Ananthagiri, Kodad, Telangana508206, India.

Department of Electronics & Communication Engineering

Course File

(EC604PC) Digital Signal Processing

III B.Tech II Semester

2023-24

Mrs.V.Kalyani
Assistant Professor

Department of Electronics & Communication Engineering

DIGITAL SIGNAL PROCESSING
Check List

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20	Mid-II mark
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22	Course materials like Notes, PPT's, etc.

Department of Electronics & Communication Engineering

Int.Marks:25 Ext. Marks: 75 Total Marks: 100

ANURAG ENGINEERING COLLEGE

(An Autonomous Institution)

III Year B.Tech. ECE - II Sem	L	T/P/D	C
	3	-/-/-	3

(EC604PC) DIGITAL SIGNAL PROCESSING

Prerequisites: SS

Course Objectives:

1. To understand characteristics of discrete time signals and systems
2. To analyze and process signals using various transform techniques
3. To understand various factors involved in design of digital IIRfilters
4. To understand various factors involved in design of digital FIRfilters
5. To understand multi rate digital signal processing

UNIT I:

Introduction: Introduction to Digital Signal Processing: Discrete time signals & sequences,linear shift invariant systems, stability, and causality. Linear constant coefficient difference equations. Frequency domain representation of discrete time signals and systems.

Realization of Digital Filters: Review of Z-transforms, Applications of Z – transforms, solution ofdifference equations of digital filters, Block diagram representation of linear constant-coefficient difference equations, Basic structures of IIR systems, Transposed forms, Basic structures of FIR systems, System function,

UNIT II:

Discrete Fourier Transform: Properties of DFT, linear convolution of sequences using DFT, Computation of DFT. Overlap addmethod, Overlap save method Relation between Z-transform and DFT. **Fast Fourier Transforms:** Fast Fourier transforms (FFT) - Radix-2 decimation in timeand decimation in frequency FFT Algorithms, Inverse FFT, and FFT with General Radix N

UNIT III

IIR Digital Filters: Analog filter approximations – Butter worth and Chebyshev, Design of IIRDigital filters from analog filters, Step and Impulse Invariant Techniques, Bilinear Transformation Techniques, Spectral transformation, Design Examples: Analog-Digital transformations.

UNIT IV

FIR Digital Filters: Characteristics of FIR Digital Filters, frequency response. Design of FIRDigital Filters using Window Techniques, Frequency Sampling technique, Comparison of IIR & FIR filters.

UNIT V: Multi-rate Digital Signal Processing: introduction, Down sampling, Decimation, Up sampling, Interpolation, Sampling Rate conversion, Conversion of Band Pass Signals, Applications of Multi-rate Digital Signal Processing

TEXT BOOKS:

1. Digital Signal Processing, Principles, Algorithms, and Applications: John G. Proakis, Dimitris G. Manolakis, Pearson Education / PHI, 2007.
2. Discrete Time Signal Processing – A.V.Oppenheim and R.W. Schaffer, PHI

REFERENCE BOOKS:

1. Digital Signal Processing: Andreas Antoniou, TATA McGraw Hill , 2006
2. Digital Signal Processing: MH Hayes, Schaum's Outlines, TATA Mc-Graw Hill, 2007.
3. Fundamentals of Digital Signal Processing using Matlab – Robert J. Schilling, Sandra L. Harris, Thomson, 2007.

Expected Course Outcomes: Upon the successful completion of this course, the student will be able to:

1. Perform time frequency and Z transform analysis on signals and systems
2. Understanding the inter-relationship between DFT and various transforms
3. Understand the significance of various filter structures
4. Design a digital filter for a given specification.
5. Understand multi rate Digital signal processing

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	PO12
CO1	H	H								M	M	M
CO2	H	H								M	M	M
CO3	H	M	M	M							M	
CO4	H	M	M	M							M	
CO5					M	M	M			H	H	M

H-HIGH **M-MEDIUM** **L-LOW**

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INDIVIDUAL TIMETABLE

SUBJECT: (EC604PC) DIGITAL SIGNAL PROCESSING

DAY / PERIOD	I	II	11.10-11.20	III	IV	1.00-1.40	V	VI	3.10-3.15	VII
	9.30-10.20	10.20-11.10		11.20-12.10	12.10-1.00		1.40-2.25	2.25-3.10		3.15-4.00
MON		III ECE-B								
TUE	III ECE-A	III ECE-B		III ECE-A						
WED	III ECE-B			III ECE-A	II ECE-A					
THU	III ECE-A	III ECE-B					DE LAB(II EEE)			
FRI							II ECE-A	Real Time Projects-A		
SAT	III ECE-B			III ECE-A						

ANRK/TT/04/23-24/3-2

Time Table: B.Tech III Year II Semester (A Sec)

DAY	9:30-10:20	10:20-11:10	11:20-12:10	12:10-1:00	1:00-1:40	1:40-2:25	2:25-3:10	3:15-4:00
MON	MWE	CN	WM/SE	DSP	LUNCH	MWE&DC/DSP LAB		
TUE	DSP	TSS/TV	CN	WM/SE		MEFA	MWE	IPR
WED	CN	MEFA	DSP	TSS/TV		SDP	CRT-E	IPR
THU	DSP	CN	TSS/TV	WM/SE		MWE&DC/DSP LAB		
FRI	MEFA	MWE	CN	TSS/TV		MWE	WM/SE	WM/SE
SAT	MWE	CRT-M	DSP	TSS/TV		MEFA	CRT-C	SPORTS/LIB

S.No	Course Code	Course Name	Faculty Name
1	**AE601HS**	MANAGERIAL ECONOMICS AND FINANCIAL ANALYSIS(MEFA)	Mr.S.KOTIREDDY
2	**EC602PC**	MICROWAVE ENGINEERING(MWE)	Mr.M.BASHA
3	**EC603PC**	COMPUTER NETWORKS(CN)	Dr.G.V.HARI PRASAD
4	**EC604PC**	DIGITAL SIGNAL PROCESSING(DSP)	Mrs.V.KALYANI
5	**EC621PE**	(PE-II)TELECOMMUNICATION SWITCHING SYSTEMS	Mr.B.NAGARAJU
	EC622PE	(PE-II) TELEVISION ENGINEERING	Ms.D.SHIRISHA
6	**CE612OE**	(OE-I)-WASTE MANAGEMENT	Mr.SK.REHMAN
	CS611OE	(OE-I)-SOFTWARE ENGINEERING	Mr.K.BIKSHAPATHI
7	**EC605PC**	MICROWAVE ENGINEERING AND DIGITAL COMMUNICATION LAB	Mrs.G.SHOBHA
8	**EC606PC**	DIGITAL SIGNAL PROCESSING LAB	Mr.B.NAGARAJU
9	**HS607MC**	INTELLECTUAL PROPERTY RIGHTS(IPR)	Mr.V.DAVID

III B.Tech. II Semester Academic Calendar		
I Spell Instruction	22.01.2024	16.03.2024
I Mid Examinations	18.03.2024	20.03.2024
II Spell Instruction	21.03.2024	08.05.2024
Industry oriented mini project/internship	09.05.2024	05.06.2024
Summer Vacation	23.05.2024	05.06.2024
II Spell Instruction Continuation	06.06.2024	12.06.2024
II Mid Examinations	13.06.2024	15.06.2024
Preparation Holidays	18.06.2024	24.06.2024
Semester End Examinations (Theory & Practical's)	25.06.2024	20.07.2024

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10	**CRT-M**	CAMPUS RECRUITMENT MATHEMATICS	Dr.Y.HARIKRISHNA
11	**CRT-E**	CAMPUS RECRUITMENT ENGLISH	Mr.J.PURNA KUMAR
12	**CRT-C**	CAMPUS RECRUITMENT C LANGUAGE	Mr.B.ANAND KUMAR

Academic Counselor	**Mrs.V.Kalyani** (9603107049)
CR's	**Nikam.Balaji**
	Bolla.Kavya

ROOM NUMBERS	Lecture Hall (E-307)	DSP Lab (E-401)	MWE & DC Lab (D-216)

ANRK/TT/04/23-24/3-2

Time Table: B.Tech III Year II Semester (B Sec)

DAY	9:30-10:20	10:20-11:10	11:20-12:10	12:10-1:00	1:00-1:40	1:40-2:25	2:25-3:10	3:15-4:00
MON	MEFA	DSP	WM/SE	CN	LUNCH	MWE	CRT-E	IPR
TUE	MWE	TSS/TV	DSP	WM/SE		MWE&DC/DSP LAB		
WED	MEFA	DSP	CN	TSS/TV		MWE&DC/DSP LAB		
THU	MWE	DSP	TSS/TV	WM/SE		CRT-C	CN	MEFA
FRI	CN	MEFA	MWE	TSS/TV		CRT-M	WM/SE	WM/SE
SAT	DSP	MWE	CN	TSS/TV		SDP	IPR	SPORTS/LIB

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3	**EC603PC**	COMPUTER NETWORKS(CN)	Dr.G.V.HARI PRASAD
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5	**EC621PE**	(PE-II)TELECOMMUNICATION SWITCHING SYSTEMS	Mr.B.NAGARAJU
	EC622PE	(PE-II) TELEVISION ENGINEERING	Ms.D.SHIRISHA
6	**CE612OE**	(OE-I)-WASTE MANAGEMENT	Mr.SK.REHMAN
	CS611OE	(OE-I)-SOFTWARE ENGINEERING	Mr.K.BIKSHAPATHI
7	**EC605PC**	MICROWAVE ENGINEERING AND DIGITAL COMMUNICATION LAB	Mrs.G.SHOBHA
8	**EC606PC**	DIGITAL SIGNAL PROCESSING LAB	Mr.B.NAGARAJU
9	**HS607MC**	INTELLECTUAL PROPERTY RIGHTS(IPR)	Mr.K.RAMAKRISHNA
10	**CRT-M**	CAMPUS RECRUITMENT MATHEMATICS	Dr.Y.HARIKRISHNA
11	**CRT-E**	CAMPUS RECRUITMENT ENGLISH	Mr.J.PURNA KUMAR
12	**CRT-C**	CAMPUS RECRUITMENT C LANGUAGE	Mr.B.ANAND KUMAR

III B.Tech. II Semester Academic Calendar		
I Spell Instruction	22.01.2024	16.03.2024
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Semester End Examinations (Theory & Practical's)	25.06.2024	20.07.2024

Academic Counselor	**Mr.B.Nagaraju** (9000170322)
CR's	**Chakilam.Sathwika**
	Thummepalli.Tharun

ROOM NUMBERS	Lecture Hall (E-309)	DSP Lab (E-401)	MWE & DC Lab (D-216)

Department of Electronics & Communication Engineering

Vision of the Institute

To be a premier Institute in the country and region for the study of Engineering, Technology and Management by maintaining high academic standards which promotes the analytical thinking and independent judgment among the prime stakeholders, enabling them to function responsibly in the globalized society.

Mission of the Institute

To be a world-class Institute, achieving excellence in teaching, research and consultancy in cutting-edge Technologies and be in the service of society in promoting continued education in Engineering, Technology and Management.

Quality Policy

To ensure high standards in imparting professional education by providing world-class infrastructure, top-quality-faculty and decent work culture to sculpt the students into Socially Responsible Professionals through creative team-work, innovation and research.

Vision of the Department

Our vision is to develop the department into a full-fledged center of learning in various fields of Electronics & Communication Engineering keeping in view the latest developments.

Mission of the Department

The Mission of the department is to turnout full-fledged Engineers in the field of Electronics Communication Engineering with an overall background suitable for making a successful career either in industry/research or higher education in India and abroad. To inculcate professional behavior, strong ethical values, innovative research capabilities and leadership abilities in the young minds so as to work with a commitment to the progress of the nation.

Department of Electronics & Communication Engineering

Program Educational Objectives (B.Tech)

Graduates will be able to

PEO1: Excel in professional career & higher education, by acquiring knowledge in related fields of Electronics & Communication Engineering.

PEO2: Exhibit leadership in their profession, through technological ability and contemporary knowledge for solving the real life problems appropriately that are technically sound, economically feasible & socially acceptable.

PEO3: Adapt to the emerging technologies for sustenance by exhibiting professionalism, ethical attitude & communication skills in their relevant areas of interest by engaging in lifelong learning.

Program Specific Outcome's

PSO1: Professional Skills: An ability to understand the basic concepts in Electronics & Communication Engineering and to applythemtovariousareas,likeElectronics,Communications,Signalprocessing, VLSI, Embedded systems etc., in the design and implementation of complex systems.

PSO2: Problem-Solving Skills: An ability to solve complex Electronics and communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions.

PSO3: Successful Career and Entrepreneurship: An understanding of social- awareness &environmental-wisdom along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an Entrepreneur.

Department of Electronics & Communication Engineering

Program Outcomes (B.Tech–ECE)

At the end of the Program, a graduate will have the ability to

PO1: An ability to apply Knowledge of mathematics, science, fundamentals of engineering to solve electronics and communication engineering problems.

PO2: An ability to identify, formulate and analyze and solve complex electronics and communication engineering using the first principles of mathematics and engineering science.

PO3: An ability to develop solutions to electronics and communication systems to meet the specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.

PO4: An ability to design and perform experiments of electronic circuits and systems, analyze and interpret data to provide valid conclusions.

PO5: An ability to learn, select and apply appropriate techniques, resources and modern engineering tools including prediction and modeling, to complex electronics and communication systems.

PO6: An ability to assess the knowledge of contemporary issues to the societal responsibilities relevant to the professional practice.

PO7: An ability to understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge for the need of sustainable development.

PO8: An ability to demonstrate the understanding of professional, ethical responsibilities and norms of engineering practice.

PO9: An ability to function effectively as an individual and as a member or leader in diverse teams and in multidisciplinary settings.

PO10: An ability to communicate effectively with engineering community and with society at large.

PO11: An ability to demonstrate knowledge and understanding of engineering and management principles and apply these to manage projects.

PO12: An ability to recognize the need for, and engage in lifelong learning in the broadest of technological change.

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COURSE OBJECTIVES

On completion of this Subject/Course the student shall be able to:

1. To understand characteristics of discrete time signals and systems
2. To analyze and process signals using various transform techniques
3. To understand various factors involved in design of digital IIR filters
4. To understand various factors involved in design of digital FIR filters
5. To understand multi rate digital signal processing.

COURSE OUTCOMES

The expected outcomes of the Course/Subject are:

6. Perform time frequency and Z transform analysis on signals and systems
7. Understanding the inter-relationship between DFT and various transforms
8. Understand the significance of various filter structures
9. Design a digital filter for a given specification.
10. Understand multi rate Digital signal processing

Signature of faculty

Note: Please refer to Bloom's Taxonomy, to know the illustrative verbs that can be used to state the outcomes.

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GUIDELINES TO STUDY THE COURSE/SUBJECT

Course Design and Delivery System (CDD):

- The Course syllabus is written into number of learning objectives and outcomes.
- Every student will be given an assessment plan, criteria for assessment, scheme of evaluation and grading method.
- The Learning Process will be carried out through assessments of Knowledge, Skills and Attitude by various methods and the students will be given guidance to refer to the text books, reference books, journals, etc.

The faculty be able to–

- Understand the principles of Learning
- Understand the psychology of students
- Develop instructional objectives for a given topic
- Prepare course, unit and lesson plans
- Understand different methods of teaching and learning
- Use appropriate teaching and learning aids
- Plan and deliver lectures effectively
- Provide feedback to students using various methods of Assessments and tools of Evaluation
- Act as a guide, advisor, counselor, facilitator, motivator and not just as a teacher alone

Signature of HOD

Signature of faculty

Date:

Date:

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COURSE SCHEDULE

The Schedule for the whole Course/Subject is:

S.No.	Description	Duration(Date)		Total No. of Periods
		From	To	
1.	**UNIT I: Introduction:** Introduction to Digital Signal Processing: Discrete time signals & sequences, linear shift invariant systems, stability, and causality. Linear constant coefficient difference equations. Frequency domain representation of discrete time signals and systems. Realization of Digital Filters: Review of Z-transforms, Applications of Z – transforms, solution of difference equations of digital filters, Block diagram representation of linear constant-coefficient difference equations, Basic structures of IIR systems, Transposed forms, Basic structures of FIR systems, System function,	22/01/2024	21/02/2024	21
2.	**UNIT II: Discrete Fourier Transform**: Properties of DFT, linear convolution of sequences using DFT, Computation of DFT. Overlap add method, Overlap save method Relation between Z-transform and DFT. Fast Fourier Transforms: Fast Fourier transforms (FFT) - Radix-2 decimation in time and decimation in frequency FFT Algorithms, Inverse FFT, and FFT with General Radix N	22/02/2024	05/03/2024	13
3.	**UNIT III IIR Digital Filters**: Analog filter approximations – Butter worth and Chebyshev, Design of IIR Digital filters from analog filters, Step and Impulse Invariant Techniques, Bilinear Transformation Techniques, Spectral transformation, Design Examples: Analog-Digital transformations.	06/03/2024	04/04/2024	16
4.	**UNIT IV FIR Digital Filters**: Characteristics of FIR Digital Filters, frequency response. Design of FIR Digital Filters using Window Techniques, Frequency Sampling technique, Comparison of IIR & FIR filters.	06/04/2024	25/04/2024	12
5.	**UNIT V: Multi-rate Digital Signal Processing:** Introduction, Down sampling, Decimation, Up sampling, Interpolation, Sampling Rate conversion, Conversion of Band Pass Signals, Applications of Multi-rate Digital Signal Processing.	27/04/2024	12/06/2024	12

Total No. of Instructional periods available for the course:

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SCHEDULE OF INSTRUCTIONS-COURSE PLAN

Unit No.	Lesson No.	Date	No. of Periods	Topics / Sub-Topics	Objectives & Outcomes Nos.	References (Textbook, Journal)
1	1	22-01-2024	1	Unit-1 introduction	1,1	Digital Signal Processing: by P. Ramesh Babu
	2	24-01-2024	1	Introduction to DSP	1,1	Digital Signal Processing: by P. Ramesh Babu
	3	25-01-2024	1	Classification of signals	1,1	Digital Signal Processing: by P. Ramesh Babu
	4	29-01-2024	1	Classification of systems	1,1	Digital Signal Processing: by P. Ramesh Babu
	5	30-01-2024	1	Operation on signals	1,1	Digital Signal Processing: by P. Ramesh Babu
	6	31-01-2024	1	Discrete time signals and sequences	1,1	Digital Signal Processing: by P. Ramesh Babu
	7	01-02-2024	1	Linear shift invariant systems	1,1	Digital Signal Processing: by P. Ramesh Babu
	8	03-02-2024	1	Stability of systems	1,1	Digital Signal Processing: by P. Ramesh Babu
	9	05-02-2024	1	Causality of systems	1,1	Digital Signal Processing: by P. Ramesh Babu
	10	06-02-2024	1	Linear constant coefficient difference equations	1,1	Digital Signal Processing: by P. Ramesh Babu
	11	07-02-2024	1	Frequency domain representation of discrete signals	1,1	Digital Signal Processing: by P. Ramesh Babu
	12	08-02-2024	1	Frequency domain representation of discrete signals	1,1	Digital Signal Processing: by P. Ramesh Babu
	13	09-02-2024	1	Review of Z-transforms	1,1	Digital Signal Processing: by P. Ramesh Babu
	14	12-02-2024	1	Applications of Z-transforms	1,1	Digital Signal Processing: by P. Ramesh Babu
	15	13-02-2024	1	Solution of difference equations of digital filters	1,1	Digital Signal Processing: by P. Ramesh Babu

