdamentals of signal and system		

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COURSE FILE

ACADEMIC YEAR	**2022-23**	**CLASS**	**T.E.**	**SEM**	**V**
NAME OF FACULTY	**Dr. Aarti Bakshi**				
DESIGNATION	**Assistant Professor**				
DEPARTMENT	**Electronics & Telecommunication**				
COURSE CODE	**ECL502.**				
NAME OF SUBJECT	**Discrete-Time Signal Processing Laboratory**				

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Cover Page

Prepared by:

Name: Dr. Aarti Bakshi

Sign: Bakshi

Designation: Asst. Prof

Date: 24/02/2023

Verified by:

Name: AVISHEK RAY

Sign: ARay

Designation: ASSOCIATE PROF.

Date: 16/9/23

Approved by:

Name: Dr R N Duche

Sign:

Designation: Professor & HOD ETC, KCOE

Date: 16/9/2023

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Department of Electronics & Telecommunication

Institute Vision

To be an organization with potential for excellence in engineering and management for the advancement of society and human kind.

Institute Mission

To excel in academics, practical engineering, management and to commence research endeavors.

To prepare students for future opportunities.

To nurture students with social and ethical responsibilities.

Department Vision

To shape Electronics & Telecommunication engineers to be professionally and socially competent.

Department Mission

To aim for excellence in teaching learning process and analytical thinking.

To conduct skill development programs in order to become industry ready.

To impart students with social and moral education.

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Department PEO

After successful completion of the program graduates will be able to

PEO1- Title: Skill

Apply engineering knowledge and skills to meet the requirements of present and emerging technological needs.

PEO2- Title: Professional development

Inculcate life-long learning in electronics & telecommunication for developing modernized projects, technologies and services

PEO3 - Title: Ethics

Actively involved in socially relevant projects for electronics in the context of developments and services.

PEO4 – Title: Communication & Teamwork

Communicate effectively and operate in cross functional domains.

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Program outcomes

Engineering Graduates will be able to:

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write

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effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Department PSO

PSO1:

Knowledge in communication engineering technologies for application in areas of image processing, signal processing, wireless communication.

PSO2:

Apply hardware & software tools in domains of analog & digital electronic system design.

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL502	Discrete-Time Signal Processing Laboratory	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam.			
		Test 1	Test 2	Avg.				
ECL502	Discrete-Time Signal Processing Laboratory	--	--	--	--	25	25	

Course objectives:

1. To carryout basic discrete time signal processing operations.
2. To implement and design FIR filters and IIR filters.
3. To implement applications related to the field of biomedical signal processing and audio signal processing.

Course outcomes:

Learners will be able to …

1. Perform basic discrete time signal processing operations such as Linear Convolution, Circular Convolution, Auto Correlation, Cross Correlation, etc. and interpret the results.
2. Demonstrate their ability towards interpreting and performing frequency analysis of different discrete time sequences and systems.
3. Design and implement the FIR and IIR Filters for given specifications.
4. Implement and analyse applications related to the field of biomedical signal processing and audio signal processing.

Suggested list of experiments:

1) To perform linear convolution of two signals, auto correlation of non-periodic signals, periodic signals and random noise and interpret the results obtained.
2) To linearly convolve swept frequency sinusoidal wave with LPF and HPF impulse response filters in time domain and interpret the results obtained.

3) To obtain cross correlation of a signal with its delayed and attenuated version (Concept of radar signal processing).

4) To perform block convolution using overlap - add method and overlap-save method.

5) To determine impulse, magnitude, phase response and pole-zero plot of given transfer functions.

6) To perform circular convolution and linear convolution of two sequences using DFT.

7) To perform the DFT of DT sequence and sketch its magnitude and phase spectrum or To Generate a discrete time signal having minimum three frequencies and analyse its frequency spectrum.

8) To study the effect of frequency resolution and zero padding.

9) DFT based spectral analysis to detect the signal buried in noise.

10) To perform denoising of a speech signal using circular convolution.

11) Design of IIR digital filters and use the designed filter to filter an input signal which has both low and high frequency components or real-world signal like ECG/EEG, speech signal etc).

12) Design a notch filter to supress the power supply hum in audio signals.

13) Design a comb filter to suppress 50Hz hum in biomedical signals.

14) Design of FIR filter using windowing method and use the designed filter to filter an input signal which has both low and high frequency components or real-world signal like ECG/EEG, speech signal etc.

15) Design of FIR filter using frequency sampling technique.

16) Design of minimum phase, maximum phase and mixed phase systems.

17) To verify the location of zeros in symmetric and antisymmetric FIR filters.

18) To reconstruct DT signals contaminated with sinusoidal interference using FIR filters.

19) To realise an IIR filter in cascade and parallel form.

20) To obtain lattice parameters of a given transfer function (FIR and IIR systems).

21) To perform coefficient quantisation using truncation and rounding.

22) To study the effect of coefficient quantisation on the frequency response of an IIR filter.

23) To study the effect of coefficient quantisation on the frequency response of an FIR filter.

24) To investigate the behaviour of limit cycle in an IIR system.

25) To generate the ECG signal and detect the characteristic points.

26) Classification of ECG signals.

27) To read an ECG signal and separate the QRS Complex.

28) To filter out the noise in an ECG signal using Spectral subtraction.

29) To extract delta, theta, alpha, sigma, and beta waveforms from EEG signal.

30) Perform sub-band coding on speech signal.

31) To generate Echo, Reverberation, Flanging effects in a sound signal.

32) Musical tone generation.

33) DTMF tone generation and detection.

34) Echo cancellation.

Also check

Virtual Laboratory http://vlabs.iitkgp.ernet.in/dsp/# for demonstration of concepts like DFT and its inverse, FIR filter using windowing method etc

Term Work:

At least 08 experiments covering the entire syllabus must be given "Batch Wise" and implemented using any software namely C, Python, Scilab, Matlab, Octave, etc. The experiments should be set to have well predefined inference and conclusion. Application oriented one course-project can be conducted for maximum batch of four students. Teacher should refer the suggested experiments and can design additional experiment to maintain better understanding and quality.

The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting and innovative.

Term work assessment must be based on overall performance of the student with every experiment graded. The grade must be converted to marks as per credit and grading system manual, and should be added and averaged. Based on above scheme, grading and term work assessment should be done. Practical and oral examination will be based on entire syllabus. Students are encouraged to share their experiments codes on online repository. Practical exam slip should cover all 08 experiments for examination.

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12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Bloom Taxonomy Level

Bloom's Taxonomy level	Keywords	Activities
Remembering	Define, Duplicate, List, Memorize, Recall, Repeat, State	Television Shows, Magazine articles, Reading
Understanding	Classify, Describe, Discuss, Explain ,Identify, Locate, Recognize, Report, Select, Translate, Paraphrase	Diagram, Speech(Seminar),Graph, Outline
Applying	Choose, Demonstrate, Dramatize, Employ, Illustrate, Interpret, Operate, Schedule, Sketch, Solve, Use, Write	Mini Project, Quiz
Analyzing	Appraise, Compare, Contrast, Criticize, Differentiate, Discriminate, Distinguish, Examine, Experiment, Question, Test	Survey, Conclusion, Report, Questionnaire
Evaluating	Appraise, Argue, Defend, Judge, Select, Support, Value(Output), Evaluate	Group Discussion, Self evaluation, Recommendation
Creating	Assemble, Construct, Create, Design, Develop, Formulate, Write	Experiment, Simulation, major project

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Course objectives:

1. To carryout basic discrete time signal processing operations.

2. To implement and design FIR filters and IIR filters.

3. To implement applications related to the field of biomedical signal processing and audio signal processing.

Course outcomes:

Course outcome code	Lab outcome At the end of the course student will be able to	Bloom Level
ECL502.1	Perform basic discrete time signal processing operations such as Linear Convolution, Circular Convolution, Auto Correlation, Cross Correlation, etc. and interpret the results	Applying
ECL502.2	Demonstrate their ability towards interpreting and performing frequency analysis of different discrete time sequences and systems.	Analyzing
ECL502.3	Design and implement the FIR and IIR Filters for given specifications.	Applying
ECL502.4	Implement and analyze applications related to the field of biomedical signal processing and audio signal processing	Analyzing