	16	14-02-2024	1	Block diagram representation of linear constant coefficient difference equation	1,1	Digital Signal Processing: by P. Ramesh Babu
	17	15-02-2024	1	Basic structures of IIR filters	1,1	Digital Signal Processing: by P. Ramesh Babu
	18	17-02-2024	1	Basic structures of IIR filters	1,1	Digital Signal Processing: by P. Ramesh Babu
	19	20-02-2024	1	Types of IIR filters	1,1	Digital Signal Processing: by P. Ramesh Babu
	20	20-02-2024	1	Types of IIR filters	1,1	Digital Signal Processing: by P. Ramesh Babu
	21	21-02-2024	1	System function	1,1	Digital Signal Processing: by P. Ramesh Babu
2	22	22-02-2024	1	Unit –II Discrete Fourier transform	2,2	Digital Signal Processing: by P. Ramesh Babu
	23	22-02-2024	1	Properties of DFT	2,2	Digital Signal Processing: by P. Ramesh Babu
	24	24-02-2024	1	Linear convolution of sequences using DFT	2,2	Digital Signal Processing: by P. Ramesh Babu
	25	25-02-2024	1	Overlap save method	2,2	Digital Signal Processing: by P. Ramesh Babu
	26	27-02-2024	1	Overlap add method	2,2	Digital Signal Processing: by P. Ramesh Babu
	27	27-02-2024	1	Relation between Z-transform and DFT	2,2	Digital Signal Processing: by P. Ramesh Babu
	28	28-02-2024	1	Fast Fourier transform	2,2	Digital Signal Processing: by P. Ramesh Babu
	29	29-02-2024	1	Radix- 2 DIT algorithm	2,2	Digital Signal Processing: by P. Ramesh Babu
	30	01-03-2024	1	Radix-2 DIF algorithm	2,2	Digital Signal Processing: by P. Ramesh Babu
	31	02-03-2024	1	Inverse FFT	2,2	Digital Signal Processing: by P. Ramesh Babu
	32	02-03-2024	1	Time and Frequency Algorithms	2,2	Digital Signal Processing:

						by P. Ramesh Babu
	33	05-03-2024	1	FFT with Radix N	2,2	Digital Signal Processing: by P. Ramesh Babu
3	34	05-03-2024	1	Test on unit-2	3,3	Digital Signal Processing: by P. Ramesh Babu
	35	06-03-2024	1	Unit-III IIR Filters	3,3	Digital Signal Processing: by P. Ramesh Babu
	36	07-03-2024	1	Introduction to IIR filters	3,3	Digital Signal Processing: by P. Ramesh Babu
	37	11-03-2024	1	Difference between IIR and FIR filters	3,3	Digital Signal Processing: by P. Ramesh Babu
	38	12-03-2024	1	Difference between analog and digital filters	3,3	Digital Signal Processing: by P. Ramesh Babu
	39	12-03-2024	1	Analog filter approximations	3,3	Digital Signal Processing: by P. Ramesh Babu
	40	14-03-2024	1	Butterworth analog filter design steps	3,3	Digital Signal Processing: by P. Ramesh Babu
	41	16-03-2024	1	Problems on Butterworth analog filter	3,3	Digital Signal Processing: by P. Ramesh Babu
	42	23-03-2024	1	Chebyshev filter design steps	3,3	Digital Signal Processing: by P. Ramesh Babu
	43	26-03-2024	1	Problems on Chebyshev filter	3,3	Digital Signal Processing: by P. Ramesh Babu
	44	28-03-2024	1	Step and impulse invariant method introduction	3,3	Digital Signal Processing: by P. Ramesh Babu
	45	30-03-2024	1	Designing steps of impulse invariance method	3,3	Digital Signal Processing: by P. Ramesh Babu
	46	02-04-2024	1	Bilinear transformation method design	3,3	Digital Signal Processing: by P. Ramesh Babu
	47	02-04-2024	1	Problems on Bilinear transformation method	3,3	Digital Signal Processing: by P. Ramesh Babu
	48	03-04-2024	1	Spectral transformation	3,3	Digital Signal Processing: by P. Ramesh Babu
	49	04-04-2024	1	Design examples : analog digital transformation	3,3	Digital Signal Processing: by P. Ramesh Babu

	50	04-04-2024	1	Test on unit-3	3,3	Digital Signal Processing: by P. Ramesh Babu
4	51	06-04-2024	1	Unit-IV FIR digital filters	4,4	Digital Signal Processing: by P. Ramesh Babu
	52	10-04-2024	1	Characteristics of FIR filters	4,4	Digital Signal Processing: by P. Ramesh Babu
	53	15-04-2024	1	Frequency response	4,4	Digital Signal Processing: by P. Ramesh Babu
	54	16-04-2024	1	Design of FIR digital filters using window techniques	4,4	Digital Signal Processing: by P. Ramesh Babu
	55	18-04-2024	1	Rectangular window	4,4	Digital Signal Processing: by P. Ramesh Babu
	56	19-04-2024	1	Hamming window	4,4	Digital Signal Processing: by P. Ramesh Babu
	57	20-04-2024	1	Hanning Window	4,4	Digital Signal Processing: by P. Ramesh Babu
	58	20-04-2024	1	And some other window techniques	4,4	Digital Signal Processing: by P. Ramesh Babu
	59	22-04-2024	1	Frequency sampling techniques	4,4	Digital Signal Processing: by P. Ramesh Babu
	60	23-04-2024	1	Frequency sampling techniques	4,4	Digital Signal Processing: by P. Ramesh Babu
	61	24-04-2024	1	Comparison of IIR and FIR filters	4,4	Digital Signal Processing: by P. Ramesh Babu
	62	25-04-2024	1	Some examples problems on window techniques	4,4	Digital Signal Processing: by P. Ramesh Babu
5	63	27-04-2024	1	Unit-V Multi rate DSP	5,5	Digital Signal Processing: by P. Ramesh Babu
	64	30-04-2024	1	Single and multi-rate DSP	5,5	Digital Signal Processing: by P. Ramesh Babu
	65	30-04-2024	1	Downsampling	5,5	Digital Signal Processing: by P. Ramesh Babu
	66	01-05-2024	1	How Downsampling is related to decimation	5,5	Digital Signal Processing: by P. Ramesh Babu

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	67	03-05-2024	1	Upsampling	5,5	Digital Signal Processing: by P. Ramesh Babu
	68	04-05-2024	1	How upsampling is related to interpolation	5,5	Digital Signal Processing: by P. Ramesh Babu
	69	06-05-2024	1	Sampling rate conversion	5,5	Digital Signal Processing: by P. Ramesh Babu
	70	07-05-2024	1	Conversion of band pass signals	5,5	Digital Signal Processing: by P. Ramesh Babu
	71	07-05-2024	1	Applications of multirate DSP	5,5	Digital Signal Processing: by P. Ramesh Babu
	72	08-05-2024	1	Problems on decimation and interpolation	5,5	Digital Signal Processing: by P. Ramesh Babu
	73	11-06-2024	1	Revision	5,5	Digital Signal Processing: by P. Ramesh Babu
	74	12-06-2024	1	Revision	5,5	Digital Signal Processing: by P. Ramesh Babu

Signature of HOD

Signature of faculty

Date:

Date:

Note:

1. Ensure that all topics specified in the course are mentioned.
2. Additional topics covered, if any, may also be specified in bold.
3. Mention the corresponding course objective and outcome numbers against each topic.

Department of Electronics & Communication Engineering

LESSON PLAN (U-I)

Lesson No: 3& 4 Duration of Lesson: 1hr 20Min

Lesson Title: Linear constant coefficient difference equation

Instructional/Lesson Objectives:

On completion of this lesson the student's hall is able to:

- Understand discrete signals.
- To make the students understand about difference equations
- To familiarize about the forced and natural response of the system

Teaching AIDS : PPTs, Digital Board
Time Management of Class :

5 mins for taking attendance 90m in for the lecture delivery 5 min for doubts session

Assignment/ Questions:

Draw the magnitude and phase plot of y(n)-5y(n-1)+6y(n-2)=x(n) if x(n) is a unit step signal and y(n) is the output..(Obj;-1Out;-1)

Refer assignment–I & tutorial-I sheets

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Department of Electronics & Communication Engineering

LESSON PLAN (UNIT-II)

Lesson No: 4& 5 Duration of Lesson: 1hr 20Min

Lesson Title: Fast Fourier transforms

Instructional/Lesson Objectives:

On completion of this lesson the student's hall is able to:

- Understand butterfly diagrams.
- To make the students understand DFT and IDFT
- To familiarize about the DIT and DFT algorithms

Teaching AIDS : PPTs, Digital Board
Time Management of Class :

5 mins for taking attendance 5 mins for revision of previous class 85 min for lecture delivery 5 min for doubt session

Assignment/ Questions:
To find the DFT and IDFT of the given sequence. (Obj; 2, Out;-2)
Refer assignment–II & tutorial-II sheets

Signature of faculty

Department of Electronics & Communication Engineering

LESSON PLAN (U-III)

Lesson No: 4& 5 Duration of Lesson: 1hr 20Min

Lesson Title: IIR filters

Instructional/Lesson Objectives:

On completion of this lesson the student's hall is able to:

- Understand analog filters and digital filters.
- Various designing steps of analog filters
- Converters of analog to digital filters

Teaching AIDS : PPTs, Digital Board
Time Management of Class :

5min.: Taking attendance
10min.: Recollecting the contents of previous class.
55 min.: Explain the designing steps of analog filters.
10min.: Doubts clarification and Review of the class.

Assignment/ Questions:

Design steps of analog Butterworth filters (Obj;-3Out;-3)
Refer assignment–III & tutorial-III sheets

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LESSON PLAN (U-IV)

Lesson No: 6,7 Duration of Lesson:1hr30 Min

Lesson Title: FIR Filters

Instructional/Lesson Objectives:

On completion of this lesson the student's hall is able to:

1. Design of filters using window techniques.
2. Comparison of IIR and FIR filters.

Teaching AIDS : PPTs, Digital Board
Time Management of Class :

5min.: Taking attendance
15 min.: Recollecting the contents of previous class.
60min.: Explain about window techniques.
10min.: Doubts clarification and Review of the class.

Assignment/ Questions:
Problems on window techniques (Obj;-4 Out;-4)
Refer assignment–IV & tutorial- IV sheets

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LESSON PLAN (U-V)

Lesson No: 01, 02 Duration of Lesson: 1hr 30Min

Lesson Title: Multirate DSP

Instructional/Lesson Objectives:

On completion of this lesson the student's hall is able to:

1. Up sampling and down sampling

2. Sample rate conversion.

Teaching AIDS : PPTs, Digital Board
Time Management of Class :

5min.: Taking attendance 15 min.: Recollecting the contents of previous class. 60min.: Explain about Sample rate conversion. 10min.: Doubts clarification and Review of the class.

Assignment/ Questions:
Sample rate conversion by I/D factor (Obj;-5 Out;-5)
Refer assignment–V & tutorial- V sheets

Signature of faculty

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Department of Electronics & Communication Engineering

ASSIGNMENT–1

This Assignment corresponds to Unit No.1

Question No.	Question	Objective No.	Outcome No.
1	Examine the following system y(n)=x(n)+nx(n-1) and determine whether the system is i) static ii) Linear iii) Time variant iv) stabl	1	CO1
2	Draw the magnitude and phase plot of y(n)-5y(n-1)+6y(n-2)=x(n) if x(n) is a unit step signal and y(n) is the output.	1	CO1

Signature of HOD

Date:

Signature of faculty

Date:

Department of Electronics & Communication Engineering

ASSIGNMENT–2

This Assignment corresponds to Unit No.2

Question No.	Question	Objective No.	Outcome No.
1	Using linear convolution find y(n)=x(n)*h(n) for the sequences x(n)=(1,2,-1,2,3,-2,-3,-1,1,1,2,-1) and h(n)=(1,2), compare the problem using overlap save method and overlap add method.	2	2
2	Compute the 16 point DFT of the sequence.	2	2

Signature of HOD
Date:

Signature of faculty
Date:

Department of Electronics & Communication Engineering

ASSIGNMENT–3

This Assignment corresponds to Unit No.3

Question No.	Question	Objective No.	Outcome No.
1	Write a brief note about IIR Filters.	3	3
2	Design 8 bit DIF algorithm.	3	3

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Date:

Department of Electronics & Communication Engineering

ASSIGNMENT–4

This Assignment corresponds to Unit No.4

Question No.	Question	Objective No.	Outcome No.
1	Design a high pass filter with Hamming window with a cut off frequency of 1.2 rad/sec, N=9 and realise with direct form-II.	4	4
2	Design and ideal band pass filter with Hd(e^jw)=1 for π/2<=w<=3π/4 =0 otherwise Using rectangular window for N=5	4	4

Signature of HOD

Signature of faculty

Date:

Date:

Department of Electronics & Communication Engineering

ASSIGNMENT–5

This Assignment corresponds to Unit No.5

Question No.	Question	Objective No.	Outcome No.
1	Illustrate the decimation process with a factor of D and derive the expression for spectrum of decimator output.	5	5
2	Consider the signal x (n) = a"u(n), for lal < 1 i) Determine the spectrum of the signal. ii) Determine the spectrum of the signal if it is applied to an interpolator that increases the sampling rate by 2.	5	5

Signature of HOD

Date:

Signature of faculty

Date:

DepartmentofElectronics&CommunicationEngineering

TUTORIAL– 1

This tutorial corresponds to Unit No.1 (ObjectiveNos.1, OutcomeNos.1)

1. Draw the block diagram of DSP
2. What is time reversal property.
3. Sketch the continuous time signal x(t)=2e^-2t for an interval 0≤t≤2. sample the continous time signal with a sampling period T=0.2 sec and sketch the discrete signal.
4. Build the direct form-II realization of the system described by difference equation y(n)= - 13/12 y(n-1)-9/24y(n-2)-1/24y(n-3)+x(n)+4x(n-1)+3x(n-2).
5. Explain about the discrete Fourier and write linearity and time shifting properties.

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Date:

Signature of faculty

Date:

DepartmentofElectronics&CommunicationEngineering

TUTORIAL– 2

This tutorial corresponds to Unit No.2 (ObjectiveNos.2, OutcomeNos.2)

1. What is zero padding?
2. Write the equations of N-point DFT and IDFT of the sequence x(n) and X(k). Compute 4-point DFT of a sequence x(n)={0,2,4,6} and IDFT of the sequence Y(K)={1,0,1,0}.
3. Explain the relation between Z transform and DFT?
4. write about Radix-2 decimation and what is the direct evaluation of DFT.
5. Compute the 8 point DIT FFT algorithm with radix-2 with neat steps.

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DepartmentofElectronics&CommunicationEngineering

TUTORIALSHEET– 3

This tutorial corresponds to Unit No.3 (ObjectiveNos.3, OutcomeNos.3)

1. Compare digital and analog filters?
2. What is meant by frequency wrapping?
3. Compare IIR and FIR filters.
4. Explain in detail about the steps to design an analog butterworth and chebyshey low pass filter.
5. Using impulse invariance with T=1sec determine the H(Z) if H(s)=1/(s2+root 2+1)

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TUTORIAL– 4

This tutorial corresponds to Unit No.4 (ObjectiveNos.3, OutcomeNos.3)

1. Explain in detail about the deisgn of FIR digital filters using window techniques
2. Design the symmetric FIR LPF whose

   Hd(w) = $_e$-jwτ , |w|≤wc ,

   0 , otherwise

   With M=7 and wc=1 rad/sec using rectangular window .
3. Design a low pass filter using Hanning window with cutoff frequency of 0.9 rad/sec and N=6. Draw the filter structure and plot its spectrum?
4. Design a ideal high pass filter with Hd(ejw) = 1 for $\pi/4 \le w \le \pi$ using hamming window N=11

   = 0 for $w \le \pi/4$
5. i) Design a HPF with hamming window with a cut off frequency of 1.2 rad/sec, N=9 and realize with the direct form -II .

   ii) Explain the various window functions used in the design of the FIR filters with neat schematics.

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Department of Electronics & Communication Engineering

TUTORIALSHEET– 5

This tutorial corresponds to Unit No.5 (ObjectiveNos.5, OutcomeNos.5)

1. Explain in detail the spectrum of up sampling and down sampling with necessary expressions.
2. Illustrate the interpolation process with a factor of I and derive the expression for spectrum of interpolator output.
3. Explain the effect of aliasing in decimation with the frequency spectrum and discuss how the aliasing can be eliminated
4. What are difference between decimation and interpolation with neat diagrams?
5. Illustrate the decimation process with a factor of D and derive the expression for spectrum of decimator output.

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Department of Electronics & Communication Engineering

EVALUATION STRATEGY

Target(s)

a. Percentage of Pass :90%

COURSEPLAN&CONTENTDELIVERY:

- ICT class
- Solving exercise problems
- Model questions

Assessment Method(s) (Maximum Marks for evaluation are defined in the Academic Regulations)

a. Daily Attendance
b. Assignments
c. Online Quiz (or)Seminars
d. Continuous Internal Assessment
e. Semester /End Examination

List out any new topic(s) or any innovation you would like to introduce in teaching the subjects in this semester

Case Study of any one existing application

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COURSECOMPLETIONSTATUS

Actual Date of Completion & Remarks if any

Units	Remarks	Objective No. Achieved	Outcome No. Achieved
Unit-1	completed on 21.02.2024	1	1
Unit-2	completed on 05.03.2024	2	2
Unit-3	completed on 04.04.2024	3	3
Unit-4	completed on 25.04.2024	4	4
Unit-5	completed on 12.06.2024	5	5

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Date:

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Mappings

1. Course Objectives-Course Outcomes Relationship Matrix

Course-Outcomes / Course-Objectives	1	2	3	4	5
1	3				
2		3			
3			3		
4				3	
5					3

2. Course Outcomes-Program Outcomes(POs) & PSOs Relationship Matrix

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	PO12
CO1	H	H								M	M	M
CO2	H	H								M	M	M
CO3	H	M	M	M							M	
CO4	H	M	M	M							M	
CO5					M	M	M			H	H	M

H-HIGH M-MEDIUM L-LOW

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III B.TECH VI SEMESTER I MID EXAMINATIONS - MARCH 2024

Branch : B.Tech. (ECE) | **Subject : DIGITAL SIGNAL PROCESSING,EC604PC** | **Max. Marks : 20M**
Date : 19.03.2024 AN | **Time : 90 Minutes**

PART - A

ANSWER ALL THE QUESTIONS. **5 X 1M = 5M**

Q.No	Question	CO	BTL
1.	Define static and dynamic system.	CO-1	1
2.	Sketch the continous thime signal x(t)=2e^-2t for an interval 0t2. sample the continous time signal with a sampling period T=0.2 sec and sketch the discrete signal.	CO-1	2
3.	What is zero padding?	CO-2	1
4.	Explain the relation between Z transform and DFT?	CO-2	2
5.	Compare digital and analog filters?	CO-3	1

PART - B

ANSWER ALL THE QUESTIONS. **3 X 5M = 15M**

Q.No	Question	CO	BTL
6.	Explain about the discrete fourier and write linearity and time shiffting properties.	CO-1	2
	OR		
7.	Find the natural response of the system described by difference equation y(n)+2y(n-1)+y(n-2)=x(n)+x(n-1) with initial condition y(-1)=y(-2)=1	CO-1	2
8.	Compute the 8 point DIT FFT algoritm with radix-2 with neat steps.	CO-2	2
	OR		
9.	Compute 4-point DFT of a sequence x(n)={0,2,4,6} and IDFT of the sequence Y(K)={1,0,1,0}.	CO-2	3
10.	compare IIR and FIR filters.	CO-3	2
	OR		
11.	List the different methods that can be used to convert an analogue filter into its digital equivalent	CO-3	2

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III B.TECH VI SEMESTER II MID EXAMINATIONS - JUNE 2024

Branch : B.Tech. (ECE) **Max. Marks : 20M**
Date : 19-Jun-2024 **Session : Afternoon** **Time : 90 Min**
Subject : DIGITAL SIGNAL PROCESSING,EC604PC

PART - A

ANSWER ALL THE QUESTIONS **5 X 1M = 5M**

Q.No	Question	CO	BTL
1.	What are the features of FIR filters	CO3	L1
2.	List the different types of window techniques.	CO4	L1
3.	Write about linear phase FIR Filters.	CO4	L1
4.	What is sampling rate and sampling process.	CO5	L1
5.	Write the equation for frequency response of down sampling.	CO5	L1

PART - B

ANSWER ALL THE QUESTIONS **3 X 5M = 15M**

Q.No	Question	CO	BTL
6.	Apply bilinear transformation to transfer function H(s)= 2/((s+1)(s+2)) with T=1sec and Find H(z).	CO3	L3
	OR		
7.	Explain in detail about the steps to design an analog butterworth and chebyshey low pass filter.	CO3	L2
8.	Design a HPF with hamming window with a cut off frequency of 1.2 rad/sec , N=9 and realise with the direct form -II .	CO4	L3
	OR		
9.	Design a low pass filter using Hanning window with cutoff frequency of 0.9 rad/sec and N=6 . Draw the filter structure and plot its spectrum?	CO4	L3
10.	Illustrate the interpolation process with a factor of I and derive the expression for spectrum of interpolator output.	CO5	L3
	OR		
11.	consider the signal X(n)=a^n u(n), for lal<1. i) determine the spectrum of the signal . ii) determine the spectrum of the signal if it is applied to an interpolator that increases the sampling rate by 2.	CO5	L3

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Ananthagiri (V&M), Suryapet (Dt)

A+ GRADE ACCREDITED BY NAAC NATIONAL ASSESSMENT AND ACCREDITATION COUNCIL

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Direct Assessment: Micro Analysis for Internal Exams	**Academic Year :** 2023-2024	**Batch : 21-25**
Course Name :DIGITAL SIGNAL PROCESSING	**Course code : EC604PC**	**MID :** I
Faculty Name : : Mrs.V.Kalyani	**Year /Semester :** III/II	**Section : ECE-A**

S.No.	Hall ticket No.	Name of the Student	SHORT ANSWER QUESTIONS					LONG ANSWER QUESTIONS						Assignment	Total
			Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11		
1	19C11A0422	M.MOUNIKA	1	1	1	1	1		5	4	5	5		5	25
2	20C11A0427	G. MAHESH KUMAR													0
3	21C11A0402	AKHIL SAI KORLAPTI	0.5				0.5		2	4		4		5	16
4	21C11A0403	ANIL SIRAMSETTI	0	0			0		2	5		4	5	5	17
5	21C11A0404	ANIL BORRA	0.5	0		0	0.5	5	5	5		5		5	21
6	21C11A0405	ANUSHA THURAKA	1	1	0	0	1	5		5	2	5		5	23
7	21C11A0406	ARCHITHA REDDY MANDADI	1	0.5	0	0.5	1		5	5		5		5	23
8	21C11A0407	ASIF SAYED	0.5	1	1	0.5	1		5	5		5		5	24
9	21C11A0408	ASRA BEGUM SHEK	1	0.5	0	0.5	1		5	5		5		5	23
10	21C11A0410	BALAJI UTHARADHI	0.5		1	0	1		4		2	4		5	18
11	21C11A0411	BALAJI NIKAM	1	0.5	1	0.5	1		4	5		5		5	23
12	21C11A0412	BANGARU BABU BHUKYA	0	0	0	0	0.5		4	0	2	4		5	16
13	21C11A0413	BHANU PRAKASH. CH	0.5	0		0	0		5	5	2	4		5	20
14	21C11A0415	BHARGAV AKULA	1	0.5	1	0	1		5		0	5		5	19
15	21C11A0416	BHAVANA GOUD BANDI	0	0	0.5	0	0.5		2	4	2	4		5	16
16	21C11A0417	BHAVANA SATHULURI	0.5	0.5	0	0.5	1		5	5		5		5	23
17	21C11A0418	BHAVANI ELAVALA	1	1	1	0.5	1		5	5		5		5	25
18	21C11A0419	BHAVYA SRI VANGAVETI	1	0.5	0	0.5	1		4.5		5	5		5	23
19	21C11A0420	CHAITANYA KARNATI	1	0	1	0.5			5	5		5		5	23
20	21C11A0421	CHAKRADHAR SAI .P					1		2	4		3		5	15
21	21C11A0422	CHARAN CHENNOJU	0		0					2		4			6
22	21C11A0423	CHETAN SAI GAVINI				0	0.5		4	5		5		5	20
23	21C11A0424	DEEPAK JUPUDI	1	1	0	1	1		5	5		5		5	24
24	21C11A0425	DEVIKA BOMMU	1	1	1	0.5	1		5	5		5		5	25
25	21C11A0426	DHANUSH TANNEERU								3		2		5	10
26	21C11A0428	DRAKSHAYANI VEMULA	1	0.5	0		1		5	5		5		5	23

Department of Electronics & Communication Engineering

27	21C11A0429	DURGA BHAVANI .D	1	0.5	0		1		2			5		5	15
28	21C11A0430	GEETHANJALI BORRA	0.5		0				2	4		4		5	16
29	21C11A0431	GNANESHWAR KOSURU	1	1	1	0	1		5	5		5		5	24
30	21C11A0432	GOPIRAJU GAVINI	1	0.5	0		1		2	5		5		5	20
31	21C11A0433	INDRASENA REDDY. K	0.5	0	0	0	0.5		5		2	5		5	18
32	21C11A0434	JARINA BEGAM SHAIK		0	0		0.5		2	5		3		5	16
33	21C11A0435	KALYAN PAMULAPARTHI	0	1	0	0						5		5	11
34	21C11A0436	KARISHMA SHAIK	1	1	1	1	1		5	5		5		5	25
35	21C11A0438	KAVYA BOLLA	1	1	1	0.5	1		5	5		5		5	25
36	21C11A0440	LAHARI DEVINENI	1	1	1	0.5	1		5	5	3	5		5	25
37	21C11A0441	LAVANYA KASARLA	0.5	0	0	0	0.5		3	5		5		5	19
38	21C11A0442	LIKHITH KUMAR . S	0.5		0		1		2	5		4		5	18
39	21C11A0443	LOKESH THUMMA	0.5	1	1	0.5	1		5	5		5		5	24
40	21C11A0444	MAHENDER REDDY. V	1		0	0	1		2		2	4		5	15
41	21C11A0445	MANOHAR KOMMINENI		0.5					5	5		5		5	21
42	21C11A0446	MANOJ KUMAR KOLA	0.5	0	0	0	0.5		2		2	4		5	14
43	21C11A0447	MANOJ SAI KETHAM								5		3		5	13
44	21C11A0449	NARESH REDDY BEDEDALA			0		1		3		2	4		5	15
45	21C11A0450	NASEERUDDIN BABA .SK							3	4		4		5	16
46	21C11A0451	NAVEEN REDDY. S	0.5	0	0		1		3			4		5	14
47	21C11A0452	NAVEEN YARASANGI	0.5	0.5	0	0	0		**5**	0		3		5	14
48	21C11A0453	NAVYA VURUKONDA	1	0.5	0	1	1	5	3	5		5		5	24
49	21C11A0454	NAVYASRI POTLAPALLI	1		1	0.5	0		5	4			5	5	22
50	21C11A0455	NAZIYA BUSHRA SHAIK	0.5			0	1		3	2		5		5	17
51	21C11A0456	NITHIN REDDY .B	0	0	0	0					2	3		5	10
52	21C11A0457	POOJITHA ANANTHU	1	1	1	0.5	1		5	5		5		5	25
53	21C11A0458	PRASANNA KUMAR .M	0.5	0.5	0		0		4	3		4		5	17
54	21C11A0459	PRAVEEN REDDY. K					0		3	5		4		5	17
55	21C11A0460	PRIYA P	1	1	1	0.5	0.5		3		2		3	5	17
56	21C11A0461	RAGHUVEER.N			1		0.5		2	5		5		5	19
57	21C11A0463	RAKESH BORRA	1	1		0	1		5			4		5	17
58	21C11A0465	RAKESH MESHAM	1	1	1	1	1	5	5	5		5		5	25
59	21C11A0466	RAM KUMAR ANASURI	0	0		0	0.5		2		2	4		5	14
60	21C11A0467	RAMA KRISHNA REDDY .A	0	0	0	0	0.5		2			4		5	12
61	21C11A0468	RAMAKRISHNA. M	0	0	0	0	0.5		3.5	5		4		5	18

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Direct Assessment: Micro Analysis for Internal Exams	**Academic Year** : 2023-2024	**Batch : 21-25**
Course Name :DIGITAL SIGNAL PROCESSING	**Course code : EC604PC**	**MID** : I
Faculty Name : : Mrs.V.Kalyani	**Year /Semester :** III/II	**Section : ECE-B**

S. No.	Hall ticket No.	Name of the Student	SHORT ANSWER QUESTIONS					LONG ANSWER QUESTIONS						Assignment	Total
			Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11		
1	21C11A0469	RAMASRI CHIMATA	0	0.5	0		0		4	3.5		5		5	18
2	21C11A0470	ROSHINI REDDYMALLA	1	0.5	0	1	1	5	3	4	2	5		5	23
3	21C11A0471	RUSHITHA TUMURUGOTI		0.5	0		0.5		4.5	4.5		5		5	20
4	21C11A0472	SAI GOWTHAM VARMA BADE	1	0.5	0	1	0.5		5	5	5	5		5	23
5	21C11A0473	SAI MADHULATHA PAIDIMARRI	0.5		0	0	0	5	5	5		5		5	21
6	21C11A0474	SAI MADHURI RAGAM	0.5		1		0.5		4	5				5	16
7	21C11A0475	SAIDA KASIM SHAIK	0		0		0	2		4		5		5	16
8	21C11A0476	SAIDEEPA BANOTHU	1	1	0		1		5	5		5		5	23
9	21C11A0477	SAIKIRAN CHINTALA	0	1	0	0	0.5		5	5		5		5	22
10	21C11A0478	SAIKRISHNA VADAKOPULA													0
11	21C11A0479	SAMEENA SHAIK	1	1	0	0	0.5		5		3	5		5	21
12	21C11A0480	SAMEER SHAIK	0	0	0	0	0		5	5		5		5	20
13	21C11A0481	SAMEER AHMED SHAIK							3		2	5		5	15
14	21C11A0482	SANDEEP RANGISETTI	1	1	0	0.5	1	4	4	5		5		5	23
15	21C11A0483	SANDHYA DARA	1	0.5	0.5	0	0	5			2	5		5	19
16	21C11A0484	SATHWIK VORUGANTI	1	1	0	0.5	0.5	5			5	5		5	23
17	21C11A0485	SATHWIKA CHAKILAM	1	1	0	1	1		5	5	4	5		5	24
18	21C11A0486	SATYANARAYANA. A	1	0.5	0	0	0.5			5		5		5	17
19	21C11A0487	SHAREEF SHAIK							2		2	5		5	14
20	21C11A0488	SHIVA BARI	0.5	0.5	0	0	0.5		5	5		4		5	21
21	21C11A0490	SHIVANI GUDISE	0.5	0.5	0	0	0	3	3	3		4		5	16
22	21C11A0492	SHIVASAI BARMAVATH	0.5	0.5	0	0	1	4	3	3	2	5		5	19

23	21C11A0493	SRAVYA GOVINDU		0.5	0		0.5	4		4	2	3		5	17
24	21C11A0494	SRI SAI SRINIVASA PANINDRA. P	1	1	0	1	1		5		5	5		5	24
25	21C11A0495	SRI SAILAJA PASUPULETI	0	1	1	1	1		5	5	2	5		5	24
26	21C11A0496	SRIDHAR BOILLA	0.5	1	0	0.5	1		4.5		4.5	5		5	22
27	21C11A0497	SRIKANTH MUNAGA	1		0	0			2	5		4		5	17
28	21C11A0498	SRIRAM NANDIGAMA							2	4		4		5	15
29	21C11A0499	SUJITH KUMAR BOGOJU							2			4		5	11
30	21C11A04A0	SUNIL PATHANAPU	0	0.5	0	0	0	2		4	2	4		5	16
31	21C11A04A1	SUSHMA THOKALA	0.5	0.5	0	0	1		5	5	2	5		5	22
32	21C11A04A2	TAGORE KHANNA .S	1	0.5	0	0.5	1		2	5		3		5	18
33	21C11A04A3	THAMRIN SHAIK	1	1	1	0	1		5		3	5		5	22
34	21C11A04A4	THARUN THUMMEPALLI	1		0	0	1		2	5		4		5	18
35	21C11A04A5	UMA MAHESWARI BATHULA	0	0.5	0	0	0.5		5	0		5		5	16
36	21C11A04A6	USHA SRI PATTHIPATI	1	1	0.5	0.5	1		5		2	5		5	21
37	21C11A04A7	VAHINI CHOWDARY . K	0		0					0	2	4		5	11
38	21C11A04A8	VAMSHI BOLLEPALLI	1	0	0	0	0.5		4	5		4		5	20
39	21C11A04A9	VARSHITHA KOMMAINENI	0	0.5	0	0	0		4	5	2	4		5	19
40	21C11A04B0	VARUN KUMAR KARNIKANTI	1	0.5	0.5	0.5	1	5	5		5	5		5	24
41	21C11A04B1	VEERAVENKATA SATYASAI BALAKRISHNA PRASAD P	1	1	1	1	1		5		5	5		5	25
42	21C11A04B5	VENKAT REDDY .K	0.5		1		0.5		2	4		4		5	17
43	21C11A04B6	VENKAT SAI VALLURI													0
44	21C11A04B7	VENKATESH MOGARALA	0	0.5	0	0.5	1		2	2		5		5	16
45	21C11A04B9	VENKATESH KALVAKUNTLA	1		0		0			4		3			8
46	21C11A04C0	VENNELA EATUKURI	1	1	1	1	1	2	5		2	5		5	22
47	21C11A04C1	VIGNESHWAR REDDY . P	0	0.5	0	0	0.5		2	5		5		5	18
48	21C11A04C2	VIGNESHWAR REDDY POSHAM	0.5	0	0		0		5	5		5		5	21
49	21C11A04C3	VIJINITH UPPALA	0.5	0	0	0	0.5		4	5		5		5	20
50	21C11A04C4	VIKAS MAMIDI							2	5	2	2		5	14
51	21C11A04C5	VILASH GARA	0		0	0	1		2	5		4.5		5	18
52	21C11A04C6	VINAY REDDY SAMA	0.5	1	0	0			5	5		5		5	22
53	21C11A04C7	VINITHA KANDULA				0	1	3	2	5		5		5	19
54	21C11A04C8	VIVEK VALLAPU	1	0.5	0	0	1		5	3		4		5	20
55	21C11A04C9	YASHWASRI KOTHA	0		0		1				2	4		5	12

56	22C15A0401	ASRITHA.PONNA	0.5		0	0	1		3	5		4		5	19
57	22C15A0402	LAHARI.BATTU		1	0	0.5	1		5	5		5		5	23
58	22C15A0403	NIKHIL.KURDULA			0	0	1		2	5		5		5	18
59	22C15A0404	NIKHIL.SIRIPURAM	1	1	0		1		2		3	5		5	18
60	22C15A0405	SAI MAHESH.YERRAMSETTI	1	1	0	1	1		5		5	5		5	24
61	22C15A0407	TRIVENI.ERUGU		1				3	2	5		5		5	19
62	22C15A0408	VENKATA SAI JASWANTH.B			0					4		5		5	14
63	22C15A0409	YASHWANTH.VEGGALAM	1	0.5	0	0	0.5		5	5		5		5	22
64	19C11A0422	M.MOUNIKA	1	1	1	1	1		5	4	5	5		5	25

Department of Electronics & Communication Engineering

ANURAG Engineering College

(An Autonomous Institution)

(Approved by AICTE, NewDelhi, Permanently Affiliated to JNTUH, Hyd)

Ananthagiri (V&M), Suryapet (Dt)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Direct Assessment: Micro Analysis for Internal Exams	**Academic Year :** 2023-2024	**Batch : 21-25**
Course Name :DIGITAL SIGNAL PROCESSING	**Course code : EC604PC**	**MID :** II
Faculty Name : : Mrs.V.Kalyani	**Year /Semester :** III/II	**Section : ECE-A**