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CLASS : T.E. **SUBJECT : DTSP-Lab**
SEMESTER : V **YEAR : 2022-23**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
ECL502.1	3	2	2										2	2
ECL502.2	3	2											2	
ECL502.3	3	2	1										2	
ECL502.4	3		1	1		1						3	3	1
Avgerage	3	2	2	1		1						3	2	1.5

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Department of Electronics & Telecommunication

Practical Delivery Plan (A1 Batch)

Sr. No	Name of Experiment	Date of Performance	Date of Submission
1	Program to compute linear convolution, auto-correlation and cross-correlation.	13/07/2022	20/07/2022
2	Program to generate unit impulse, unit step, ramp and exponential sequences.	20/07/2022	28/07/2022
3	Program to compute DFT, Circular Convolution using formula and DFT.	28/07/2022	03/08/2022
4	Program to compute magnitude and phase response of a given equation.	03/08/2022	10/08/2022
5	Program to compute transfer function using impulse invariance method and bilinear transformation method.	10/08/2022	17/08/2022
6	Design and implementation of FIR filter to meet given speciations.	17/08/2022	24/08/
7	Design the following Low Pass analog filters with the given specification. (1) Butter Worth (2) Chebyshev-I (3) Chebyshev-II.	24/08/2022	14/09/2022
8	Musical Tone Generation [sa re ga ma pa dh ni sa] with each Tone has time duration 0.5 sec.	14/09/2022	21/09/2022
9	Content Beyond Syllabus: Convert colour image to gray-scale image.	21/09/2022	28/09/2022
10	Implementation and analyse the application of DSP.	28/09/2022	12/10/2022

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Practical Delivery Plan (A2 Batch)

Sr. No	Name of Experiment	Date of Performance	Date of Submission
1	Program to compute linear convolution, auto-correlation and cross-correlation.	11/07/2022	18/07/2022
2	Program to generate unit impulse, unit step, ramp and exponential sequences.	18/07/2022	25/07/2022
3	Program to compute DFT, Circular Convolution using formula and DFT.	25/07/2022	01/08/2022
4	Program to compute magnitude and phase response of a given equation.	01/08/2022	08/08/2022
5	Program to compute transfer function using impulse invariance method and bilinear transformation method.	08/08/2022	22/08/2022
6	Design and implementation of FIR filter to meet given speciations.	22/08/2022	19/09/2022
7	Design the following Low Pass analog filters with the given specification. (1) Butter Worth (2) Chebyshev-I (3) Chebyshev-II.	19/09/2022	26/09/2022
8	Musical Tone Generation [sa re ga ma pa dh ni sa] with each Tone has time duration 0.5 sec.	26/09/2022	03/10/2022
9	Content Beyond Syllabus: Convert colour image to gray-scale image.	03/10/2022	10/10/2022
10	Implementation and analyse the application of DSP.	10/10/2022	17/10/2022

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Practical Delivery Plan (A3 Batch)

Sr. No	Name of Experiment	Date of Performance	Date of Submission
1	Program to compute linear convolution, auto-correlation and cross-correlation.	14/07/2022	14/07/2022
2	Program to generate unit impulse, unit step, ramp and exponential sequences.	21/07/2022	21/07/2022
3	Program to compute DFT, Circular Convolution using formula and DFT.	28/07/2022	28/07/2022
4	Program to compute magnitude and phase response of a given equation.	04/08/2022	04/08/2022
5	Program to compute transfer function using impulse invariance method and bilinear transformation method.	25/08/2022	25/08/2022
6	Design and implementation of FIR filter to meet given speciations.	08/09/2022	08/09/2022
7	Design the following Low Pass analog filters with the given specification. (1) Butter Worth (2) Chebyshev-I (3) Chebyshev-II.	22/09/2022	22/09/2022
8	Musical Tone Generation [sa re ga ma pa dh ni sa] with each Tone has time duration 0.5 sec.	29/09/2022	29/09/2022
9	Content Beyond Syllabus: Convert colour image to gray-scale image.	06/10/2022	06/10/2022
10	Implementation and analyse the application of DSP.	13/10/2022	17/10/2022

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Practical Delivery Plan (A4 Batch)

Sr. No	Name of Experiment	Date of Performance	Date of Submission
1	Program to compute linear convolution, auto-correlation and cross-correlation.	12/07/2022	19/07/2022
2	Program to generate unit impulse, unit step, ramp and exponential sequences.	19/07/2022	26/07/2022
3	Program to compute DFT, Circular Convolution using formula and DFT.	26/07/2022	02/08/2022
4	Program to compute magnitude and phase response of a given equation.	02/08/2022	23/08/2022
5	Program to compute transfer function using impulse invariance method and bilinear transformation method.	23/08/2022	30/08/2022
6	Design and implementation of FIR filter to meet given speciations.	30/08/2022	13/09/2022
7	Design the following Low Pass analog filters with the given specification. (1) Butter Worth (2) Chebyshev-I (3) Chebyshev-II.	13/09/2022	20/09/2022
8	Musical Tone Generation [sa re ga ma pa dh ni sa] with each Tone has time duration 0.5 sec.	20/09/2022	27/09/2022
9	Content Beyond Syllabus: Convert colour image to gray-scale image.	27/09/2022	04/10/2022
10	Implementation and analyse the application of DSP.	04/10/2022	11/10/2022

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List of Experiments & Mapping with LOs

Sr. No	Name of Experiment	Blooms Taxonomy	LO
1	Program to compute linear convolution, auto-correlation and cross-correlation.	Applying	ECL502.1
2	Program to generate unit impulse, unit step, ramp and exponential sequences.	Applying	ECL502.1
3	Program to compute DFT, Circular Convolution using formula and DFT.	Applying	ECL502.2
4	Program to compute magnitude and phase response of a given equation.	Applying	ECL502.2
5	Program to compute transfer function using impulse invariance method and bilinear transformation method.	Applying	ECL502.3
6	Design and implementation of FIR filter to meet given speciation's.	Applying	ECL5[illegible]
7	Design the following Low Pass analog filters with the given specification. (1) Butter Worth (2) Chebyshev-I (3) Chebyshev-II.	Applying	ECL502.3
8	Musical Tone Generation [sa re ga ma pa dh ni sa] with each Tone has time duration 0.5 sec.	Applying	ECL502.4
9	Content Beyond Syllabus: Convert colour image to gray-scale image.	Applying	ECL502.4
10	Implementation and analyse the application of DSP.	Creating	ECL502.4

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Rubrics for Experiment

Semester: V **Class: TE**

Subject: Discrete-Time Signal Processing Laboratory

Rubrics Description	Maximum Marks Weight	Excellent 15 – 12	Good 12-9	Fair 9-6	Poor 6-0
Implementation (R1)	**5**	Successful completion with accurate OUTPUT **(5-4)**	One error in the OUTPUT **(4-3)**	Two errors in the OUTPUT **(3-2)**	More than two errors in OUTPUT **(2-0)**
Understanding (R2)	**5**	Presents a logical explanation for findings and addresses most of the questions. **(5-4)**	Presents a logical explanation for findings and addresses some of the questions. **(4-3)**	Presents an illogical explanation for findings and addresses few questions. **(3-2)**	Presents an illogical explanation for findings and does not address any of the questions sug[illegible]
Punctuality (R3)	**5**	Submission within a week **(5-4)**	Submission after a week **(4-3)**	Submission after two weeks **(3-2)**	Submission after three weeks or more **(2-0)**

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Innovative Experiment

AIM: - Convert colour image to gray-scale image. [Content Beyond Syllabus]

PROGRAM:

```
//convert colour image to grayscale image
im=imread('C:\Users\PC00\Pictures\Saved Pictures/Birds.jpg');
[rowcolbyt]=size(im);
a=im(:,:,1);//Red Plane;
b=im(:,:,2);//Green Plane);
c=im(:,:,3);//Blue Plane;
a=double(a);
b=double(b);
c=double(c);
forx=1:1:row;
fory=1:1:col;
new(x,y)=(a(x,y)+b(x,y)+c(x,y))/3;
new1(x,y)=3*a(x,y)+0.59*b(x,y)+0.11*c(x,y);
end
end
figure(1)
imshow(uint8(im));
figure(2)
imshow(uint8(new));
figure(3)
imshow(uint8(new1));
```