S.No.	Hall ticket No.	Name of the Student	SHORT ANSWER QUESTIONS					LONG ANSWER QUESTIONS						Assignment	Total
			Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11		
1	19C11A0422	M.MOUNIKA	1	1	1	1	0.5	5		5		5		5	25
2	20C11A0427	G. MAHESH KUMAR													0
3	21C11A0402	AKHIL SAI KORLAPTI	0.5	1		1	1		5	2		3		5	19
4	21C11A0403	ANIL SIRAMSETTI	0	1		0.5	0	5		2		2		5	16
5	21C11A0404	ANIL BORRA	1	1	1	1	0	5		5		3		5	22
6	21C11A0405	ANUSHA THURAKA	1	1	1	1	1	5		2	1	2	3	5	20
7	21C11A0406	ARCHITHA REDDY MANDADI	1	1	0.5	1	1	5		2		5		5	22
8	21C11A0407	ASIF SAYED	1	1	1	1	1	5	5	2		5		5	22
9	21C11A0408	ASRA BEGUM SHEK	1	1	1	1	1		5	0.5	0.5	5		5	21
10	21C11A0410	BALAJI UTHARADHI	1	1	0.5	0.5	0	5		1		4		5	18
11	21C11A0411	BALAJI NIKAM	1	1	0.5	1		5		5		5		5	24
12	21C11A0412	BANGARU BABU BHUKYA	0.5	0.5	0.8	1	0		4		2	0.5		5	14
13	21C11A0413	BHANU PRAKASH. CH	1	1	0	0	1	5				2	0.5	5	15
14	21C11A0415	BHARGAV AKULA	1	1	0.5	1		4.5	5		2	5		5	21
15	21C11A0416	BHAVANA GOUD BANDI	0.5	1	0	1	0	5		0.5			0.5	5	14
16	21C11A0417	BHAVANA SATHULURI	1	1	0	1	1	5	5		5			5	19
17	21C11A0418	BHAVANI ELAVALA	1	1	0.5	1	1	5	5	5		5		5	25
18	21C11A0419	BHAVYA SRI VANGAVETI	1	1	1	1	1	5		5	3		5	5	25
19	21C11A0420	CHAITANYA KARNATI	1	1	1	1	1	5		2		5		5	22
20	21C11A0421	CHAKRADHAR SAI .P	0.5	1	0.5	0.5	0.5	5		1			4	5	18
21	21C11A0422	CHARAN CHENNOJU	1	1		0.5			1		2			5	11

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22	21C11A0423	CHETAN SAI GAVINI	0	1	0	1	0.5		5		1		5	5	19
23	21C11A0424	DEEPAK JUPUDI	1	1	0.5	1	1	3	5	5	3	5		5	25
24	21C11A0425	DEVIKA BOMMU	1	1	1	1	1	5		1	5		5	5	25
25	21C11A0426	DHANUSH TANNEERU	1	1	1	1	0	5				3		5	17
26	21C11A0428	DRAKSHAYANI VEMULA	1	1	1	1	1	5			2	4		5	21
27	21C11A0429	DURGA BHAVANI .D	1	1	1	1	1	5	5		2	5	3	5	22
28	21C11A0430	GEETHANJALI BORRA						4.5				3		0	8
29	21C11A0431	GNANESHWAR KOSURU	1	1		1		5			5	5		5	23
30	21C11A0432	GOPIRAJU GAVINI	1	1	0.5	1	0	5			2	5		5	21
31	21C11A0433	INDRASENA REDDY. K	1	1	0	1	0.5	5			2	5		5	21
32	21C11A0434	JARINA BEGAM SHAIK		1				5				2		5	13
33	21C11A0435	KALYAN PAMULAPARTHI		1	0	0		4.5				3		5	14
34	21C11A0436	KARISHMA SHAIK	1	1	1	1	1	5	5	5		5	3	5	25
35	21C11A0438	KAVYA BOLLA	1	1	1	1	1	5		5		5	5	5	25
36	21C11A0440	LAHARI DEVINENI	1	1	1	1	1	5	5	5		5		5	25
37	21C11A0441	LAVANYA KASARLA	1	1	1	1	1	5			2	4		5	21
38	21C11A0442	LIKHITH KUMAR . S	0.5	1	1			5			3			5	16
39	21C11A0443	LOKESH THUMMA	1	1	0.5	1	1	5			5	4		5	24
40	21C11A0444	MAHENDER REDDY. V	0	0	0.5	1	0		3	0.5		3		5	13
41	21C11A0445	MANOHAR KOMMINENI	1	1		0.5		5			2			5	15
42	21C11A0446	MANOJ KUMAR KOLA	1	1	0.5	1	0.5	1		3		1		5	14
43	21C11A0447	MANOJ SAI KETHAM												5	5
44	21C11A0449	NARESH REDDY BEDEDALA	1	1	1	1		5			2		2	5	18
45	21C11A0450	NASEERUDDIN BABA .SK	1	1	1	1			2				4	5	15
46	21C11A0451	NAVEEN REDDY. S	1	1		0	0.5	5				4		5	17
47	21C11A0452	NAVEEN YARASANGI	1	1	0.5	0	0	5				5		5	18
48	21C11A0453	NAVYA VURUKONDA	1	1	1	1	1	2	4	5		3		5	22
49	21C11A0454	NAVYASRI POTLAPALLI	1	1	1	0.5	0.5		5		5	2		5	21
50	21C11A0455	NAZIYA BUSHRA SHAIK	0.5	1	0.5	0.5	0.5		5		2	4		5	19
51	21C11A0456	NITHIN REDDY .B	1	1	0.5	1	1	5				5		5	20
52	21C11A0457	POOJITHA ANANTHU	1	1	1	1	1	5	5	5			5	5	25
53	21C11A0458	PRASANNA KUMAR .M	1	1	1	0.5	0	5				1	5	5	19
54	21C11A0459	PRAVEEN REDDY. Kz		1					3	3			5	0	12
55	21C11A0460	PRIYA P	1	1	0.5	0.5		5	3	1		3		5	17
56	21C11A0461	RAGHUVEER.N	1	1	0	1	1	5				4		5	18
57	21C11A0463	RAKESH BORRA	1	1	0	1	0.5	5		4		5		5	23
58	21C11A0465	RAKESH MESHAM	1	1	1	1	1	5			5	5		5	25
59	21C11A0466	RAM KUMAR ANASURI	1	1	0.5	1	0	5			2	3		0	14

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60	21C11A0467	RAMA KRISHNA REDDY .A	1	1	0	1	1	5						5	14
61	21C11A0468	RAMAKRISHNA. M	1	1	0.5	1	0	5			2	4		5	20

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

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Faculty Name : : Mrs.V.Kalyani	**Year /Semester** : III/II	**Section : ECE-B**

S.No.	Hall ticket No.	Name of the Student	SHORT ANSWER QUESTIONS					LONG ANSWER QUESTIONS						Assignment	Total
			Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11		
1	21C11A0469	RAMASRI CHIMATA	1	1	0	1	0.5	5	4	2				5	16
2	21C11A0470	ROSHINI REDDYMALLA	1	1	0.5	1	1	5		2	1	5		5	22
3	21C11A0471	RUSHITHA TUMURUGOTI	0.5	1	1	1	1	5		5				5	20
4	21C11A0472	SAI GOWTHAM VARMA BADE	1	1	1	1	1	5	5	4		5		5	24
5	21C11A0473	SAI MADHULATHA PAIDIMARRI	0.5	1	0.5	1	1		5		2		2	5	18
6	21C11A0474	SAI MADHURI RAGAM	1	1	1	1	0	4	4		2		1	5	16
7	21C11A0475	SAIDA KASIM SHAIK	1	1	0	0.5		5		5		3		5	21
8	21C11A0476	SAIDEEPA BANOTHU	1	1	1	1	1	5		3		5		5	23
9	21C11A0477	SAIKIRAN CHINTALA	0.5	1	0.5	0.5	1	5		2		2		5	18
10	21C11A0478	SAIKRISHNA VADAKOPULA												0	0
11	21C11A0479	SAMEENA SHAIK	1	1		1	1	5		2		4.5		5	21
12	21C11A0480	SAMEER SHAIK	1	1	0	0	0		5	3		2		5	17
13	21C11A0481	SAMEER AHMED SHAIK	0.5	1	0.5	0.5	0	5				5		5	18
14	21C11A0482	SANDEEP RANGISETTI	1	1	1	1	1	5	5		3	2		5	20
15	21C11A0483	SANDHYA DARA	1	1	0.5	1	0.5	5		3		5		5	22
16	21C11A0484	SATHWIK VORUGANTI	1	1	1	1	1		5	5		5		5	25
17	21C11A0485	SATHWIKA CHAKILAM	1	1	1	1	1	5	4.5	5		4.5		5	25
18	21C11A0486	SATYANARAYANA. A	1	1	0.5	1	1	5				5		5	20
19	21C11A0487	SHAREEF SHAIK							3					5	8
20	21C11A0488	SHIVA BARI	1	1	0	1	1	5		4		3		5	21
21	21C11A0490	SHIVANI GUDISE	1	1	0.5	1	1	5	5		2			5	17
22	21C11A0492	SHIVASAI BARMAVATH	0.5	1	0.5	1	1	5	5		2	3		5	19
23	21C11A0493	SRAVYA GOVINDU	0.5	1	0.5	1	0	5			2	2		5	17
24	21C11A0494	SRI SAI SRINIVASA PANINDRA. P	0.5	1	0.5	1	1		5	4		4	4	5	22

25	21C11A0495	SRI SAILAJA PASUPULETI	0.5	1	1	0.5	0.5	5	5	2		3		5	19
26	21C11A0496	SRIDHAR BOILLA	1	1	0.5	1	1	5		2		3		5	20
27	21C11A0497	SRIKANTH MUNAGA	0	1	0.5	0	0		3			3		5	13
28	21C11A0498	SRIRAM NANDIGAMA	0.5	1		1	1	5						5	14
29	21C11A0499	SUJITH KUMAR BOGOJU	1	1		1	1	3		1		2		5	15
30	21C11A04A0	SUNIL PATHANAPU	0.5	1	0.5	0.5	0	5	5	2		2		5	17
31	21C11A04A1	SUSHMA THOKALA	0.5	1	0.5	1	1	5		2		2		5	18
32	21C11A04A2	TAGORE KHANNA .S	1	1	0.5	0.5	1	5				4		5	18
33	21C11A04A3	THAMRIN SHAIK	1	1	0.5	1	0	4.5			1	2		5	16
34	21C11A04A4	THARUN THUMMEPALLI	0.5	1		0.5		3	5			2		5	14
35	21C11A04A5	UMA MAHESWARI BATHULA	1	1	0.5	1	1	5	5	2		4		5	21
36	21C11A04A6	USHA SRI PATTHIPATI	1	1	0.5	1	0.5	5	5	2		3		5	19
37	21C11A04A7	VAHINI CHOWDARY . K	0.5	0.5		0.5		2				2		5	11
38	21C11A04A8	VAMSHI BOLLEPALLI	1	1	0.5	1	0		5	2		3		5	19
39	21C11A04A9	VARSHITHA KOMMAINENI	0.5	1	0	0	1	5	2	2	3	3	2	5	19
40	21C11A04B0	VARUN KUMAR KARNIKANTI	0.5	1	0	1	1	5		5		5		5	24
41	21C11A04B1	VEERAVENKATA SATYASAI BALAKRISHNA PRASAD P	1	1	1	1	1	5		5	2	5		5	25
42	21C11A04B5	VENKAT REDDY .K	0	1	0.5	0.5	0		5	2		3.5		5	18
43	21C11A04B6	VENKAT SAI VALLURI												0	0
44	21C11A04B7	VENKATESH MOGARALA	1	1	0.5	0.5	0.5	3	5	2		2		5	18
45	21C11A04B9	VENKATESH KALVAKUNTLA												0	0
46	21C11A04C0	VENNELA EATUKURI	1	1	0.5	1	1		4.5			4		5	18
47	21C11A04C1	VIGNESHWAR REDDY . P	0	1	0	0	0	5			2	2		5	15
48	21C11A04C2	VIGNESHWAR REDDY POSHAM	1	1	0.5	0.5	0	5		2		2		5	17
49	21C11A04C3	VIJINITH UPPALA	0	1	0	1	0		5		2	3		5	17
50	21C11A04C4	VIKAS MAMIDI				0.5	0.5	5			2	2		5	15
51	21C11A04C5	VILASH GARA	0.5	1	0.5	1	0.5	2	4		2	5		5	20
52	21C11A04C6	VINAY REDDY SAMA	1	1	0.5	1	1	5				5		5	20
53	21C11A04C7	VINITHA KANDULA	0.5	1	0.5	0.5	1	5	5			5		5	19
54	21C11A04C8	VIVEK VALLAPU	0.5	1		1		5	5			2		5	15
55	21C11A04C9	YASHWASRI KOTHA	1	1	0.5	0.5	0.5		2		1			5	12
56	22C15A0401	ASRITHA.PONNA		1		0.5	1		5		2	5		5	20

57	22C15A0402	LAHARI.BATTU	1	1	0.5	1	0.5	4	5	5		5		5	24
58	22C15A0403	NIKHIL.KURDULA	0.5	1	0.5	0.5	0.5	2		1				5	11
59	22C15A0404	NIKHIL.SIRIPURAM	0.5	1		1	0.5		5		2	2		5	17
60	22C15A0405	SAI MAHESH.YERRAMSETTI	0.5	1		1	1	5		5		4		5	23
61	22C15A0407	TRIVENI.ERUGU		1		0.5	1	5			2	2		5	17
62	22C15A0408	VENKATA SAI JASWANTH.B	1	1	1	0.5			2		2		2	5	15
63	22C15A0409	YASHWANTH.VEGGALAM	1	1	0.5	1	0.5	5		2		5		5	21

Department of Electronics & Communication Engineering

ANURAG Engineering College

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Ananthagiri (V & M), Suryapet (Dt.), Telangana - 508206.

Electronics and Communication Engineering - A

III B.Tech I Semester Mid Marks List

Faculty: V.KALYANI | **Subject: LDICA**

S.No.	H.T.No.	Name of the Student	Mid - I	Assignment - I	Mid - I Total	Mid - II	Assignment - II	Mid - II Total	AVG
1	19C11A0422	Mounika Maddi	9	5	14	18	5	23	19
2	21C11A0401	Akash Reddy Madduri	AB	AB	0	AB	AB	0	0
3	21C11A0402	Akhil Sai Korlapti	4	5	9	12	5	17	13
4	21C11A0403	Anil Siramsetti	7	5	12	13	5	18	15
5	21C11A0404	Anil Borra	9	5	14	16	5	21	18
6	21C11A0405	Anusha Thuraka	11	5	16	18	5	23	20
7	21C11A0406	Architha Reddy Mandadi	12	5	17	19	5	24	21
8	21C11A0407	Asif Sayed	20	5	25	20	5	25	25
9	21C11A0408	Asra Begum Shek	13	5	18	16	5	21	20
10	21C11A0410	Balaji Utharadhi	5	5	10	10	5	15	13
11	21C11A0411	Balaji Nikam	16	5	21	20	5	25	23
12	21C11A0412	Bangaru Babu Bhukya	3	5	8	12	5	17	13
13	21C11A0413	Bhanu Prakash Chowgani	10	5	15	14	5	19	17
14	21C11A0415	Bhargav Akula	16	5	21	18	5	23	22
15	21C11A0416	Bhavana Goud Bandi	10	5	15	14	5	19	17
16	21C11A0417	Bhavana Sathuluri	10	5	15	19	5	24	20
17	21C11A0418	Bhavani Elavala	19	5	24	19	5	24	24
18	21C11A0419	Bhavya Sri Vangaveti	18	5	23	20	5	25	24
19	21C11A0420	Chaitanya Karnati	14	5	19	17	5	22	21
20	21C11A0421	Chakradhar Sai Peddoju	9	5	14	9	5	14	14
21	21C11A0422	Charan Chennoju	0	AB	0	5	AB	5	3
22	21C11A0423	Chetan Sai Gavini	7	5	12	16	5	21	17
23	21C11A0424	Deepak Jupudi	19	5	24	19	5	24	24
24	21C11A0425	Devika Bommu	19	5	24	19	5	24	24
25	21C11A0426	Dhanush Tanneeru	4	5	9	8	5	13	11

26	21C11A0427	Dinesh Kudumula	AB	AB	0	AB	AB	0	0
27	21C11A0428	Drakshayani Vemula	9	5	14	14	5	19	17
28	21C11A0429	Durga Bhavani Doddapaneni	17	5	22	16	5	21	22
29	21C11A0430	Geethanjali Borra	0	AB	0	5	5	10	5
30	21C11A0431	Gnaneshwar Kosuru	AB	5	5	18	5	23	14
31	21C11A0432	Gopiraju Gavini	10	5	15	13	5	18	17
32	21C11A0433	Indrasena Reddy Kurakula	13	5	18	14	5	19	19
33	21C11A0434	Jarina Begam Shaik	2	5	7	5	5	10	9
34	21C11A0435	Kalyan Pamulaparthi	0	5	5	5	5	10	8
35	21C11A0436	Karishma Shaik	19	5	24	19	5	24	24
36	21C11A0437	Karthik Aanandapu	AB	AB	0	AB	AB	0	0
37	21C11A0438	Kavya Bolla	20	5	25	20	5	25	25
38	21C11A0439	Koushik Gella	0	AB	0	AB	AB	0	0
39	21C11A0440	Lahari Devineni	17	5	22	20	5	25	24
40	21C11A0441	Lavanya Kasarla	18	5	23	18	5	23	23
41	21C11A0442	Likhith Kumar Sangapu	11	5	16	14	5	19	18
42	21C11A0443	Lokesh Thumma	18	5	23	20	5	25	24
43	21C11A0444	Mahender Reddy Vustella	5	5	10	11	5	16	13
44	21C11A0445	Manohar Kommineni	12	5	17	17	5	22	20
45	21C11A0446	Manoj Kumar Kola	0	5	5	7	5	12	9
46	21C11A0447	Manoj Sai Ketham	AB	AB	0	5	AB	5	3
47	21C11A0449	Naresh Reddy Bededala	10	5	15	14	5	19	17
48	21C11A0450	Naseeruddin Baba Shaik	8	5	13	16	5	21	17
49	21C11A0451	Naveen Reddy S	8	5	13	14	5	19	16
50	21C11A0452	Naveen Yarasangi	12	5	17	13	5	18	18
51	21C11A0453	Navya Vurukonda	14	5	19	18	5	23	21
52	21C11A0454	Navyasri Potlapalli	AB	5	5	16	5	21	13
53	21C11A0455	Naziya Bushra Shaik	8	5	13	17	5	22	18
54	21C11A0456	Nithin Reddy B	8	5	13	12	5	17	15
55	21C11A0457	Poojitha Ananthu	17	5	22	20	5	25	24
56	21C11A0458	Prasanna Kumar M	10	5	15	15	5	20	18
57	21C11A0459	Praveen Reddy K	3	5	8	6	5	11	10
58	21C11A0460	Priya P	12	5	17	14	5	19	18
59	21C11A0461	Raghuveer N	12	5	17	18	5	23	20

Department of Electronics & Communication Engineering

60	21C11A0463	Rakesh Borra	14	5	19	19	5	24	22
61	21C11A0464	Rakesh Chinthala	0	AB	0	AB	AB	0	0
62	21C11A0465	Rakesh Mesham	20	5	25	20	5	25	25
63	21C11A0466	Ram Kumar Anasuri	4	5	9	13	5	18	14
64	21C11A0467	Rama Krishna Reddy A	2	5	7	3	5	8	8
65	21C11A0468	Ramakrishna Mundra	10	5	15	12	5	17	16

Department of Electronics & Communication Engineering

ANURAG Engineering College

(An Autonomous Institution)

Ananthagiri (V & M), Suryapet (Dt.), Telangana - 508206.

Electronics and Communication Engineering - A

III B.Tech II Semester Mid Marks List

Faculty: V.KALYANI			Subject: DIGITAL SIGNAL PROCESSING						
S.No.	H.T.No.	Name of the Student	Mid - I	Assignment - I	Mid - I Total	Mid - II	Assignment - II	Mid - II Total	AVG
1	19C11A0422	Mounika Maddi	20	5	25	20	5	25	25
2	20C11A0427	Mahesh Kumar Gunja	0	0	0	0	0	0	0
3	21C11A0402	Akhil Sai Korlapti	11	5	16	14	5	19	18
4	21C11A0403	Anil Siramsetti	12	5	17	11	5	16	17
5	21C11A0404	Anil Borra	16	5	21	17	5	22	22
6	21C11A0405	Anusha Thuraka	18	5	23	15	5	20	22
7	21C11A0406	Architha Reddy Mandadi	18	5	23	17	5	22	23
8	21C11A0407	Asif Sayed	19	5	24	17	5	22	23
9	21C11A0408	Asra Begum Shek	18	5	23	16	5	21	22
10	21C11A0410	Balaji Utharadhi	13	5	18	13	5	18	18
11	21C11A0411	Balaji Nikam	18	5	23	19	5	24	24
12	21C11A0412	Bangaru Babu Bhukya	11	5	16	9	5	14	15
13	21C11A0413	Bhanu Prakash Chowgani	15	5	20	10	5	15	18
14	21C11A0415	Bhargav Akula	14	5	19	16	5	21	20
15	21C11A0416	Bhavana Goud Bandi	11	5	16	9	5	14	15
16	21C11A0417	Bhavana Sathuluri	18	5	23	14	5	19	21
17	21C11A0418	Bhavani Elavala	20	5	25	20	5	25	25
18	21C11A0419	Bhavya Sri Vangaveti	18	5	23	20	5	25	24
19	21C11A0420	Chaitanya Karnati	18	5	23	17	5	22	23
20	21C11A0421	Chakradhar Sai Peddoju	10	5	15	13	5	18	17

21	21C11A0422	Charan Chennoju	6	5	11	6	5	11	11
22	21C11A0423	Chetan Sai Gavini	15	5	20	14	5	19	20
23	21C11A0424	Deepak Jupudi	19	5	24	20	5	25	25
24	21C11A0425	Devika Bommu	20	5	25	20	5	25	25
25	21C11A0426	Dhanush Tanneeru	5	5	10	12	5	17	14
26	21C11A0428	Drakshayani Vemula	18	5	23	16	5	21	22
27	21C11A0429	Durga Bhavani Doddapaneni	10	5	15	17	5	22	19
28	21C11A0430	Geethanjali Borra	11	5	16	8	AB	8	12
29	21C11A0431	Gnaneshwar Kosuru	19	5	24	18	5	23	24
30	21C11A0432	Gopiraju Gavini	15	5	20	16	5	21	21
31	21C11A0433	Indrasena Reddy Kurakula	13	5	18	16	5	21	20
32	21C11A0434	Jarina Begam Shaik	11	5	16	8	5	13	15
33	21C11A0435	Kalyan Pamulaparthi	6	5	11	9	5	14	13
34	21C11A0436	Karishma Shaik	20	5	25	20	5	25	25
35	21C11A0438	Kavya Bolla	20	5	25	20	5	25	25
36	21C11A0440	Lahari Devineni	20	5	25	20	5	25	25
37	21C11A0441	Lavanya Kasarla	14	5	19	16	5	21	20
38	21C11A0442	Likhith Kumar Sangapu	13	5	18	11	5	16	17
39	21C11A0443	Lokesh Thumma	19	5	24	19	5	24	24
40	21C11A0444	Mahender Reddy Vustella	10	5	15	8	5	13	14
41	21C11A0445	Manohar Kommineni	16	5	21	10	5	15	18
42	21C11A0446	Manoj Kumar Kola	9	5	14	9	5	14	14
43	21C11A0447	Manoj Sai Ketham	8	5	13	0	5	5	9
44	21C11A0449	Naresh Reddy Bededala	10	5	15	13	5	18	17
45	21C11A0450	Naseeruddin Baba Shaik	11	5	16	10	5	15	16
46	21C11A0451	Naveen Reddy Sankalamaddi	9	5	14	12	5	17	16
47	21C11A0452	Naveen Yarasangi	9	5	14	13	5	18	16
48	21C11A0453	Navya Vurukonda	19	5	24	17	5	22	23

Department of Electronics & Communication Engineering

49	21C11A0454	Navyasri Potlapalli	17	5	22	16	5	21	22
50	21C11A0455	Naziya Bushra Shaik	12	5	17	14	5	19	18
51	21C11A0456	Nithin Reddy Bommareddy	5	5	10	15	5	20	15
52	21C11A0457	Poojitha Ananthu	20	5	25	20	5	25	25
53	21C11A0458	Prasanna Kumar Meesala	12	5	17	14	5	19	18
54	21C11A0459	Praveen Reddy Kakunuri	12	5	17	12	AB	12	15
55	21C11A0460	Priya P	12	5	17	12	5	17	17
56	21C11A0461	Raghuveer Nallanchakravarthula	14	5	19	13	5	18	19
57	21C11A0463	Rakesh Borra	17	5	22	18	5	23	23
58	21C11A0465	Rakesh Mesham	20	5	25	20	5	25	25
59	21C11A0466	Ram Kumar Anasuri	9	5	14	14	AB	14	14
60	21C11A0467	Rama Krishna Reddy Amaravadi	7	5	12	9	5	14	13
61	21C11A0468	Ramakrishna Mundra	13	5	18	15	5	20	19

Department of Electronics & Communication Engineering

ANURAG Engineering College

(An Autonomous Institution)

Ananthagiri (V & M), Suryapet (Dt.), Telangana - 508206.

Electronics and Communication Engineering - B

III B.Tech II Semester Mid Marks List

Faculty: V.KALYANI			Subject: DIGITAL SIGNAL PROCESSING						
S.No.	H.T.No.	Name of the Student	Mid - I	Assignment - I	Mid - I Total	Mid - II	Assignment - II	Mid - II Total	AVG
1	21C11A0469	Ramasri Chimata	13	5	18	11	5	16	17
2	21C11A0470	Roshini Reddymalla	18	5	23	17	5	22	23
3	21C11A0471	Rushitha Tumurugoti	15	5	20	15	5	20	20
4	21C11A0472	Sai Gowtham Varma Bade	18	5	23	19	5	24	24
5	21C11A0473	Sai Madhulatha Paidimarri	16	5	21	13	5	18	20
6	21C11A0474	Sai Madhuri Ragam	11	5	16	11	5	16	16
7	21C11A0475	Saida Kasim Shaik	11	5	16	16	5	21	19
8	21C11A0476	Saideepa Banothu	18	5	23	18	5	23	23
9	21C11A0477	Saikiran Chintala	17	5	22	13	5	18	20
10	21C11A0478	Saikrishna Vadakopula	0	0	0	0	0	0	0
11	21C11A0479	Sameena Shaik	16	5	21	16	5	21	21
12	21C11A0480	Sameer Shaik	15	5	20	12	5	17	19
13	21C11A0481	Sameer Ahmed Shaik	10	5	15	13	5	18	17
14	21C11A0482	Sandeep Rangisetti	18	5	23	15	5	20	22
15	21C11A0483	Sandhya Dara	14	5	19	17	5	22	21
16	21C11A0484	Sathwik Voruganti	18	5	23	20	5	25	24
17	21C11A0485	Sathwika Chakilam	19	5	24	20	5	25	25
18	21C11A0486	Satyanarayana Amaraboina	12	5	17	15	5	20	19
19	21C11A0487	Shareef Shaik	9	5	14	3	5	8	11
20	21C11A0488	Shiva Bari	16	5	21	16	5	21	21

21	21C11A0490	Shivani Gudise	11	5	16	12	5	17	17
22	21C11A0492	Shivasai Barmavath	14	5	19	14	5	19	19
23	21C11A0493	Sravya Govindu	12	5	17	12	5	17	17
24	21C11A0494	Sri Sai Srinivasa Panindra Pidathala	19	5	24	17	5	22	23
25	21C11A0495	Sri Sailaja Pasupuleti	19	5	24	14	5	19	22
26	21C11A0496	Sridhar Boilla	17	5	22	15	5	20	21
27	21C11A0497	Srikanth Munaga	12	5	17	8	5	13	15
28	21C11A0498	Sriram Nandigama	10	5	15	9	5	14	15
29	21C11A0499	Sujith Kumar Bogoju	6	5	11	10	5	15	13
30	21C11A04A0	Sunil Pathanapu	11	5	16	12	5	17	17
31	21C11A04A1	Sushma Thokala	17	5	22	13	5	18	20
32	21C11A04A2	Tagore Khanna Siddamsetti	13	5	18	13	5	18	18
33	21C11A04A3	Thamrin Shaik	17	5	22	11	5	16	19
34	21C11A04A4	Tharun Thummepalli	13	5	18	9	5	14	16
35	21C11A04A5	Uma Maheswari Bathula	11	5	16	16	5	21	19
36	21C11A04A6	Usha Sri Patthipati	16	5	21	14	5	19	20
37	21C11A04A7	Vahini Chowdary Koganti	6	5	11	6	5	11	11
38	21C11A04A8	Vamshi Bollepalli	15	5	20	14	5	19	20
39	21C11A04A9	Varshitha Kommaineni	14	5	19	14	5	19	19
40	21C11A04B0	Varun Kumar Karnikanti	19	5	24	19	5	24	24
41	21C11A04B1	Veeravenkata Satyasai Balakrishna Prasad P	20	5	25	20	5	25	25
42	21C11A04B5	Venkat Reddy Kandimalla	12	5	17	13	5	18	18
43	21C11A04B6	Venkat Sai Valluri	0	0	0	0	0	0	0
44	21C11A04B7	Venkatesh Mogarala	11	5	16	13	5	18	17
45	21C11A04B9	Venkatesh Kalvakuntla	8	0	8	0	0	0	4
46	21C11A04C0	Vennela Eatukuri	17	5	22	13	5	18	20
47	21C11A04C1	Vigneshwar Reddy Pandiri	13	5	18	10	5	15	17
48	21C11A04C2	Vigneshwar Reddy Posham	16	5	21	12	5	17	19

49	21C11A04C3	Vijinith Uppala	15	5	20	12	5	17	19
50	21C11A04C4	Vikas Mamidi	9	5	14	10	5	15	15
51	21C11A04C5	Vilash Gara	13	5	18	15	5	20	19
52	21C11A04C6	Vinay Reddy Sama	17	5	22	15	5	20	21
53	21C11A04C7	Vinitha Kandula	14	5	19	14	5	19	19
54	21C11A04C8	Vivek Vallapu	15	5	20	10	5	15	18
55	21C11A04C9	Yashwasri Kotha	7	5	12	7	5	12	12
56	22C15A0401	Asritha Ponna	14	5	19	15	5	20	20
57	22C15A0402	Lahari Battu	18	5	23	19	5	24	24
58	22C15A0403	Nikhil Kurdula	13	5	18	6	5	11	15
59	22C15A0404	Nikhil Siripuram	13	5	18	12	5	17	18
60	22C15A0405	Sai Mahesh Yerramsetti	19	5	24	18	5	23	24
61	22C15A0407	Triveni Erugu	14	5	19	12	5	17	18
62	22C15A0408	Venkata Sai Jaswanth Bommisetty	9	5	14	10	5	15	15
63	22C15A0409	Yashwanth Veggalam	17	5	22	16	5	21	22

ANURAG ENGINEERING COLLEGE

(An Autonomous Institution)

(Approved by AICTE, New Delhi, Affiliated to JNTUH, Hyderabad, Accredited by NAAC with A+ Grade)

Ananthagiri (V & M), Kodad, Suryapet (Dist), Telangana.

Program			YEAR	SEMESTER	MID EXAMINATION
B.Tech. ✓	M.Tech.	M.B.A.	III	II	I

HALL TICKET NO.										Regulation: R-18	Branch or Specialization: ECE
1	9	C	1	1	A	0	4	2	2		

Course: DSP

Signature of Student: M. Manasvika

Signature of invigilator with date:

Signature of the Evaluator:

Q.No. and Marks Awarded											Maximum Marks	20.	Marks Obtained	20.
1	2	3	4	5	6	7	8	9	10	11				
✓	✓	✓	✓	✓		5	9	5	5					

(Start Writing From Here)

(7) Given equation

$y(n) + 2y(n-1) + y(n-2) = x(n) + x(n-1)$

with initial condition $y(-1) = y(-2) = 1$

for Natural response of the system:

Let us assume Homogeneous equation $y_h(n) = \lambda^n$

$y(n) + 2y(n-1) + y(n-2) = 0$ — ①

$\lambda^n + 2\lambda^{n-1} + \lambda^{n-2} = 0$

$\lambda^{n-2}[\lambda^2 + 2\lambda + 1] = 0$

$\lambda^2 + 2\lambda + 1 = 0$

$\lambda = -1, -1$

∴ Roots are real and equal

$y(n) = C_1(\lambda_1)^n + C_2(\lambda_2)^n \cdot n$

if $n = 0$

$y(0) = C_1(-1)^0 + C_2(-1)^0 \cdot 0$

$y(0) = -C_1$ — ②

if $n = 1$ $\quad y(1) = C_1(-1)^1 + C_2(-1)^1 \cdot 1$

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

$\boxed{y(0) = -3}$ — (4)

for $\boxed{n=1}$ eqn (2) becomes

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

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

$\boxed{y(1) = 5}$ — (5)

Substitute eqn (4) in eqn (3)

$\boxed{C_1 = +3}$

eqn (3) ⇒

$5 = -[3 + C_2]$

$\boxed{C_2 = -2}$

Substitute C_1 & C_2 values in

$y(n) = -3(-1)^n + (-2)(-1)^n \cdot n$

$\therefore y(n) = (-1)^n [3 - 2n]$

(9) Given sequence $x(n) = \{0, 2, 4, 6\}$

to find DFT of sequence

we know that

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

where $N = 4$

$$X(0) = \sum_{n=0}^{3} x(n) e^{-j\frac{2\pi}{4} \cdot nk}$$

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

$X(0) = 0 + 2 + 4 + 6$

$\boxed{X(0) = 12}$

$X(1) = x(0)[$

$X(1) = x(0) + x(1)e^{-j\frac{\pi}{2}} + x(2)e^{-j\pi} + x(3)e^{-j\frac{3\pi}{2}}$

$X(1) = 0 + 2(0-j) + 4(-1+0j) + 6(0-j)$

$X(1) = -2j - 4 - 6j$

$X(1) = -4 - 8j$

$X(2) = x(0) + x(1)e^{-j\pi} + x(2)e^{-j2\pi} + x(3)e^{-j3\pi}$

$x(2) = 0 + 2(-1) + 4(1) + 6(-1)$

$x(2) = -2 + 4 - 6$

$x(2) = -4$

$X(3) = x(0) + x(1)e^{-j\frac{3\pi}{2}} + x(2)e^{-j3\pi} + x(3)e^{-j9\pi/2}$

$= 0 + 2(0) + 4(-1) + 6(0-j)$

$X(3) = -4 - 6j$

$X(k) = \{12, -4-8j, -4, -4-6j\}$

to find
IDFT of the sequence

$y(k) = \{1, 0, 1, 0\}$ where $N=4$

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

$y(0) = \frac{1}{4}\left[y(k)e^{j\frac{\pi}{2}}\right]$

$y(0) = \frac{1}{4}[y(0) + y(1) + y(2) + y(3)]$

$y(0) = \frac{2}{4} \Rightarrow y(0) = \frac{1}{2} = 0.5$

$y(1) = \frac{1}{4}[y(0) + 0 + y(2)e^{j\pi} + 0]$

$$y(2) = \frac{1}{4}\left[y(0) + 0 + y(2)e^{-2\pi} + 0\right]$$

$$y(2) = \frac{2}{4} = 0.5$$

$$y(3) = \frac{1}{4}\left[y(0) + 0 + y(2)e^{-3\pi} + 0\right]$$

$$y(3) = \frac{1}{4}[1 - 1]$$

$$y(3) = 0$$

$$y(n) = \{0.5, 0, 0.5, 0\}$$

Comparision of IIR and FIR filters

IIR	FIR
⇒ IIR stands for Infinite Impulse response	⇒ FIR stands for finite Impulse Response
⇒ IIR filters gives the Impulse responses of Infinite time duration	⇒ FIR filters gives the impulse Responses of finite time duration
⇒ IIR filters are recursive in nature	⇒ FIR filters are non-recursive in nature
⇒ IIR filters are less stable than that of FIR filters due to presence of poles	⇒ FIR filters are more stable compare to IIR filters. because there is no poles in output
⇒ feedback path is present in IIR filters	⇒ feedback path is not present in FIR filters
⇒ The computability efficiency of IIR filters is more	⇒ The computability efficiency is less in FIR filters
⇒ In the output poles & zeros are present	⇒ It contains only zeros
⇒ Butterwood, chebyshev filter-1, chebyshev filter 2 are used	⇒ Hilbert transform is used in FIR filters
⇒ Bio medical Sensor, Telecommunication, are used in IIR filters	⇒ Audio control, medical devices are used

5

① Static System

The present output depends upon the present input then that System is called static System

dynamic System:

The present output depends upon the past and future inputs then that system is called dynamic system

$$y(n) = x(n) + x(n+1) + x(n-1)$$

③ zero padding.