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Course Exit Survey Analysis

Class: TE **Sub: DTSP Lab**

Sem : V **Year: 222-23**

Timestamp	Email Address	Score	First Name	Surname	Roll Number	Are you able to perform basic discrete time signal processing operations such as Linear Convolution, Circular Convolution, Auto Correlation, Cross Correlation, etc. and interpret the results.	Are you able to demonstrate frequency analysis of different discrete time sequences and systems?	Are you able to design and implement the FIR and IIR Filters for given specifications?	Are you able to implement and analyse applications related to the field of biomedical signal processing and audio signal processing
10/30/2022 17:29:41	kumarabhishek@kccemsr.edu.in	0	Abhishek	Shukla	1	High	High	High	High
10/15/2022 16:20:30	swathibandi@kccemsr.edu.in	0	Swathi	Bandi	3	Medium	High	High	Medium
11/3/2022 9:13:28	nareshdhondu@kccemsr.edu.in	0	Naresh	Dhondu	4	High	High	Medium	Medium
11/3/2022 11:04:48	omgadkar@kccemsr.edu.in	0	Om	Gadkar	5	Medium	Medium	Medium	Medium
10/28/2022 11:10:13	devendrajgurav@kccemsr.edu.in	0	Devendra	Gurav	6	High	High	High	High
10/29/2022 15:39:44	chinmayjadhav@kccemsr.edu.in	0	Chinmay	Jadhav	7	High	High	High	High
10/28/2022 10:17:56	siddheshjadhav@kccemsr.edu.in	0	Siddhesh	Jadhav	8	Medium	Medium	Medium	Medium
10/29/2022 14:22:27	nikhiljamdade@kccemsr.edu.in	0	NIKHIL	JAMDE	9	High	High	High	High
10/31/2022 16:07:15	tanyakanthe@kccemsr.edu.in	0	Tanya	Kanthe	10	Medium	Medium	Medium	Medium
10/29/2022 17:36:17	parthkathar@kccemsr.edu.in	0	Parth	Kathar	11	High	High	High	High
10/29/2022 13:34:20	harshadakhade@kccemsr.edu.in	0	harshada	khade	12	Medium	Medium	Medium	Medium
10/29/2022 14:13:17	yusufkharbe@kccemsr.edu.in	0	Yusuf	Kharbe	13	Medium	Medium	Medium	Medium
10/29/2022 19:32:49	harshalkolhe@kccemsr.edu.in	0	Harshal	Kolhe	14	High	Medium	High	Medium
10/30/2022 16:14:41	rohankulkarni@kccemsr.edu.in	0	Rohan	Kulkarni	15	Medium	Medium	Medium	Medium
10/29/2022 13:44:18	bhaktikumawat@kccemsr.edu.in	0	Bhakti	Kumawat	16	Medium	Medium	Medium	Medium
10/29/2022 10:05:30	soumyadipmistry@kccemsr.edu.in	0	Soumyadip	Mistry	17	High	High	High	High
10/30/2022 20:06:37	mayurmalaye@kccemsr.edu.in	0	Mayur	Malaye	18	Medium	Medium	Medium	Medium
10/16/2022 11:11:48	akshitamishra@kccemsr.edu.in	0	AKSHAT	MISHRA	19	Medium	Medium	Medium	Medium
10/15/2022 16:49:04	snehalmore@kccemsr.edu.in	0	Snehal	More	20	Medium	High	Medium	Low
11/2/2022 21:17:39	sahilpanchal@kccemsr.edu.in	0	Sahil	panchal	22	High	High	High	High
10/28/2022 0:15:58	kunalparkar@kccemsr.edu.in	0	Kunal	parkar	24	Medium	Medium	Medium	Medium
10/16/2022 22:09:21	saurabhpatade@kccemsr.edu.in	0	saurabh	patade	25	High	High	High	High
10/15/2022 16:16:28	tarakpbhadle@kccemsr.edu.in	0	Tarak	Phadke	27	High	Medium	Medium	High
10/30/2022 18:30:34	chaitanyapol@kccemsr.edu.in	0	chaitanya pol	pol	28	High	Medium	High	Low
10/15/2022 15:52:55	dhurvalrane@kccemsr.edu.in	0	Dhaval	Rane	30	Medium	Medium	Medium	Medium
10/29/2022 16:16:28	shivaniraorane@kccemsr.edu.in	0	Shivani	Raorane	31	Medium	Medium	Medium	Medium
10/27/2022 13:46:33	shrikantsabbani@kccemsr.edu.in	0	SHRIKANT	SABBANI	32	High	High	High	High
11/2/2022 14:48:50	ruchitasable@kccemsr.edu.in	0	Ruchita	Sable	33	High	High	High	High
11/1/2022 15:07:28	atharvasalvi@kccemsr.edu.in	0	Atharva	Salvi	34	High	High	High	High
10/15/2022 18:54:42	swarajsalvi@kccemsr.edu.in	0	Swaraj	Salvi	35	High	High	High	High
10/27/2022 12:42:28	ananyashetty@kccemsr.edu.in	0	Ananya	Shetty	36	Medium	High	High	Medium
11/1/2022 15:12:39	aryanshinde@kccemsr.edu.in	0	Aryan	Shinde	37	High	High	High	High
10/31/2022 11:20:15	shraddhasingh@kccemsr.edu.in	0	Shraddha	Singh	38	High	Medium	High	High
10/15/2022 19:30:43	adeshtaramale@kccemsr.edu.in	0	Adesh	Taramle	39	High	High	High	High
10/30/2022 17:47:12	rohanwalimbe@kccemsr.edu.in		Rohan	Walimbe	40	High	High	High	High
10/31/2022 2:05:39	nirajbamne2021@kccemsr.edu		NIRAJ	BAMNE	42	High	High	High	High
10/15/2022 19:04:08	aniketbhoir2021@kccemsr.edu	1	Aniket	Bhoir	44	Medium	Medium	Medium	Medium

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11/3/2022 20 32 11	gayatrigawai 2021@kccemsr.ed	0	Gayatri	Gawai	46	Medium	Medium	Medium	Medium
10/18/2022 19 09 45	vaibhavghegad 2021@kccemsr	0	Vaibhav	Ghegad	47	High	High	High	High
11/1/2022 19 23 23	aryangurjar 2021@kccemsr.edu	0	Aryan	Gurjar	50	Medium	High	Medium	High
10/29/2022 12 53 30	aniketkamble 2021@kccemsr.ed	0	Aniket	Kamble	51	Medium	Medium	Medium	Medium
10/16/2022 17 48 15	vrushalilawand 2021@kccemsr	0	Vrushali Sanjay Law	Lawand	53	Medium	Medium	Medium	Medium
11/6/2022 23 33 50	tejasmalekar 2021@kccemsr.ed	0	Tejas	Malekar	54	Medium	Medium	Medium	High
11/2/2022 15 20 17	abhishekpandey 2021@kccemsr	0	Abhishek	Pandey	56	High	Medium	Medium	Medium
10/30/2022 4 48 59	rupeshrai 2021@kccemsr.edu.in	0	RUPESH	RAI	57	High	High	High	High
10/31/2022 1 45 57	shrinivasramanna 2021@kccem	0	Shrinivas	Ramanna	58	High	High	High	High
11/5/2022 14 11 21	aniketrane 2021@kccemsr.edu	0	Aniket	Rane	59	High	High	Medium	Medium
10/30/2022 12 48 56	tanmayeerawt 2021@kccemsr.ed	0	Tanmayee	Rawt	60	Medium	Medium	Medium	Medium
10/30/2022 10 30 14	jayshreesagvekar 2021@kccems	0	Jayshree	Sagvekar	62	Medium	High	Medium	High
10/17/2022 21:01 11	adnansayyed 2021@kccemsr.ed	0	Adnan Zahid	Sayyed	64	High	Medium	Medium	High
11/7/2022 0 21 59	shaikhmehrajuddinjalil 2021@k	0	Mehraj	Shaikh	65	High	High	High	High
11/2/2022 14 20 18	amitkumarsharma 2021@kccem	0	Amitkumar	Sharma	67	High	Medium	Medium	High
11/1/2022 21:43 53	prathameshejwal 2021@kccemsr	0	Pratham	Shejwal	68	Medium	Medium	Medium	Medium
11/5/2022 13 13 29	snehalshinde 2021@kccemsr.ed	0	Snehal	Shinde	69	High	High	High	High
10/31/2022 23 38 56	priteshsurve 2021@kccemsr.edu	0	pritesh	surve	71	High	High	High	High
11/1/2022 16 21:09	vedantswami 2021@kccemsr.ed	0	Vedant	Swami	73	High	High	High	High
10/31/2022 12:03.57	vaibhavitalawdekar 2021@kccc	0	Vaibhavi	Talawdekar	74	Medium	Medium	Medium	Medium
11/7/2022 10 31 12	prathamtiwari 2021@kccemsr.e	0	Pratham	Tiwari	75	High	High	High	High
10/29/2022 0 33 35	abodhundage 2021@kccemsr.ed	0	Abodh	Undage	76	High	High	High	High
11/2/2022 15:23 18	chandanshreshramyadav 2021@	0	Chandan	Yadav	77	Medium	Medium	Medium	Medium
11/5/2022 15:04:44	swapnilutekar 2022@kccemsr.e	0	Swapnil	Utekar	78	High	Medium	Medium	Medium