The number of zeros added to the length of the sequence is called zero padding

$$n = 2^M$$

where 'M' is number of stages

⑤

Analog filters	digital filters
⇒ FDM	⇒ TDM
⇒ more complexity to design the circuit	⇒ less complexity to design circuit
⇒ more cost	⇒ less cost
⇒ repeaters are not used	⇒ repeaters are used
⇒ frequency	⇒ Amplitude and frequency keying

④

DFT	Z transform
⇒ S domain	⇒ z domain
⇒ $S = j\omega$	⇒ $z = e^{j\omega}$

$x(t) = 2e^{-2t}$ for 0 to 2

$T = 0.2$ sec

$x(0) = 2$

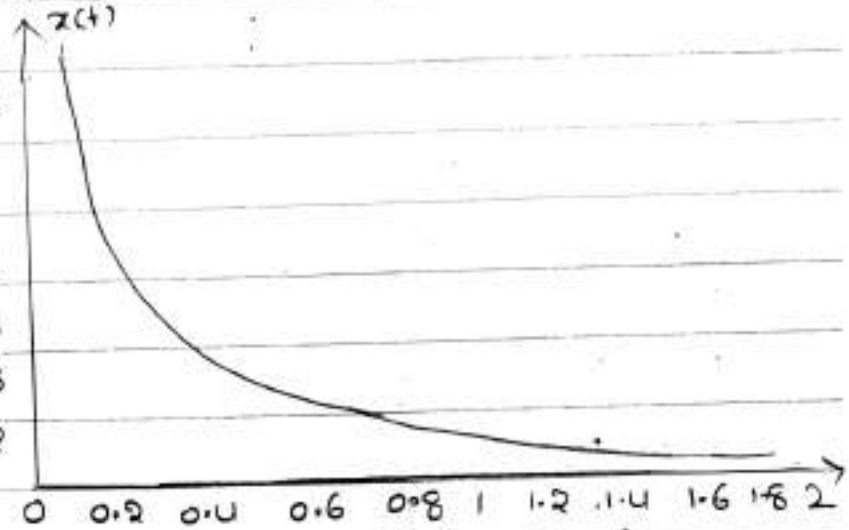
$x(0.2) = 1.34$

$x(0.4) = 0.8$

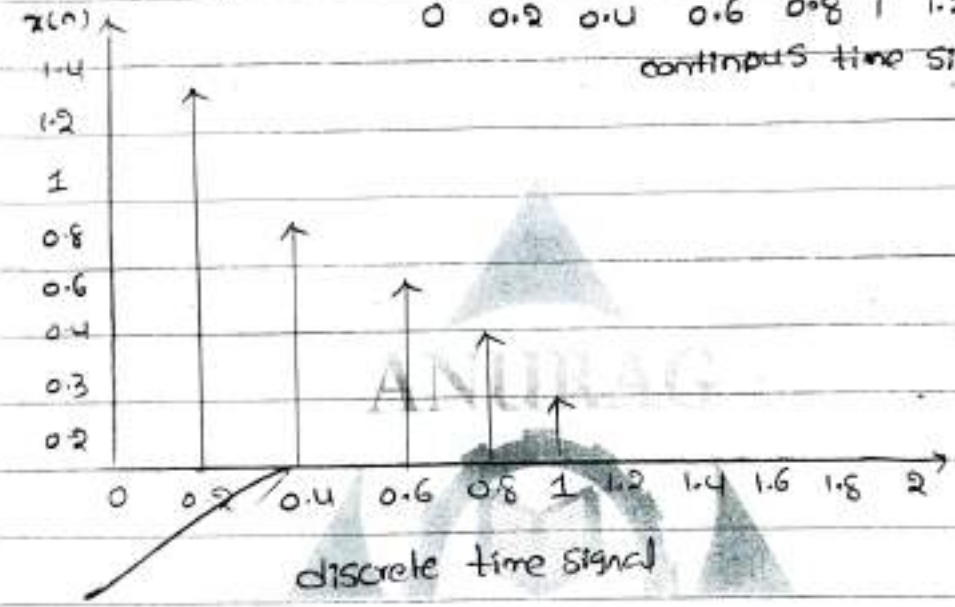
$x(0.6) = 0.6$

$x(0.8) = 0.4$

$x(1) = 0.2$



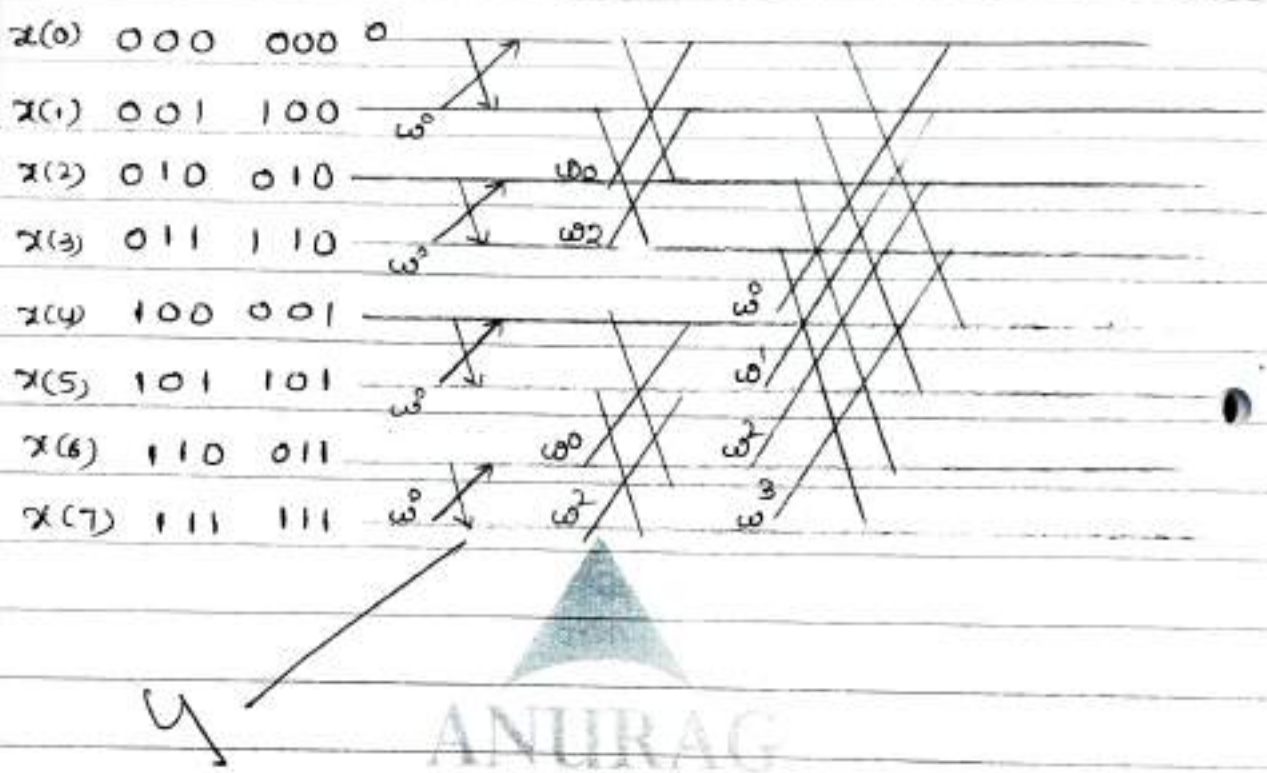
continous time signal



discrete time signal

⑧ 8 Point DIT FFT

Consider sequence $x(n) = \{0, 1, 2, 1, 1, 2, 1, 1\}$



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Program		
B.Tech.	M.Tech.	M.B.A.

HALL TICKET NO.

2	1	C	1	1	A	0	4	5	6

Course: DSP

Q.No. and Marks Awarded										
1	2	3	4	5	6	7	8	9	10	11
0	0	0	0					2	3	

YEAR	SEMESTER	MID EXAMINATION
III	II	I

Regulation: R18 | Branch or Specialization: ECE/A

Signature of Student: B. Vi Reddy

Signature of invigilator with date:

Signature of the Evaluator: Anup

Maximum Marks: 20 | Marks Obtained: 5

(Start Writing From Here)

(10) · Compare IIR and FIR filters.

IIR	FIR
IIR Filter's are always unstable	FIR filter's are always stable.
IIR filters are low cost	FIR filter's are Hig cost
IIR filter's are classified into 4 type's of sub filter's analog character - I. Dscread character - II Direct character - III Indirect character - IV	FIR filter's are classified into 3 type's of sub filter's analog character - I Direct FIR Filter's and Indirect FIR Filter's
IIR Filter's are give good	FIR filter's are got give

(9)

Given $x(n) = \{0, 2, 4, 6\}$.

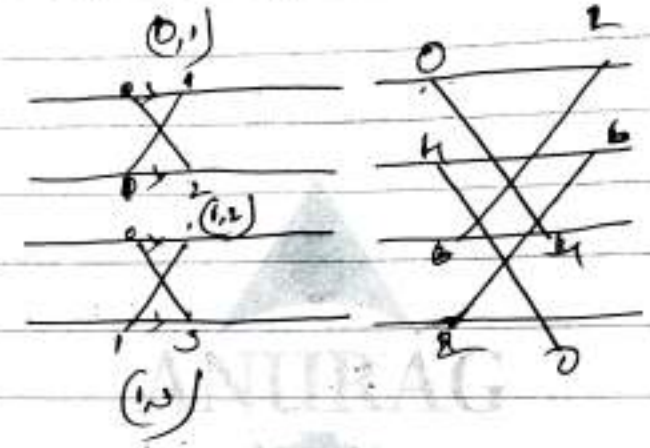
$y(k) = \{0, 1, 0\}$

$00 \rightarrow 00 \rightarrow x(0) = 0$

$01 \rightarrow 10 \rightarrow x(1) = 2$

$10 \rightarrow 01 \rightarrow x(2) = 1$

$11 \rightarrow 11 \rightarrow x(3) = 3$



$x(0) = 0$

$x(1) = 2$

$x(2) = 1$

$x(3) = 3$

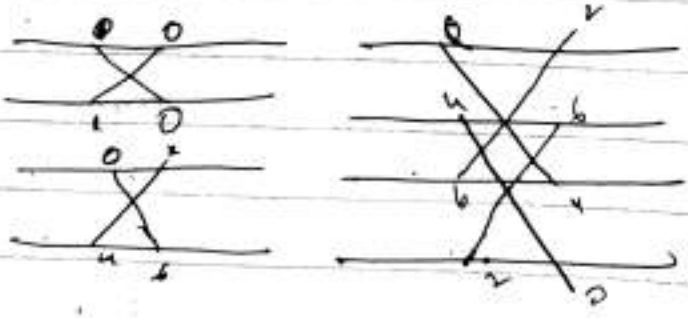
$y(k) =$

$00 \rightarrow 00 \rightarrow x(0) = 0$

$01 \rightarrow 10 \rightarrow x(1) = 2$

$10 \rightarrow 01 \rightarrow x(2) = 1$

$11 \rightarrow 11 \rightarrow x(3) = 3$



$x(0) = 0$

$x(1) = 2$

$x(2) = 1$

$x(3) = 3$

Static and dynamic system

Static	Dynamic
$s = j\omega$	$s = j\omega$
$s = \sigma + j\omega$	$s = \sigma + j\omega$
$s = -\infty$ to ∞	$s = -\infty$ to $-\infty$
open not at out of the circle.	closed path into or the inside the circle.

The relation ship between z-transform and DFT.

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

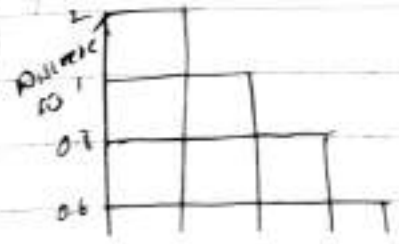
Adding no of Example's in the sequence is know as padding.

$$N = \omega^{N}$$

$$x(t) = 2e^{-1} - 2t$$

Where $t = 0$ to 2

0.2, 0.4, 0.6, 0.8, 1.0



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HALL TICKET NO.									
2	1	C	1	1	A	0	4	9	8

Course: DSP

Q.No. and Marks Awarded										
1	2	3	4	5	6	7	8	9	10	11
						2	4		4	

YEAR	SEMESTER	MID EXAMINATION
III	II	1

Regulation : 19 | Branch or Specialization: ECE

Signature of Student:

Signature of Invigilator with date:

Signature of the Evaluator:

Maximum Marks: 20 | Marks Obtained: 10

(Start Writing From Here)

7) given that,

$y(n) + 2y(n-1) + y(n-2) = x(n) + x(n-1)$

$y(-1) = y(-2) = 1$

Let us consider given equation is Homogenous

$y = \lambda^n$

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

$= \lambda(n) + 2\lambda(n-1) + \lambda(n-2)$

$= \lambda^{n-2}[2\lambda + \lambda + 1]$

$= [-1, -1]$

Roots are real and imaginary

$x_1 = -c_1$

$x_2 = -c_1 + c_2$

$n = 0$

$y(n) + 2y(n-1) + y(n-2)$

$y(0) + 2y(0-1) + y(0-2)$

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

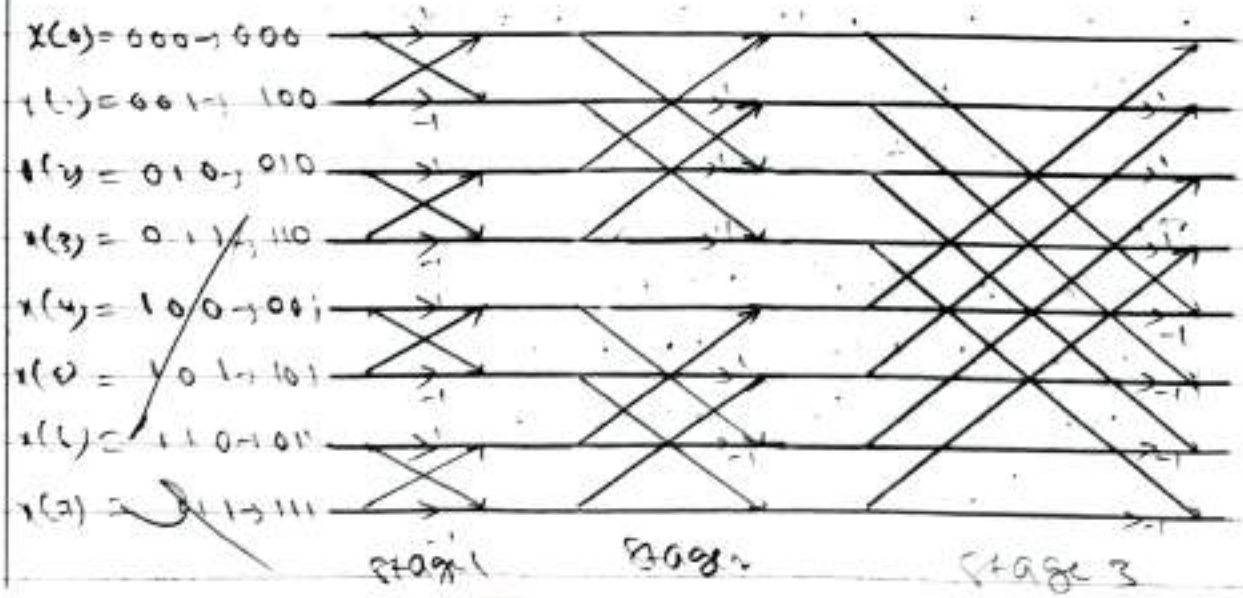
$[= -3]$

$n = 1$

10)

IIR Filter	FIR Filters
i) IIR is known as Infinite Impulse response	i) FIR is known as Finite Impulse response
ii) In IIR filters feedback is present	ii) In FIR filters feedback is present
iii) Infinite duration of time	iii) Finite duration of time
iv) less memory	iv) more memory
v) less time	v) more time
vi) Recursive	vi) non recursive
vii) Frequency fourier transform cannot be used	vii) frequency fourier transform can be used.

8) 8 Point DIT FFT



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Program			YEAR	SEMESTER	MID EXAMINATION
B.Tech. ✓	M.Tech.	M.B.A.	III	II	II

HALL TICKET NO: 2 1 C 1 1 A 0 4 3 8

Regulation: R18 Branch or Specialization: ECE-A

Course: DSP

Signature of Student: Kavya

Signature of invigilator with date: Sujitha/19-06-24

Signature of the Evaluator: Devi

Q.No.	1	2	3	4	5	6	7	8	9	10	11
Marks Awarded	1	1	1	1	1	5		5		5	(5)

Maximum Marks: 20 Marks Obtained: 20

(Start Writing From Here)

Part-A

1: Features of FIR:

→ FIR (Finite Impulse Response), The output sample depends on present and past inputs

→ FIR are always stable

→ FIR are exactly linear in phase response, pass a signals without phase distortion

→ Finite duration

2: Types of window techniques

1) Rectangular window technique

2) Bartlett / Triangular

3) Hanning

4) Hamming

3: In FIR filters, the phase response varys linearly with the frequency.

FIR casual filters of transform function

$$H(z) = \sum h(n) z^{-n}$$

4A: Sampling Rate: The number of samples taken per second is known as Sampling rate

Sampling process: The process of converting continuous time signal to a sequence of numbers is known as sampling process

---

5A: Frequency Response of down sampling

$$Y(z) = \frac{1}{M}\sum_{n=0}^{M-1} X(n) z^{-n}$$

$z = e^{j\omega}$

$$Y(e^{j\omega}) = \frac{1}{M}\sum_{n=0}^{M-1} X\left(e^{j\frac{2\pi k}{M}} z^{1/n}\right)$$

$$= \frac{1}{M}\sum_{n=0}^{M-1} X\left(e^{j\frac{2\pi k}{M}} e^{j/n}\right)$$

$$\boxed{Y(e^{j\omega}) = \frac{1}{M}\sum_{n=0}^{M-1} X\left(e^{-j/n(2\pi k - \omega)}\right)}$$

6A: Given

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

$T = 1$

$H(z) = ?$

$$H(z) = H(s)\Big|_{s=\frac{2}{T}\left[\frac{1-z^{-1}}{1+z^{-1}}\right]} \quad \left[\because H(z) = H(s)\right]$$

Substitute $s = \frac{2}{T}\left(\frac{1-z^{-1}}{1+z^{-1}}\right)$

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

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

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

$$= \frac{2(1+z^{-1})^2}{(3-z^{-1})(4)_2}$$

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

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

$$= \frac{1}{6}\frac{(1+z^{-1})}{\left(1-\frac{z^{-1}}{3}\right)}$$

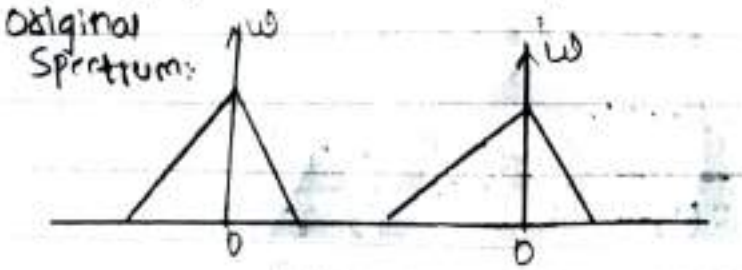
$$= \frac{0.166\,(1+z^{-1})}{1-0.333z^{-1}}$$

$$\therefore \boxed{H(z) = \frac{0.166(1+z^{-1})}{1-0.333z^{-1}}}$$

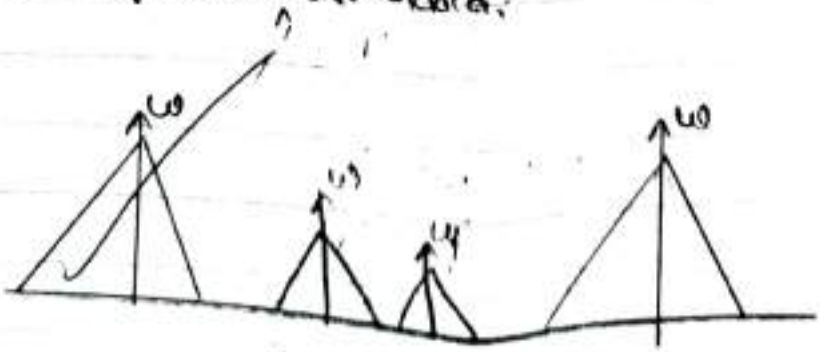
IDA: Interpolation process (up sampling) is defined as the increasing of the sample
→ [Interpolation is known Interpolation.
Sampling Rate

$y(n) = x\left(\frac{n}{I}\right)$

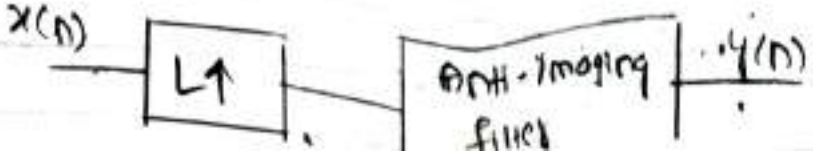
→ The Interpolation is denoted by factor "L".
→ In this we are going add the zero's based on the "L-1" factor.
→ By increasing the more samples the unwanted samples (are formed in between) or Extra frequencies are formed in between the samples.
→ To Remove the Extra frequencies, we are using the anti imaging filter



Extra frequencies are added:

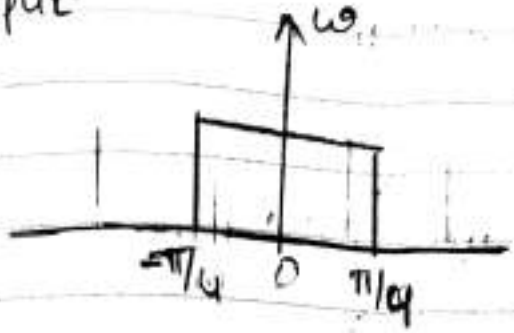


To overcome this we are using the anti imaging filter



The combination of upsampling and Anti imaging filter is known interpolation.