	High	Medium	Low	Level	Percentage
Are you able to perform basic discrete time signal processing operations such as Linear Convolution, Circular Convolution, Auto Correlation, Cross Correlation, etc and interpret the results.	35	26	0	2.57	85.79
Are you able to demonstrate frequency analysis of different discrete time sequences and systems?	32	29	0	2.52	84.15
Are you able to design and implement the FIR and IIR Filters for given specifications?	30	31	0	2.49	83.06
Are you able to implement and analyse applications related to the field of biomedical	32	27	2	2.49	83.06

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CLASS : T.E. SUBJECT : DTSP-Lab
SEMESTER : V YEAR : 2022-23

Attainment Levels Versus Target

CO Attainment Method	Attainment Level		
	1	2	3
University Examination	*50% student scoring more than or equal to 60% marks in the final examination*	*60% student scoring more than or equal to 60% marks in the final examination*	*70% student scoring more than or equal to 60% marks in the final examination*
Internal Assessment	*60% students score more than or equal to 60% marks in the internal assessment*	*70% students score more than or equal to 60% marks in the internal assessment*	*80% students score more than or equal to 60% marks in the internal assessment*
Course Exit Survey	*70% weight age average in course exit analysis*	*80% weight age average in course exit analysis*	*90% weight age average in course exit analysis*

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Electronics and Telecommunication

Calculation for Internal Assessment for Lab

CLASS : TE SUBJECT : Discrete Time Signal Processing Lab

SEMESTER : V YEAR : 2022-23

		ECL502.1		ECL502.2		ECL502.3			ECL502.4			
		Experiments		Experiments		Experiments			Experiments			
		Expt1	Expt 2	Expt 3	Expt 4	Expt 5	Expt 6	Expt 7	Expt 8	Expt 9	Expt 10	ESE
ROLL NO.	NAME OF STUDENT	15 M	15 M	15 M	15 M	15 M	15 M	15 M	15 M	15 M	15 M	25 M
	Abhishek Kumar	12	13	13	14	13	14	13	14	13	14	20
	Chandork Maheshwar	7	8	8	8	9	9	8	9	8	9	18
	Bandi Sw ath	13	12	12	13	13	13	13	13	13	13	20

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Electronics and Telecommunication

Calculation for Internal Assessment for Lab

CLASS : TE SUBJECT : Discrete Time Signal Processing Lab

SEMESTER : V YEAR : 2022-23

		ECL502.1		ECL502.2		ECL502.3			ECL502.4			
		Experiments		Experiments		Experiments			Experiments			
ROLL.NO.	NAME OF STUDENT	Expt1	Expt 2	Expt 3	Expt 4	Expt 5	Expt 6	Expt 7	Expt 8	Expt 9	Expt 10	ESE
		15 M	15 M	15 M	15 M	15 M	15 M	15 M	15 M	15 M	15 M	25 M
1	Abhishek Kumar	12	13	13	14	13	14	13	14	13	14	20
2	Chandan Maheshwar	7	8	8	8	9	9	8	9	8	9	18
3	Bandu Sv ath	13	12	12	13	13	13	13	13	13	13	20

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4	Dhondu Naresh Narsingh	7	7	7	7	8	8	8	8	12	12	18
5	Gadkar Om Sanjay	6	6	6	6	7	7	7	7	8	8	18
6	Girase Devendra Ravindra	14	15	15	15	15	15	15	15	15	15	21
7	Jadhav Chinmay Prasanna	13	14	15	15	15	15	15	15	15	15	22
8	Jadhav Siddhesh Abhay	13	13	14	14	13	13	14	14	15	15	22
9	Jumde Nikhil Tulsiram	12	13	13	14	14	14	13	13	14	13	16
10	Kanthe Tanya Amol	7	8	8	8	8	8	9	9	9	9	17
11	Katkar Parth Devendra	15	15	15	15	15	15	15	15	15	15	20
12	Khade Harshada Shahaji	8	8	8	9	8	9	8	9	9	10	18
13	Kharbe Yusuf Farooque	6	7	8	8	8	9	8	9	7	7	17
14	Kolhe Harshal Jitendra	13	14	15	15	15	15	15	15	15	15	21
15	Kulkarni Rohan Rupesh	12	13	14	13	12	13	12	13	13	13	18
16	Kumawat Bhakti Ramavatar	7	8	8	8	8	9	9	9	9	9	19
17	Maity Soumyadip Swapan	9	10	10	11	12	12	12	13	14	15	20
18	Malaye Mayur Uttam	15	15	15	15	15	15	15	15	15	15	20
19	Mishra Akshat Gyanprakash	15	15	15	15	15	15	15	15	15	15	22
20	More Snehal Maruti	12	13	13	12	3	12	13	13	14	15	20
22	Panchal Sanjkumar Keshav	6	6	6	6	7	7	7	7	8	8	12
23	Panpatil Om Mangesh	6	6	6	6	7	7	7	7	8	8	13
24	Parkar Kunal Santosh	15	15	15	15	15	15	15	15	15	15	19
25	Patade Saurabh Sanjay	6	6	6	6	7	7	7	8	8	8	18
27	Phadke Taraka Pravin	15	15	15	15	15	15	15	15	15	15	22
28	Pol Chaitanya Bharat	12	13	13	14	15	15	15	15	14	15	22
29	Rajak Avinash Sunil	14	15	15	15	14	15	14	15	15	15	19
30	Rane Dhaval Vinayak	7	7	8	8	8	8	9	9	9	9	19
31	Raorane Shivani Sandesh	9	9	9	9	10	11	12	11	12	15	19
32	Sabbani Shrikant Narender	15	15	15	15	12	12	12	12	11	12	20
33	Sable Ruchita Vinay	8	8	8	7	7	7	9	9	9	9	19
34	Salvi Atharva Harshal	8	9	9	9	9	10	11	12	12	12	20

Principal

35	Salvi Swaraj Vilas	8	9	8	9	8	9	10	11	11	11	21
36	Shetty Ananya Umesh	15	15	15	15	15	15	15	15	15	15	21
37	Shinde Aryan Vilas	9	10	10	11	10	11	11	10	12	12	19
38	Singh Shraddha Harishankar	15	15	15	15	10	11	10	11	10	11	21
39	Tarmale Adesh Pandurang	13	14	15	15	15	14	15	15	15	15	20
40	Walimbe Rohan Anil	3	11	12	13	14	13	14	15	15	15	21
42	Bamne Niraj Dilip	11	12	13	14	13	12	11	12	13	12	15
44	Bhoir Aniket Prabhakar	12	13	14	13	13	13	15	15	15	15	14
45	Dixit Pawan Rajkumar	7	7	7	7	8	8	8	8		8	12
46	Gawai Gayatri Yuvraj	6	6	6	6	6	7	7	7	7	7	14
47	Ghegad Vaibhav Ramesh	7	7	7	7	8	8	8	8	9	9	15
48	Gujare Chinmay Mahendra	7	8	8	8	9	9	8	8	9	8	12
50	Gurjar Aryan Sanjay	7	8	8	8	9	9	8	8	9	8	18
51	Kamble Aniket Tanaji	7	8	9	8	8	8	8	9	9	9	20
52	Karangutkar Akshay	7	7	7	8	8	8	9	9	9	9	20
53	Lawand Vrushali Sanjay	6	6	6	7	7	7	8	8	8	8	14
54	Malekar Tejas Prakash	7	7	7	7	8	8	8	8	8	8	15
55	Mhatre Purva Sanjay	12	13	13	14	13	14	14	15	15	15	15
56	Pandey Abhishek Achutanand	8	7	7	7	7	8	8	8	8	15	18
57	Rai Rupesh	13	13	13	14	14	14	14	14	14	14	16
58	Ramanna Shrinivas Baburao	15	15	15	15	15	15	15	15	15	15	22
59	Rane Aniket Vinayak	12	12	12	12	13	13	13	13	14	14	14
60	Rane Tanmayee Sudhakar	8	8	8	8	8	9	9	9	9	9	18
61	Riddhi Sudhir	9	9	9	9	9	9	10	10	10	10	19
62	Sagvekar Jayshree Yashvant	12	12	12	13	13	13	14	14	15	15	16
64	Sayyed Adnan Zahid	12	12	12	13	13	13	14	14	14	14	20
65	Shaikh Mehrajuddin Jalil	12	12	12	13	13	13	14	14	14	14	16
66	Shaikh Murtuza Farooq	13	13	13	14	14	14	14	15	15	15	15
67	Sharma Amitkumar Vinodkumar	10	10	10	10	10	10	10	10	10	10	14

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68	Shejwal Pratham Sanjay	9	9	9	10	10	10	10	11	12	12	15
69	Shinde Snehal Shivnath	6	6	6	6	7	7	7	7	7	7	15
71	Surve Pritesh Pravin	12	12	12	13	13	13	14	14	14	14	16
72	Sutar Harshwardhan Tushar	6	6	6	6	7	7	7	7	8	8	13
73	Swami Vedant Virbhadra	7	8	8	8	9	8	9	9	10	11	19
74	Talawdekar Vaibhavi Laxman	9	10	10	11	12	11	12	12	13	12	15
75	Tiwari Pratham Pramod	7	7	7	7	8	8	8	8	8	8	14
76	Undage Abodh Ravindra	13	13	13	15	15	15	15	15	15	15	17
77	Yadav Chandan Sheshram	7	7	7	7	8	8	8	8	8	8	14
78	Utekar Swapnil	10	10	10	10	10	10	10	10	10	10	13
	Above target (60%)	**40**	**43**	**43**	**44**	**45**	**50**	**50**	**54**	**56**	**56**	**58**
	No. of students appereaded	**71**	**71**	**71**	**71**	**71**	**71**	**71**	**71**	**71**	**71**	**71**
	%	**56.34**	**60.56**	**60.563**	**61.972**	**63.3803**	**70.423**	**70.4225**	**76.06**	**78.87**	**78.8732**	**81.69**

K. C. College of Engineering Management Studies and Research THANE (E)

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Deparment of Electronics and Telecommunication

Assessment Tools for Course Outcomes : (Direct Methods + Indirect Method)

Course Outcomes	Direct Assessment Tools	Internal Attainment Level of Course Outcomes in %	Internal Attainment Level	Average of Internal Attainment Level	ESE Attainment in %	ESE Attainment in level	% of Total Attainment (Direct) 80% of ESE Attainment Level + 20% of IA level	Indirect Assessment in %	% of Indirect Assessment Attainment Level	Total Attainment for (Direct & Indirect)
ECL502.1	Experiment No. 1, 2	58.44	1.8	1.8	81.69	3	2.4+ 0.36 =2.76	85.79	2.5	2.2 + 0.5 =2.7
ECL502.2	Experiment No. 3, 4	61.26	2.1	2.1	81.69	3	2.4+ 0.42 = 2.82	84.15	2.4	2.25 + 0.48 = 2.73
ECL502.3	Experiment No. 5, 6, 7	68.07	2.8	2.8	81.69	3	2.4 + 0.56 = 2.96	83.06	2.3	2.36 + 0.46 = 2.82
ECL502.4	Experiment No. 8,9,10	77.93	3	3	81.69	3	2.4 + 0.6 = 3	83.06	2.3	2.4 + 0.46 = 2.86

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CLASS : T.E. **SUBJECT : DTSP-Lab**

SEMESTER : V **YEAR : 2022-23**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
ECL502.1	2.7	1.78	1.78										1.78	1.78
ECL502.2	2.73	1.8											1.8	
ECL502.3	2.82	1.86	0.93										1.86	
ECL502.4	2.86		0.94	0.94		0.94						2.86	2.86	0.94
Avgerage	2.77	1.81	1.78	0.94		0.94						2.86	2.07	1.36

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CLASS : T.E. SUBJECT : DTSP-Lab
SEMESTER : V YEAR : 2022-23

Observation and Action Taken (Use of excel document)

	Target Level	Attainment Level	Observation
PO1	3	2.77	Gap of 0.23. Some fundamental engineering knowledge of Fourier transform, binary numbers is neede for better understanding.
Action	Motivate the students to clear their basics of discrete time signal processing from faculty while writing algorithm		
PO2	2	1.81	Gap of 0.19. Different types of FFT algorithms, FIR and IIR filters and their use in real time application should be emphasis.
Action	Motivate the students to read research paper to find out one small problem statement in discrete time signal processing		
PO3	2	1.78	Gap of 0.22. Emphasis should given on windowing method ppliction
Action	Motivate the students to analysis of one problem of discrete time signal processing		
PO4	1	0.85	Gap of 0.28. In discrete time signal processing, students should able to understand importance of algorithm in health care domain
	Motivate the students to write algorithm of analyzed problem of discrete time signal processing		
PO6	1	0.94	Gap of 0.06. Students should able to understand the applications and it impact and use in real time application
Action	Motivate the students to perform programs different applications of discrete time signal processing.		
PO12	3	2.86	Gap of 0.14. In discrete time signal processing, students should able to understand applications related to the field of biomedical signal processing and audio signal processing
Action	Motivate the students to perform programs different applications of discrete time signal processing		
PSO1	3	2.07	Gap of 0.93. Some fundamental knowledge of discrete time signal processing is needed.
Action	Motivate the students to implement different algorithms.		
PSO2	2	1.36	Gap of 0.64. Some fundamental knowledge of fiters is needed.
Action	Motivate the students to perform butterworth, chebyshev I, windowing methods etc. algorithm		

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Department of Information Technology

CO-PO MAPPING TARGET

A.Y. 2019-2020 TO 2022-2023

Course	Name	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C101	Enginnering Mathematics I	3				2									
C102	Enginnering Physics I	3	2			1									
C103	Enginnering Chemistry I	2	1.75												
C104	Enginnering Physics I LAB	3	2	2		2.25		2		2	2	1	1		
C105	Enginnering Chemistry I LAB	3	2												
C106	Engineering Mechanics LAB	3	3												
C107	Engineering Mechanics	3	3												
C108	Basic Electrical Engineering	3	2												
C109	Basic Electrical Engineering LAB	3	2			1									
C110	BasicWorkshop Practice I	3		3											
C111	Professional Communication and Ehics -I								3	3	3				
C112	Enginnering Mathematics II	3				2									
C113	Enginnering Physics II	3	2			1									
C114	Enginnering Chemistry II	2.33	1.66					2							
C115	Engineering Graphics	3	2								2				
C116	C Programming	3	2			2									
C117	Professional Communication and Ehics -I Lab								3	3	3				
C118	BasicWorkshop Practice II	3		3											
C119	Enginnering Physics II LAB	3	2	2		2.25		2		2	2	1	1		
C120	Enginnering Chemistry II LAB	3	2												
C121	Engineering Graphics Lab	3				3									

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A.Y. 2019-2020 TO 2022-2023

Course	Name	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C122	C Programming Lab	2	2	2		2			2	3	3		2	2	
C201	Engineering Mathematics-III	3	1										1	1	
C202	Data Structure and Analysis	2	3	3	2	3								3	
C203	Database Management System	3	3	3										2	
C204	Principle of Communication	3	3			3				3				3	
C205	Paradigms and Computer Programming Fundamentals	3	3	1	1	1				2	2			2	2
C206	Data Structure Lab	2	3	3		3							1		
C207	SQL Lab	3.00	3.00	3.00										3	
C208	Computer programming Paradigi	2	3	3	3	3								3	
C209	Java Lab (SBL)	1	2	3		3							1	2	1
C210	Mini Project – 1 A for Front end /backend Application using JAVA	3	3	3	3	2.66	2	2	3	3	2.5	2.75	2	3	2.66
C211	Engineering Mathematics-IV	3	2										1	1	
C212	Computer Network and Network	2	3	3										1.5	2
C213	Operating System	3	3							1	1				1
C214	Automata Theory	3	3	3	1									3	
C215	Computer Organization and Arch	1	3	3				1						1	
C216	Network Lab	1	2	3		3							2		
C217	Unix Lab	3	3	3										3	
C218	Microprocessor Lab	2	3	3		3		3						2	