→ After the anti imaging filter, the original Spectrum of the output



For Ex:-

$x(n) = \{1, 2, 3, 4, 6, 8, 9, 5\}$

$L = 2$

$L-1 = 1$, So, we have 1 zero in between the samples.

$y(n) = \{1, 0, 2, 0, 3, 0, 4, 0, 6, 0, 8, 0, 9, 0, 5\}$

The Frequency Response of the Interpolation or Upsampling is $Y(e^{j\omega}) = X(e^{j\omega L})$

→ After applying the Anti imaging, we can get the final output as a stable output one.

Given:

8A:- Cut off frequency $\omega_c = 1.2$ rad/sec

$N = 9$

Step-1:-

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

$$= \frac{1}{2\pi}\left[\int_{-\pi}^{-1.2} e^{j\omega n} d\omega + \int_{1.2}^{\pi} e^{j\omega n} d\omega\right]$$

$$= \frac{1}{2\pi}\left[\left(\frac{e^{j\omega n}}{jn}\right)_{-\pi}^{-1.2} + \left(\frac{e^{j\omega n}}{jn}\right)_{1.2}^{\pi}\right]$$

$$= \frac{1}{2\pi}\left[\left(\frac{e^{-1.2jn} - e^{-j\pi n}}{jn}\right) + \left(\frac{e^{j\pi n} - e^{j1.2n}}{jn}\right)\right]$$

$$= \frac{1}{2\pi}\left[\left(\frac{e^{j\pi n} - e^{-j\pi n}}{jn}\right) - \left(\frac{e^{j1.2n} - e^{-j1.2n}}{jn}\right)\right]$$

$$= \frac{1}{2\pi}\left[\sin\pi n - \sin(1.2)n\right] \qquad \left[\because \frac{e^{j\pi} - e^{-j\pi}}{2j} = \sin\pi\right]$$

$$\boxed{h_d(n) = \frac{\sin\pi n}{\pi n} - \frac{\sin(1.2)n}{\pi n}}$$

$-\left(\frac{N-1}{2}\right) \le n \le \frac{N-1}{2}$

$= -\left(\frac{8}{2}\right) \le n \le \frac{8}{2}$

$= -4 \le n \le 4.$

$$h_d(0) = \lim_{n\to 0}\frac{\sin\pi n}{\pi n} - \lim_{n\to 0}\frac{\sin(1.2)n}{\pi n}$$

By hospital Rule, $\frac{\sin\theta n}{n} = n.$

n=2

$h_d(2) = h_d(-2) = \frac{\sin 2\pi}{2\pi} - \frac{\sin(2\times 1.2)}{2\pi} = -0.65$

0.617

n=3

$h_d(3) = h_d(-3) = \frac{\sin 3\pi}{3\pi} - \frac{\sin(3\times 1.2)}{3\pi} = -0.65$

n=4

$h_d(4) = h_d(-4) = \frac{\sin 4\pi}{4\pi} - \frac{\sin(4\times 1.2)}{4\pi} = -0.65$

Step-2:

2) Hamming window technique

$\omega_H(n) = 0.54 + 0.46\left(\frac{\cos 2\pi n}{N-1}\right) \quad ; 0 \le n \le N-1$

$= 0 \quad ;$ otherwise

$N-1 = 9-1 = 8$

n=0

$\omega_H(0) = 0.54 + 0.46\left(\frac{\cos 2\pi(0)}{8}\right) = 1$

n=1

$\omega_H(1) = \omega_H(-1) = 0.54 + 0.46\left(\frac{\cos 2\pi(1)}{8}\right) = 0.995$

n=2

$\omega_H(2) = \omega_H(-2) = 0.54 + 0.46\left(\frac{\cos 2\pi(2)}{8}\right) = 0.99$ 0.65

n=3

Step 3:- $h1(n) = h_d(n) \times w(n)$

$n=0 \Rightarrow h(0) = h_d(0) \times w(0) = 0.618 \times 1 = 0.618$

$n=1 \Rightarrow h(1) = h(-1) = h_d(1) \times w(1) = 0.66 \times 0.59 = 0.389$

$n=2 \Rightarrow h(2) = h(-2) = h_d(2) \times w(2) = -0.65 \times 0.65 = -0.4235$

$n=3 \Rightarrow h(3) = h(-3) = h_d(3) \times w(3) = -0.65 \times 0.97 = -0.630$

$n=4 \Rightarrow h(4) = h(-4) = h_d(4) \times w(4) = -0.65 \times 0.76 = -0.49$

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

$h(n) = \{-0.494, -0.630, -0.4235, +0.389, 0.618, 0.389, -0.423, -0.630, -0.49\}$.

Step-4:-

Transfer function:-

$$H(z) = h(0) + \sum_{n=1}^{4} h(n)[z^n + z^{-n}]$$

$$H(z) = h(0) + [h(1)(z^1 + z^{-1}) + h(2)(z^2 + z^{-2}) + h(3)(z^3 + z^{-3}) + h(4)(z^4 + z^{-4})]$$

$$H(z) = 0.618[0.389(z^1 + z^{-1}) - 0.423(z^2 + z^{-2}) - 0.63(z^3 + z^{-3}) - 0.49(z^4 + z^{-4})]$$

Direct form-I

Casual Realise

$H'(z) = z^{-4} H(z)$

$H'(z) = z^{4} H(z)$

$H(z) = 0.618[$

11A) Given signal,

$x(n) = a^n u(n)$; $|a|<1$

i) The Spectrum of the signal

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

$= \sum_{n=0}^{\infty} a^n z^{-n}$

$= \sum_{n=0}^{\infty} (az^{-1})^n \Rightarrow \frac{1}{1-az^{-1}}$

$X(z) = \frac{z}{z-a}$

$z = e^{j\omega}$

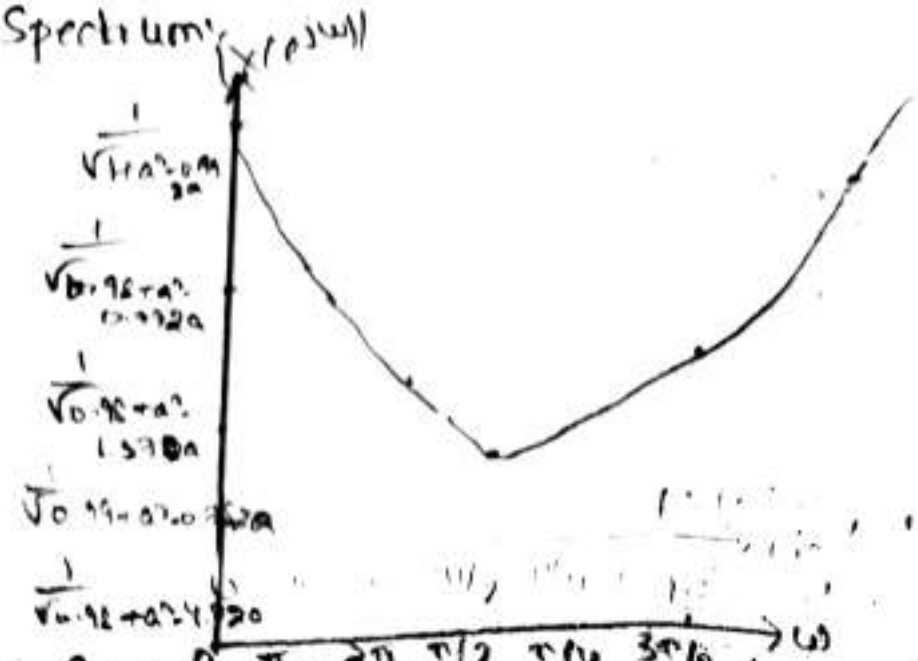
$X(e^{j\omega}) = \frac{e^{j\omega}}{e^{j\omega}-a} = \frac{\cos\omega + j\sin\omega}{\cos\omega + j\sin\omega - a}$

$= \frac{\cos\omega + j\sin\omega}{(\cos\omega - a) + j\sin\omega}$

$|X(e^{j\omega})| = \frac{\cos\omega \cdot 1}{\sqrt{(\cos\omega - a)^2 + \sin^2\omega}}$

$|X(e^{j\omega})| = \frac{1}{\sqrt{\cos^2\omega + a^2 - 2a\cos\omega}}$

Spectrum:



(ii) Sampling rate by 2.

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

$$= \sum_{n=0}^{\infty} a^{n/2} z^{-n}$$

$$= \sum_{n=0}^{\infty} (a^{1/2} z^{-1})^n \Rightarrow \frac{1}{1-\sqrt{a}z^{-1}}$$

$$= \frac{z}{z-\sqrt{a}} \Rightarrow z = e^{j\omega}$$

$$= \frac{e^{j\omega}}{e^{j\omega}-\sqrt{a}} \Rightarrow \frac{\cos\omega + j\sin\omega}{\cos\omega + j\sin\omega - \sqrt{a}} \Rightarrow |X(e^{j\omega})| = \frac{1}{\sqrt{(\cos\omega-\sqrt{a})^2 + \sin^2\omega}}$$

$$|X(e^{j\omega})| = \frac{1}{\sqrt{\cos^2\omega + a^2 - 2\sqrt{a}\cos\omega}}$$

ω	0	π	2π	$\pi/2$	$\pi/4$
$\lvert X(e^{j\omega})\rvert$	$\frac{1}{\sqrt{1+a^2}}$	$\frac{1}{\sqrt{1.5+a^2}}$	$\frac{1}{\sqrt{0.5+a^2}}$	$\frac{1}{\sqrt{0.5+a^2}}$	$\frac{1}{\sqrt{0.5+a^2}}$

Spectrum:

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Program			YEAR	SEMESTER	MID EXAMINATION
B.Tech ✓	M.Tech.	M.B.A.	III	II	II

HALL TICKET NO.										
2	1	C	1	1	A	0	4	6	7	

Regulation : | Branch or Specialization: ECE

Course: DSP

Signature of Student: HARK

Signature of invigilator with date: KH 9/10/24

Signature of the Evaluator: Suraj

Q.No. and Marks Awarded										
1	2	3	4	5	6	7	8	9	10	11
1	1	0	1	1	5					

Maximum Marks: 20 | Marks Obtained: 9

(Start Writing From Here)

(6) Given that

$H(S) = 2/((S+1)(S+2))$

we know that

$T=1$ sec

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

now

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

$= 2/\left(\frac{(1-z^{-1}+1)(1+z^{-1}+2)}{1+z^{-1}}\right)$

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

$H(z) = \frac{6(1+z^{-1}-1)(1+z^{-1}+2)}{1+z^{-1}}$

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

$H(z) = \frac{\cdot 2}{/\ /}$

$$H(z) = \frac{0.16(1+z^{-1})^2}{1.00\,3z^{-1}}$$

5

Hence proved. bilinear transformation to transfer function.

(1) To FIR filters the transfer function of
* signal symbol
* smoothly
* signal eduction

(2) * Triangle
* window
* Triangular window
* Hamming window
*

(5) $y\left(e^{j\omega} = \sum_{m=0} x(e^{-jm})\left(\frac{z}{a+w}\right)\right)$

equation of frequency response.

(3) linear phase FIR filter is frequency.

(4) * no of samples per second d known as sampling rate.
* Sampling process continue to time signal to the sequential numbers

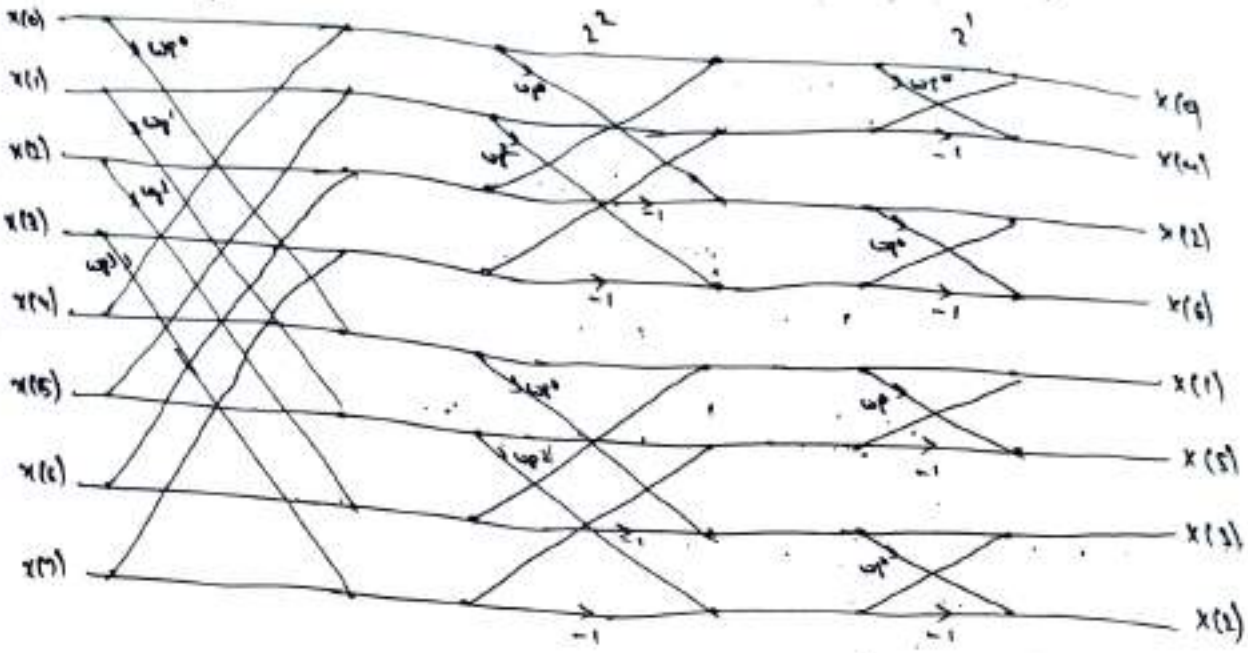
Design 8 bit DIF algorithm

8 bit DIF:

$N = 8$

$= 2^3$

$M = 3 =$ No. of stages



Natural	Bit Reversal
x(0) - 000	000 - x(0)
x(1) - 001	100 - x(4)
x(2) - 010	010 - x(2)
x(3) - 011	110 - x(6)
x(4) - 100	001 - x(1)
x(5) - 101	101 - x(5)
x(6) - 110	011 - x(3)
x(7) - 111	111 - x(7)

$x(k) = \{x(0), x(1), \ldots\ldots, x(7)\}$

Design a High Pass filter with hamming window with a cut-off of 1.2 rad/sec, N=9 & realise with direct form-II.

1. Here,

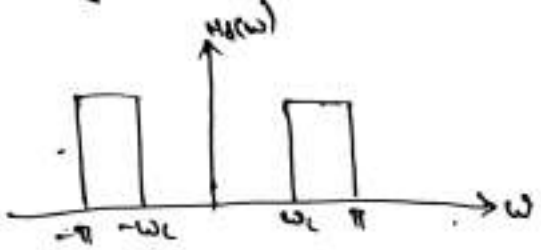
Given

$\Omega_c = 1.2$ rad/sec

As sampling frequency is not given

Assume $f_s = 1$ Hz

$\omega_c = \frac{2\Omega_c}{f_s} = 1.2$ rad/sample.