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Course	Name	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C219	Python Lab (SBL)	1	2	3		2							2	2	1
C220	Mini Project – 1 B for Python based automation projects	3	3	3	3	2.66	2	2	3	3	2.5	2.75	2	3	2.66
C301	Internet Programming	1	3	3		3				3	3	3	3	1	1
C302	Computer Network Security	1	3	2		3							3	1	1
C303	Entrepreneurship and E- business	3	2	2	2		2	1	1			3	3	1.5	2
C304	Software Engineering	1	3	2										1	1
C305	Department Optional Course – 1 A	3	3	2		2					3			2	1
C305	Department Optional Course – 1 B	3	2	1	1								2	1.67	
C306	IP Lab		1	3		2				2				2	1
C307	Security Lab	1		3		3				2	1	1		2	
C308	DevOPs Lab		3	3		3			3		3			3	3
C309	Advance DevOPs Lab	1	2	3		3							2	2	1
C310	Professional Communication & Ethics-II (PCE-II)								3	3	3				
C311	Mini Project – 2 A Web Based Business Model	3	3	3	3	3	3	3	3	3	3	3	3	3	3
C312	Data Mining & Business Intelligen	2.167	2.167	2	1.5	1								2.4	2
C313	Web X.0	3	2.16	2	2	2.33								2	2
C314	Wireless Technology	3	3	3	2	2	1		1				1	3	
C315	AI and DS – 1	2	3	3	2	2.5								2	3
C316	Department Optional Course – 2	3	2				2	1						1.5	1.5

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A.Y. 2019-2020 TO 2022-2023

Course	Name	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C317	BI Lab	3	3	3		2.8				1	1			2.66	
C318	Web Lab	2	1	3	3	3							2	2	
C319	Sensor Lab	3	3	3	2	2			2	3	3	1	1	1	
C320	MAD & PWA Lab		3	3		3			3		3			3	3
C321	DS using Python Skill based Lab	3	3	3	2.5	2.8				3	3			2	2
C322	Mini Project – 2 B Based on ML	3	3	3		2.667	2	1		1	1			3	
C401	AI and DS –II	3	2.5	2.4	2.4	2	2							2.2	2.33
C402	Internet of Everything	3	3			3				3					2
C403	Department Optional Course – 3 (STQA)	3	3	3		1								3	1
C404	Department Optional Course –4 (A	3	3	3	3				3		3		3	3	3
C405A	Institute Optional Course – 1 (PLM)	3	2	2								3	3		
C405B	Institute Optional Course – 1 (CSL)		2		1.5	3	2.6	2	1				1.8		
C405C	Institute Optional Course – 1 (MIS)	3	2		1	1			1						1
C406	Data Science Lab	3	2.4	2.667	3	2	2			3	3			2.2	2.5
C407	IOE Lab	2.75	2.75			2.75				2.5					2.75
C408	Secure Application Development	1		3		3				2	1	1		2	

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CO-PO MAPPING TARGET

A.Y. 2019-2020 TO 2022-2023

Course	Name	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C409	Recent Open Source Project Lab	2	1	2	2.25	2	1	2	2		2			2	2
C410	Major Project I	2.67	2.33	2.5	2	2.5	2	2	2.5	2.2	2.33	2.5	2	2.25	2.75
C411	Blockchain and DLT	3	3	3	2	2						1		1	
C412	Department Optional Course – 5 (	1	3	2										1	1
C413	Department Optional Course – 6 (	3	3											3	3
C414A	Institute Optional Course – 2 (PM)		3	3		3						3			
C414B	Institute Optional Course – 2 (EVM)							3						2	
C415	Blockchain Lab	2	3	3	2	2.5								2	3
C416	Cloud computing	3	3			3								3	
C417	Major Project II	2.67	2.33	2.5	2	2.5	2	2	2.5	2.2	2.33	2.5	2	2.25	2.75
	AVERAGE	2.53	2.50	2.67	2.12	2.39	1.97	1.94	2.33	2.44	2.36	2.10	1.91	2.15	1.97
	DIRECT VALUE	2.03	2.00	2.14	1.70	1.91	1.58	1.55	1.87	1.95	1.89	1.68	1.53	1.72	1.57
	INDIRECT VALUE	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
	SET VALUE	2.63	2.60	2.74	2.30	2.51	2.18	2.15	2.47	2.55	2.49	2.28	2.13	2.32	2.17

ATTAIN VALUE

0.8*direct value+0.2*indirec

CO-PSO MATRICS			
Course		PSO1	PSO2
C101			
C102			

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Course	Name	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C103															
C104															
C105															
C106															
C107															
C108															
C109															
C110															
C111															
C112															
C113															
C114															
C115															
C116															
C117															
C118															
C119															
C120															
C121															
C122															
C201															
C202															
C203		3													
C204		2													

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Course	Name	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C205		2													
C206															
C207															
C208		3													
C209		2	1												
C210															
C211															
C212		2	1												
C213		2													
C214		3	–												
C215															
C216		3													
C217		1													
C218		1	1												
C301															
C302		1	1												
C303		2	1												
C304		3													
C305A		1													
305B															
C306		2	1												
C307		2													

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Course	Name	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C308		2													
C309															
C310															
C311		1	1												
C312		1	1												
C313		3													
C314															
C315		1	1												
C316		2													
C317		3													
C318		3													
C319															
C320		3	2.6												
C401		1													
C402		1													
C403		1	1												
C404		3													
C405															
C406		2	2												
C407															
C408		2	2												
C409		3	3												

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A.Y. 2019-2020 TO 2022-2023

Course	Name	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C410		3	2												
C411		1	1												
C412		3	3												
C413															
C414		2													
C415		3	3												
C416															
C417		2.5	2												
C418		3													
C419		3	3												

341463 1.68
7073170 1.344
0.6 0.6
073170 1.944

1.64 1.31

PSO SET

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EVALUATION OF EACH PO AND PSO

019-2020 TO 2022-2023

Course		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C101	Enginnering Mathematics I	1.29				0.87									
C102	Enginnering Physics I	2.79	1.8			0.93									
C103	Enginnering Chemistry I	1.83	1.59												
C104	Enginnering Physics I LAB	2.87	1.89	1.98		1.89		1.98		1.98	1.98	0.99	0.99		
C105	Enginnering Chemistry I LAB	2.56	1.69												
C106	Engineering Mechanics LAB	2.69	2.69												
C107	Engineering Mechanics	2.68	2.68												
C108	Basic Electrical Engineering	2.96	1.95												
C109	Basic Electrical Engineering LAB	2.81	1.85			0.95									
C110	BasicWorkshop Practice I	2.99		2.99											
C111	Professional Communication and Ehics -I								2.84	2.84	2.84				
C112	Enginnering Mathematics II	2.54				1.62									
C113	Enginnering Physics II	2.70	1.75			0.89									

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C114	Enginnering Chemistry II	1.87	1.14					1.51							
C115	Engineering Graphics	2.52	1.68								1.68				
C116	C Programming	3.00	2.00			2.00									
C117	Professional Communication and Ehics -I								2.97	2.97	2.97				
C118	BasicWorkshop Practice II	2.95		2.95											
C119	Enginnering Physics II LAB	3.00	1.98	1.98		2.24		1.98		1.98	1.98	0.99	0.99		
C120	Enginnering Chemistry II LAB	2.45	1.61												
C121	Engineering Graphics Lab	2.57				2.57									
C122	C Programming Lab	1.86	1.82	1.83		1.82			1.82	2.78	2.78		1.82		
C201	Engineering Mathematics-III	2.84	0.88										0.95		
C202	Data Structure and Analysis	1.79	2.79	2.79	1.81	2.79								2.79	
C203	Database Management System	2.6	2.6	2.6										1.716	
C204	Principle of Communication	3	3			3				3				3	
C205	Paradigms and Computer Programming Fundamentals	2.24	2.24	0.7348	0.6996	0.7788				1.3992	1.3992			1.3992	1.3992
C206	Data Structure Lab	0.99	1.98	3		3							1.98		
C207	SQL Lab	2.09	2.14	2.2812										1.716	
C208	Computer programming Paradigms Lab	2.12	2.4585	2.2812	1.25	2.3922				2.1996	1.3992			1.8894	1.8894
C209	Java Lab (SBL)	0.99	1.98	3		3							0.99	1.98	0.99

C210	Mini Project – 1 A for Front end /backend Application using JAVA	3.00	3.00	3.00	3.00	2.66	1.98	2.00	3.00	3.00	2.49	2.75	1.98	3.00	2.66
C211	Engineering Mathematics-IV	2.82	1.93										0.93		
C212	Computer Network and Network Design	1.98	2.248	2.71248									0.99	1.48	1.9
C213	Operating System	1.46	1.46							0.48	0.48			1.46	0.48
C214	Automata Theory	3	2.72	3	0.44									2.57	
C215	Computer Organization and Architecture	0.46	1.37	1.37				0.46						0.46	
C216	Network Lab	0.99	1.98	3		3							1.98		
C217	Unix Lab	3	3	3										3	
C218	Microprocessor Lab	1.98	3	3		3		3						1.98	
C219	Python Lab (SBL)	0.99	1.98	3		0.99							0.99	0.99	0.99
C220	Mini Project – 1 B for Python based automation projects	3.00	3.00	3.00	3.00	2.66	1.98	2.00	3.00	3.00	2.49	2.75	1.98	3.00	2.66
C301	Internet Programming	0.99	3	3		3				3	3	3	3	0.99	0.93
C302	Computer Network Security	0.99	3	1.98		3							3	0.99	0,99
C303	Entrepreneurship and E- business	3	1.98	1.98	1.98		1.98	0.99	0.99			3	3	1.74	1.98
C304	Software Engineering	0.99	3	1.98										0.99	0.99
C305	Department Optional Course – 1 A(ADMT)	2.93	3	2.6		2.6					3			2.6	0.87
C305	Department Optional Course – 1 B(ADSA)	2.75	2	1	1								1.92	1.58	
C306	IP Lab		0.99	3		1.98	1.98			1.98				1.98	0.99
C307	Security Lab	0.99		3		3				1.98	0.99	0.99		1.98	
C308	DevOPs Lab		2.28	2.28		2.28			2.28		2.28				
C309	Advance DevOPs Lab	0.99	1.98	3		3							0.99	0.99	0.99
C310	Professional Communication & Ethics-II (PCE-II)								2.70	2.70	2.70				
C311	Mini Project – 2 A Web Based Business Model	3	3	3	3	3	3	3	3	3	3	3	3	3	3

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C312	Data Mining & Business Intelligence	1.87	1.87	1.72	1.3	0.87	2.06								1.75
C313	Web X.0	2.25	1.53	1.47	1.55	1.43								1.51	1.55
C314	Wireless Technology	1.93	2.07	2.07	1.43	1.43	0.72		0.84				0.72	2.00	
C315	AI and DS – 1	0.5	0.68	0.75	0.125	0.4								0.11	0.75
C316	Department Optional Course – 2 Green IT	2.97	2.80	0.99	1.6067		2.80	2.80	0.9768			1.98	1.98	1.485	1.485
C317	BI Lab	2.69	2.69	2.69		2.51				0.89	0.89			2.59	
C318	Web Lab	1.98	0.99	3	3	3							1.98	1.98	
C319	Sensor Lab	3	3	3	1.98	1.98			1.98	3	3	1.32	1.188	0.99	
C320	MAD & PWA Lab		2.52	2.52		2.52			2.52		2.52			2.52	2.52
C321	DS using Python Skill based Lab	2.94	2.93	2.93	2.93	2.88				2.9	2.9	2.9	2.88	1.92	1.92
C322	Mini Project – 2 B Based on ML	2.8	2.71	2.82		2.44	1.79	0.93	1.98	2.26	2	3	2.9	2.71	2.51
C401	AI and DS –II	1.22	1.07	1.06	1	1.03	0.9							0.93	0.99
C402	Internet of Everything	2.36	2.36			2.36				2.36					1.55
C403	Department Optional Course – 3 (STQA)	3	3	3		0.99								3	0.99
C404	Department Optional Course –4 (AR-VR)	2.77	2.77	2.77	2.77				2.77		2.77		2.77	2.77	2.77
C405A	Institute Optional Course – 1 (PLM)	3	1.98	1.98								3	3		
C405B	Institute Optional Course – 1 (CSL)	1.98	1.98	1.98		3	1.98							3	
C405C	Institute Optional Course – 1 (MIS)	2.79	1.83		0.88	0.99			0.88						0.917
C406	Data Science Lab	2.61	2.15	2.31	2.61	1.73	1.72			2.61	2.61			1.94	2.17
C407	IOE Lab	3	3			3				3					3
C408	Secure Application Development	1.00		3.00		3.00				2	1	1		2.00	
C409	Recent Open Source Project Lab	1.98	1.32	1.485	2.235	1.98	0.99	1.98	1.98		1.98			1.98	1.98
C410	Major Project I	2.36	2.10	2.04	1.64	2.04	1.76	1.76	2.14	1.88	1.96	2.04	1.56	1.90	2.23
C411	Blockchain and DLT	2.289	2.080	2.31	1.840	1.52	1.52						0.76		2.1025
C412	Department Optional Course – 5 (BDA)	0.99	3.00	1.98										0.99	0.99
C413	Department Optional Course – 6 (UID)	2.10667	2.10667											2.10667	
C414A	Institute Optional Course – 2 (PM)	3.00	3.00	3.00		3.00				3		3			

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C414B	Institute Optional Course – 2 (EVM)							2.307							
C415	Blockchain Lab	1.5812	2.16	2.16	1.45	2.051					0.8			1.556	1.9406
C416	Cloud computing	3	3			3								3	
C417	Major Project II	2.57	2.26	2.43	1.92	2.43	1.92	1.92	2.42	2.13	2.27	2.43	1.91	2.18	2.63
Direct Attainment															
Indirect Attainment															
	AVERAGE	2.25	2.20	2.38	1.79	2.16	1.82	1.91	2.16	2.38	2.14	2.24	1.83	1.93	1.70
	80%	1.799	1.763	1.906	1.429	1.73	1.454	1.526	1.730	1.906	1.715	1.794	1.466	1.542	1.359

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(Affiliated to the University of Mumbai)

Mith Bunder Road, Near Hume Pipe ,Kopri,Thane E-400603

POs & PSOs Attainment Levels and Actions for improvement –Batch (2019-2023)

POs	Target Level	Attainment Level	Observations
PO1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems			
PO1	**2.52**	**2.32**	**1.**Applications of concepts of stack used, different programming paradigms should be elaborated with examples. 2. Basic practice on SQL query needs to be focused. E-R Diagram design needs to be practiced. 3.Operating system basics required focus. 4. More emphasis on concepts of advanced data structures is required. 5.Fundamentals of Devops needs attention. 6.Wireless Technology concepts to be elaborated. 7.Emphasis is required to understand basic concepts of data exploration 8. Awareness is required for Green IT concepts and applications. 9. Focus should be given on concepts of AI and DS-`
Action1:Real life examples of concepts of stack used,applications of different programming paradigms will be emphasized. Action2 : Writing basic queries in SQL will be emphasized. E-R diagrams to be covered in detail. Action3 :Concepts elaboration in detail will be emphasized in theory for DBMS and Adv. Data			

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<table>
<tr><td colspan="4">structures.
Action 4: More concepts will be elaborated on data science and AI.
Action 4: Data exploration concepts will be covered in theory and experiment.
Action 5: Focus will be given on covering fundamentals of Devops.
Action 6: Concept elaboration will be done in theory class in wireless technology.
Action 7: Focus will be given on concept elaboration</td></tr>
<tr><td colspan="4">PO2:Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.</td></tr>
<tr><td>PO2</td><td>2.68</td><td>2.26</td><td>1.Focus on analysis of Object oriented concepts is required.
2.Analysis of complex query needs to be covered.
3.Analysis of Schema design & relational tables to be emphasized.
4.Analysis of different scheduling algorithms, memory management, storage management is required.
5.Analysis on flutter framework for android app development is required.
6.Analysis on wide area network technologies needs emphasis
7.Analysis of Preprocessing tools is needed
8. Analysis of different entrepreneur is required
9. Analysis of Green IT objectives is required
10 . Analyzing problems based on fuzzy controller , deep learning and ML.</td></tr>
<tr><td colspan="4">Action 1: Programs on object oriented concepts will be covered during lab hours.
Action 2:Analysis of complex queries in the lab session will be covered.
Action 3:More examples on schema design & relational tables will be taken in lectures.
Action4 :Numericals will be covered based upon concepts of scheduling algorithms, memory management, storage management will be taken.
Action 5:Flutter framework will be explained in detail during practicals.
Action 6:Wireless area networks technologies will be analyzed using case studies and assignment
Action7: Preprocessing tools will be covered in laboratory experiments.</td></tr>
</table>

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Action 8: Case study examples will be conducted to analyze different entrepreneur Action 8: Examples will be taken in the context of green objectives in IT . Action 9: Numerical will be conducted on Fuzzy controller, Deep learning etc.			
PO3:Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.			
PO3	**2.77**	**2.40**	**1.**Focus on declarative programming paradigms is needed 2.Students will be encouraged to design complex queries using PL-SQL 3. Development of android app for real time applications is required. 4.Concepts of Wireless LAN and Wireless MAN will be used to meet the specific needs with appropriate considerations for health and safety. 5.Data mining algorithms to be implemented using different datasets 6. Real time case study on challenges faced by entrepreneur is required 7. Students are not aware of designing system components or processes using green IT that meet the specified needs with appropriate green consideration for the public health and safety, and the cultural, societal, and environmental considerations. 8.Emphasis will be given on Designing solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations using data science techniques

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Action1: Declarative programming paradigms will be covered in practical hours.

Action 2:Innovative Expt will be conducted using concepts of PL-SQL. Seminar/ workshop will be conducted on query writing for some applications.

Action3 :Workshops/ mini projects will be conducted.
Action 4:Network design concepts of Wireless LAN and Wireless MAN will be taught for appropriate considerations for health and safety applications.
Action 5: More datasets will be used in laboratory to understand concepts.
Action 6: Real life examples will be conducted on challenges faced by entrepreneur in theory class

Action 7: Awareness will be provided about Green ICT Tools

Action 8: Mini projects will be given based on Data science

PO4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO4	**2.28**	**1.91**	1. students need to be encouraged to use research based knowledge and research methods including design of experiments using wireless technologies. 2. Sharing of exposure to experience, faced by budding entrepreneurs 3. Knowledge of data science is required to enhance for analysis and interpretation of data

Action 1: Mini project development will be encouraged using wireless technologies.

Action 2: Sharing of exposure to experience , faced by budding entrepreneurs will be done through guest lectures , seminars.

Action 3: Interpretation of data is enhanced using data science techniques.

PO5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

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PO5	**2.58**	**2.22**	**1**.Use of modern tools for different paradigm practices is required. 2.Use of modern tools/ framework for web development needs focus 3.Students will be encouraged to use modern IT tools for app development. 4. Use of modern tools for devops to be explored. 5.Use of simulators in Wireless technology to clear the concepts is needed 6.More tools to be incorporated for data mining algorithm execution
Action1:Modern tools will be covered in Practicals Action 2:Framework introduction such as React-JS and will be conducted through hands on workshop Action3 :Modern tools for app development will be explored during workshops. Action 4: Workshop will be conducted to use modern tools in Devops technology will be done Action 5 : Simulators NS2, NS3 will be used to demonstrate simulation. Action 6: Tools in data mining will be explored in laboratory			
PO6 :The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.			
PO6	**2.21**	**1.95**	1.Emphasis for project titles on health safety legal and cultural issues need to be given 2. Development of reasoning to assess impact of innovations with respect to societal, health, safety, legal and cultural issues
Action **1:** Project development will be emphasized on health culture safety and legal issues using various technologies. Action 2: Development of reasoning to assess impact of innovations with respect to societal, health, safety, legal and cultural issues will be done via case study			
PO7:Environment and sustainability: Understand the impact of the professional			

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engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.			
PO7	**2.36**	**1.53**	1.In major projects Green IT practices to be inculcated. 2. Impact of innovation and technology on environment and sustainability is needed
Action 1:Focus on developing solutions to address issues in agriculture/ environment etc in major projects will be done. Action 2: Students will be encourages to follow green IT practices for mini and major projects Action3 : Brainstorming sessions will be conducted to understand impact of innovation and technology on environment and sustainability			
PO8:Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.			
PO8	**2.40**	**1.73**	1.Ethical principles and responsibilities required to be inculcated in app development. 2.Students lack ethical behavior in online training mode. 3. Encouragement is required to analyze IEEE standards for implementation of wireless technology 4. Inculcation of ethical principles , professional ethics and responsibilities for making a business plan 5. IT waste management techniques
Action 1: Students will be encouraged to practice Ethical principles and responsibilities during project development. Action 2: Orientation on ethical behavior during online teaching will be conducted. Students will be encouraged to apply ethical practices in Devops technology Action 3: Different standards are covered to analyze IEEE standards for implementation of wireless technologies. Action 4: Group activity will be conducted to create business plan Action 5: Ethical IT disposal to be focused.			
PO 9: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.			
PO9	**2.39**	**1.91**	1.Students will be encouraged to function effectively as an individual and as a team for web development projects. 2.Students lack content in group discussion. 3.Emphasis will be given on functioning individual and team work in data mining mini project development

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Action1:Multidisciplinary projects will be emphasized and individual and team work will be taken care of. Action 2: Students will be encouraged to read contemporary issues			
PO10 :Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.			
PO10	**2.20**	**2.22**	1.Students lack vocabulary during communication. 2.Reading and writing skills are lacking in project development in various domains
Action 1:Students will be tested for advanced vocabulary and guided for soft skills. Action 2: Orientation and support will be provided for project development using various technologies.			
PO11 :Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.			
PO11	**2.11**	**1.79**	1.Need Emphasis on Managing Project and finances during minor and major project development. 2. Actual implementation of Green IT practices for project management
Action 1: Project Management Life cycle concepts will be elaborated. Financial literacy seminars to be conducted to create awareness amongst students. All mini projects are developed using SDLC models. Action 2: Inculcation of Green practices in Project development			
PO12 : Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change			
PO12	**2.48**	**1.79**	1.Applications of advanced data structure in the context of technological change needs to be covered. 2.Sessions are required on designing wireless network infrastructure 3. Actual implementation of Green IT practices is lagging

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Action1:Case study based on applications of advance data structured in the context of technological change will be covered Action 2: Courses/case studies sessions will be conducted on designing wireless network infrastructure Action3: Inculcation of Green practices in Project development			
PSO 1 :To apply knowledge of the latest technology to analyze problems, design algorithms and implement solutions for real time problems.			
PSO1	**2.24**	**1.87**	1.Workshop on latest technologies in DBMS for implementation solutions for real time problems is needed. 2.Knowledge of new technologies in Operating systems is required. 3. J-Query Java script library to be explored in PWA. 4.Emphasis will be given on problem analysis, use of advanced data structure for real time applications. 5.Knowledge of technologies will be used to explore using real time problems in data mining. 6. Experience sharing of budding entrepreneur is essential 7. Real time application development based on Green It techniques is required 8. Need to analyze problems, design algorithms and implement solutions for real time problems using data science techniques
Action 1:Hands-on workshops on the latest technologies will be conducted. Action 2:MOOC courses will be completed by students as well as hands-on workshops will be conducted. Action 3: Mini projects will be done based upon J-Query and Java script library concepts. Action 4: Examples will be covered on problem analysis and use of advance data structures in theory Action 5:Projects in various domains will be explored in data mining. Action 6: Sessions on experience sharing of budding entrepreneur is essential Action 7: Inculcation of Green practices in Project development			
PSO 2 Ability to recognise changes in the technology and science with respect to software development life-cycle.			

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PSO2	**1.83**	**2.06**	1.Emphasis need to be given on real time application execution wrt change in SDLC 2.Focus on PWA concepts wrt SDLC need to be explored. 3.Experience sharing of budding entrepreneur is essential 4. Green It practices to be followed 5. Need to recognise changes in the technology and science with respect to software development life-cycle in data science techniques
Action 1:Mini project development will be emphasized covering change in technology wrt SDLC and green IT practices Action 2: Focus on PWA concepts wrt SDLC will be explored. Action 3: Experience sharing of budding entrepreneurs is provided via seminars etc.			

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