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

$= \frac{1}{2\pi}\left[\int_{-\pi}^{-1.2} e^{j\omega n}\, d\omega + \int_{1.2}^{\pi} e^{j\omega n}\, d\omega\right]$

$= \frac{1}{2\pi}\left[\left(\frac{e^{j\omega n}}{jn}\right)_{-\pi}^{-1.2} + \left(\frac{e^{j\omega n}}{jn}\right)_{1.2}^{\pi}\right]$

$= \frac{1}{2\pi}\left[\left(\frac{e^{-j1.2n} - e^{-j\pi n}}{jn}\right) + \left(\frac{e^{j\pi n} - e^{j1.2n}}{jn}\right)\right]$

$= \left[\left(\frac{e^{j\pi n} - e^{-j1.2n}}{2\pi jn}\right) - \left(\frac{e^{j1.2n} - e^{-j\pi n}}{2\pi jn}\right)\right]$

$h_d(n) = \frac{\sin \pi n}{\pi n} - \frac{\sin(1.2)n}{\pi n}$

Given, N=9

$\left[\frac{N-1}{2}\right] = \left[\frac{9-1}{2}\right] = 4$

$h_d(0) = \lim_{n\to 0} \frac{\sin \pi n}{\pi n} - \lim_{n\to 0} \frac{\sin(1.2)n}{\pi n}$

Q4

$$w_H(3) = w_H(-3) = 0.54 + 0.46\cos\left(\frac{3\pi}{4}\right)$$

$$= 0.2147$$

$$w_H(4) = w_H(-4) = 0.54 + 0.46\cos\left(\frac{4\pi}{4}\right)$$

$$= 0.08.$$

3. $h[n] = h_d(n) \cdot w_H(n)$

$$h(0) = h_d(0)\, w_H(0) = 0.6180 \times 1 = 0.6180$$

$$h(1) = h_d(1) \times w_H(1) = (-0.1075)(0.54)$$

$$= -0.05805$$

$$h(4) = h_d(4) w_H(4) = (0.07927)(0.08) = 0.00634$$

$$h(n) = \{0.00634,\ 0.01008,\ -0.05805,\ -0.15667,\ 0.6180,\ -0.15667,\ -0.05805,$$

$$0.01008,\ 0.00634\}$$

4. Transfer Function :-

$$H(z) = \sum_{n=-0}^{0} h(n) z^{-n}$$

$$= \sum_{n=-b}^{a} h(n) z^{-n}$$

$$= \sum_{n=-4}^{-1} h(n) z^{-n} + h(0) + \sum_{n=1}^{4} h(n) z^{-n}$$

$$H(z) = h(0) + \sum_{n=1}^{4} h(n)\left[z^{n} + z^{-n}\right]$$

$$= 0.618 - 0.15(6)(z + z^{-1}) - 0.05805\left(z^{2} + z^{-2}\right) + 0.01008\left(z^{3} + z^{-3}\right)$$

$$+ 0.00634\left(z^{4} + z^{-4}\right)$$

Now to make it causal

$$h(n) = h(n-6) \xrightarrow{z} z^{-4} H(z)$$

$$H'(z) = z^{-4} H(z)$$

$$H'(z) = \left[0.168 - 0.2566\left(z + z^{-1}\right) - 0.05805\left(z^{2} + z^{-2}\right) + 0.01008\left(z^{3} + z^{-3}\right)\right.$$

$$\left. + 0.00634\left(z^{4} + z^{-4}\right)\right] z^{-4}$$

by hospital rule

$$\lim_{\theta \to 0} \frac{\sin\theta}{\theta} = 1$$

$$= 1 - \frac{1.1}{\pi}$$

$$h_d(0) = 0.6180$$

$$h_d[1] = h_d[-1] = \frac{\sin\pi}{\pi} - \frac{\sin(1.1)}{\pi}$$

$$= 0 - 0.2986$$

$$= -0.2986$$

$$h_d[2] = h_d[-2] = \frac{\sin 2\pi}{2\pi} - \frac{\sin(1.1\times 2)}{2\pi}$$

$$= -0.1075$$

$$h_d[3] = h_d[-3] = \frac{\sin 3\pi}{3\pi} - \frac{\sin(1.1\times 3)}{3\pi}$$

$$= 0.04615$$

$$h_d[4] = h_d[-4] = \frac{\sin 4\pi}{4\pi} - \frac{\sin(1.1\times 4)}{4\pi}$$

$$= 0.07927$$

2. Hamming window:-

$$w_H(n) = 0.54 + 0.46\cos\left[\frac{2\pi n}{N-1}\right]$$

$$-\frac{(N-1)}{2} \le n \le \left(\frac{N-1}{2}\right)$$

$w_H[0] = 1$

$$w_H[1] = w_H[-1] = 0.54 + 0.46\cos\left(\frac{2\pi}{8}\right)$$

$$= 0.8652$$

$$w_H[2] = w_H[-2] = 0.54 + 0.46\cos\left(\frac{4\pi}{8}\right)$$

$$= 0.54$$

For $n=5$

$$h_d(5) = h_d(-5) = 0$$

Step (ii): rectangular window sequence $w=1$

$$w_R(n) = \begin{cases} 1 & : -\left(\frac{N-1}{2}\right) \le n \le \frac{N-1}{2} \\ 0 & : \text{otherwise} \end{cases}$$

$$w_R(n) = w_R(-n)$$

$$w_R(0) = 1$$

$$w_R(1) = w_R(1) = w_R(2) = w_R(-2) = w_R(3) = 1$$

$$w_R(4) = w_R(-4) = w_R(-3) = w_R(4) = w_R(-5) = 1$$

Step iii: multiply $h_d(n)$ & $w_R(n)$ to get $h(n)$ for $N=11$.

$$h(n) = \begin{cases} h_d(n) \cdot w_R(n) & -5 \le n \le 5 \\ 0 & \text{otherwise.} \end{cases}$$

$$h(0) = h_d(0) \cdot w_R(0) = 0.5 \times 1 = 0.5$$

$$h(1) = h_d(1) \cdot w_R(1) = 0 \times 1 = 0 \quad \therefore h(1) = h(-1) = 0$$

$$h(2) = h_d(2) \cdot w_R(2) = -0.3183 \times 1 = -0.3183$$

$$h(2) = h(-2) = -0.3183$$

$$h(3) = h_d(3) \cdot w_R(3) = 0 \times 1 = 0 \quad \therefore h(3) = h(-3) = 0$$

$$\because h(4) = h(-4) = 0 \quad \& \quad h(5) = h(-5) = 0.$$

Step (iv):

$$H(z) = z^{-\left(\frac{N-1}{2}\right)} \left\{ h(0) + \sum_{n=1}^{\frac{N-1}{2}} h(n)\left(z^n + z^{-n}\right) \right\} = z^{-5} \left\{ h(0) + h(1)\left(z^1 + z^{-1}\right) + h(2)\left(z^2 + z^{-2}\right) + h(3)\left(z^3 + z^{-3}\right) + h(4)\left(z^4 + z^{-4}\right) + h(5)\left(z^5 + z^{-5}\right) \right\}$$

$$H(z) = 0.5\, z^{-5} - 0.3183 z^{-3} - 0.3183 z^{-7}$$

T.F of band pass filter is

$$H(z) = -0.3183 z^{-3} + 0.5 z^{-5} - 0.3183 z^{-7}.$$

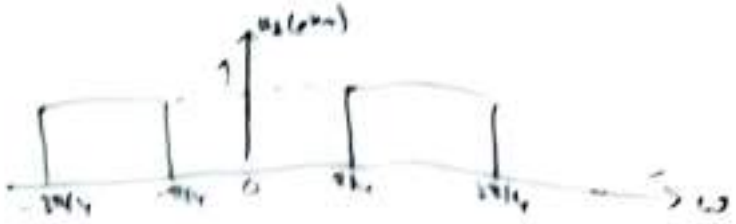
The linear phase FIR filter coefficients:

$$h(0) = 0,\ h(1) = 0,\ h(2) = 0,\ h(3) = -0.3183,\ h(4) = 0,\ h(5) = 0.161 = 0,\ h(6) = -0.3183,\ h(7) = 0,$$

$$h(8) = 0,\ h(10) = 0.$$

$$\therefore h(n) = \{ \underset{\uparrow}{0}, 0, 0, -0.3183, 0, 0.5, 0, -0.3183, 0, 0, 0 \}.$$

(i)



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

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

$$= \frac{1}{2\pi}\left\{\left(\frac{e^{j\omega n}}{jn}\right)_{-\frac{2\pi}{4}}^{-\frac{\pi}{4}} + \left(\frac{e^{j\omega n}}{jn}\right)_{\frac{\pi}{4}}^{\frac{2\pi}{4}}\right\} = \left\{\frac{1}{2\pi n}\left[e^{-j\frac{\pi n}{4}} - e^{-j\frac{2\pi n}{4}} + e^{j\frac{2\pi n}{4}} - e^{j\frac{\pi n}{4}}\right]\right.$$

$$h_d(n) = \frac{1}{n\pi}\left[\sin\left(\frac{2\pi n}{4}\right) - \sin\left(\frac{\pi n}{4}\right)\right]$$

The impulse response sequence $h_d(n)$ is symmetric about $n=0$; $\alpha = \frac{M-1}{2} = 5$

$$h_d(n) = h_d(-n)$$

$$h_d(n) = \left\{\frac{\sin\frac{2\pi n}{4} - \sin\frac{\pi n}{4}}{n\pi}\right\}$$

* For $n=0$, $h_d(0)$ becomes indeterminate

$$h_d(0) = \lim_{n\to 0}\left(\frac{\sin\frac{2\pi n}{4}}{n\pi}\right) - \lim_{n\to 0}\left(\frac{\sin\frac{\pi n}{4}}{n\pi}\right)$$

$$= \frac{2}{4}\cdot\frac{1}{4} = \frac{2}{4} = 0.5 \quad \therefore h_d(0) = 0.5$$

* For $n=1$

$$h_d(1) = h_d(-1) = 0$$

* For $n=2$

$$h_d(2) = \frac{\sin\frac{2\pi}{2} - \sin\frac{\pi}{2}}{2\pi}$$

$$= -\frac{1}{\pi}$$

$$h_d(2) = h_d(-1) = -0.3183$$

* For $n=3$

$$h_d(3) = h_d(-3) = 0$$

* For n=...

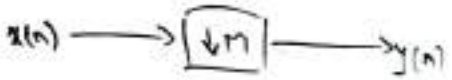
Illustrate the decimation process with a factor of 2 and derive the expression for spectrum of decimator output

Down sampling :- Reduces the no. of samples or reduces the sampling rate

The sampling rate of a discrete time signal x(n) can be reduced by a factor M by taking every M^{th} value of the signal.

The output signal y(n) is down sampled signal of the input signal x(n) and can be represented by

$$y(n) = x(Mn)$$



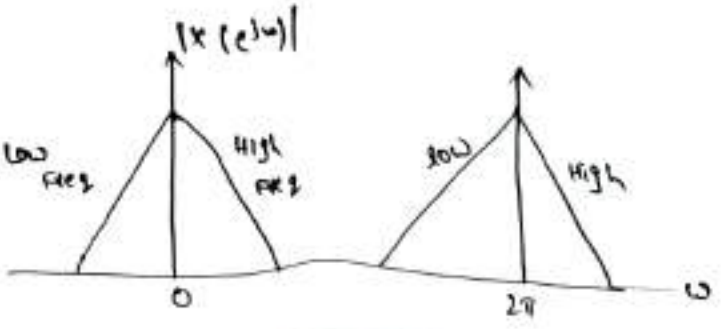
$$x(n) = \{1, 2, 4, 6, 7, 9, 2, 3, 5\}$$

Let M = down sample rate = 2. From x(n) we need to pickout the multiple of 2 - data.

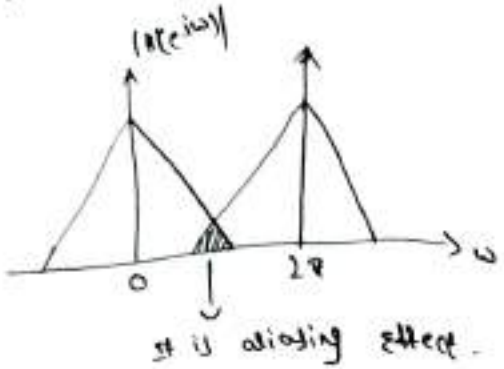
$$y(n) = x(2n) = \{1, 2, 7, -2, 5\}$$

∴ That is, we left in General M-1 samples in b/w sample of x(n) to generate y(n).

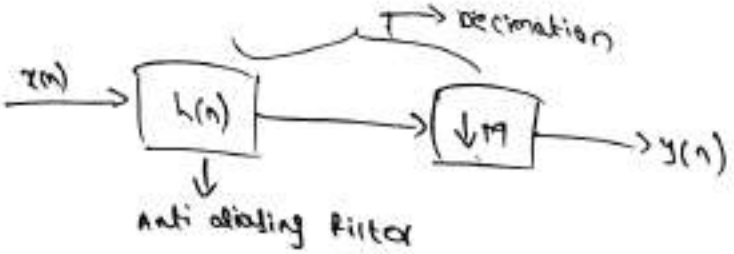
Spectrum:-



Due to down sampling, the high frequency samples overlap with low freq signals. So, it causes to the aliasing effect.



To avoid the aliasing effect we use the anti aliasing effect filter, LPF filter is used. So, we are limiting the frequency to the aliasing effect.



Before going to the down sampler, first we need to limit the band of the filter by using anti aliasing filter and then given it to the down sampler

Frequency response of Down sampling :-

$$y(n) = x(Mn)$$

In Z-transform

$$Y(z) = \frac{1}{M} \sum_{k=0}^{M-1} \left[X\left(e^{-j2\pi \frac{k}{M}} z^{1/M}\right) \right]$$

$$z = e^{j\omega}$$

$$Y(e^{j\omega}) = \frac{1}{M} \sum_{k=0}^{M-1} X\left(e^{-j2\pi \frac{k}{M}} e^{j\omega/M}\right)$$

Pg 2

$$Y(e^{j\omega}) = \frac{1}{M}\sum_{k=0}^{M-1} X\left(e^{j(\omega - 2\pi k/M)}\right)$$

Consider the signal $x(n) = a^n u(n)$, for $|a|<1$

i) Determine the spectrum of the signal

ii) Determine the spectrum of the signal if it is applied to an interpolator that increases the sampling rate by 2.

Given that,

$$x(n) = a^n u(n), \quad |a| < 1$$

Taking z-transform

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

$$X(z) = \sum_{n=0}^{\infty} (az^{-1})^n = \frac{1}{1-az^{-1}} = \frac{z}{z-a}, \quad |z| > a$$

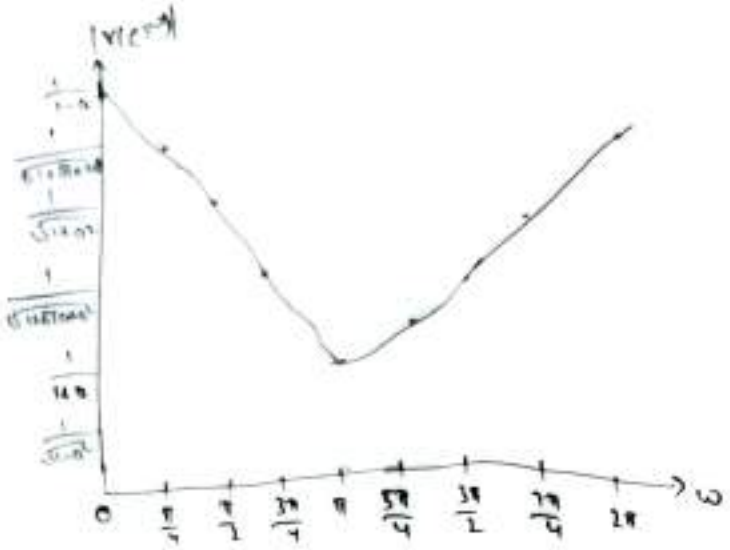
Sub $z = e^{j\omega}$

$$X(e^{j\omega}) = \frac{e^{j\omega}}{e^{j\omega} - a} = \frac{\cos\omega + j\sin\omega}{\cos\omega + j\sin\omega - a}$$

$$X(e^{j\omega}) = \frac{\cos\omega + j\sin\omega}{(\cos\omega - a) + j\sin\omega}$$

$$|X(e^{j\omega})| = \frac{1}{\sqrt{(\cos\omega - a)^2 + \sin^2\omega}} = \frac{1}{\sqrt{1 - 2a\cos\omega + a^2}}$$

ω	0	$\frac{\pi}{4}$	$\frac{\pi}{2}$	$\frac{3\pi}{4}$	π	$\frac{5\pi}{4}$	$\frac{3\pi}{2}$	$\frac{7\pi}{4}$	2π	
$\lvert X(e^{j\omega})\rvert$	$\frac{1}{1-a}$	$\frac{1}{\sqrt{1-\sqrt{2}a+a^2}}$	$\frac{1}{\sqrt{1+a^2}}$	$\frac{1}{\sqrt{1+\sqrt{2}a+a^2}}$	$\frac{1}{1+a}$	$\frac{1}{\sqrt{1+\sqrt{2}a+a^2}}$	$\frac{1}{\sqrt{1+a^2}}$	$\frac{1}{\sqrt{1+\sqrt{2}a+a^2}}$	$\frac{1}{1-a}$	



magnitude spectrum of $x(\omega)$

ii) The interpolated signal $x(n)$ is obtained by increasing the sampling rate by a factor of '2'.

$$y(n) = x(n/2) = a^{n/2} \cdot u(n)$$

$$Y(z) = \sum_{n=0}^{\infty} a^{n/2} \cdot z^{-n} = \sum_{n=0}^{\infty} \left(a^{\frac{1}{2}} \cdot z^{-1}\right)^n$$

$$Y(z) = \frac{1}{1-\sqrt{a}z^{-1}} = \frac{z}{z-\sqrt{a}} \qquad |z| > \sqrt{a}$$

$$z = e^{j\omega}$$

$$Y(e^{j\omega}) = \frac{e^{j\omega}}{e^{j\omega}-\sqrt{a}} = \frac{\cos\omega + j\sin\omega}{(\cos\omega - \sqrt{a}) + j\sin\omega}$$

$$Y(e^{j\omega}) = \frac{1}{\sqrt{(\cos\omega - \sqrt{a})^2 + \sin^2\omega}}$$

$$= \frac{1}{\sqrt{1 + a - 2\sqrt{a}\cos\omega}}$$

ω	0	$\frac{\pi}{4}$	$\frac{\pi}{2}$	$\frac{3\pi}{4}$	π	$\frac{5\pi}{4}$	$\frac{3\pi}{2}$	$\frac{7\pi}{4}$	2π
$\lvert Y(e^{j\omega})\rvert$	$\frac{1}{1-\sqrt{a}}$	$\frac{1}{\sqrt{1-\sqrt{2}a+a}}$	$\frac{1}{\sqrt{1+a}}$	$\frac{1}{\sqrt{1+\sqrt{2}a+a}}$	$\frac{1}{1+\sqrt{a}}$	$\frac{1}{\sqrt{1+\sqrt{2}a+a}}$	$\frac{1}{\sqrt{1+a}}$	$\frac{1}{\sqrt{1+\sqrt{2}a+a}}$	$\frac{1}{1-\sqrt{a}}$

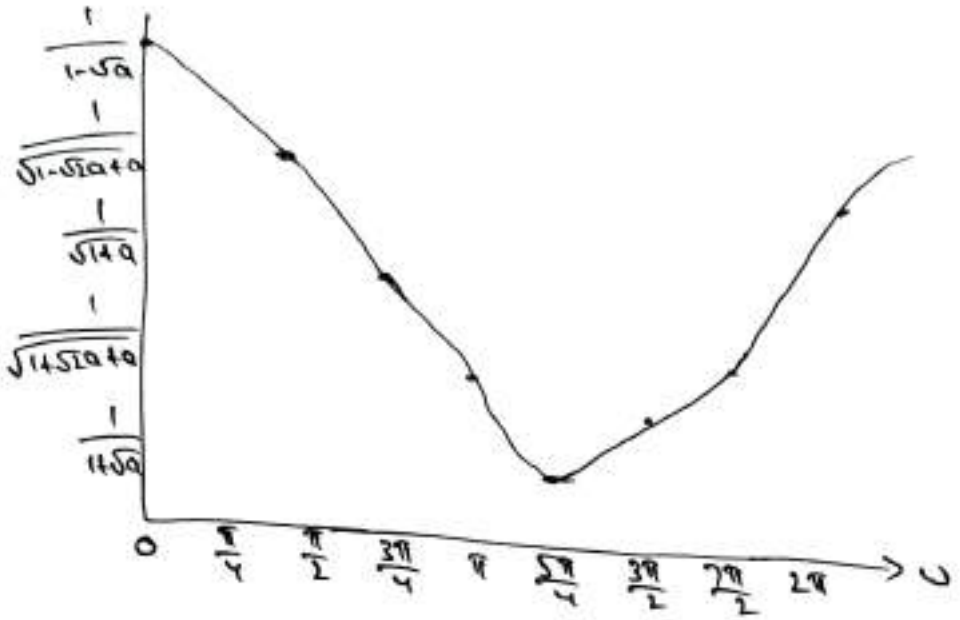


Fig:- magnitude spectrum of $y(n) = x(n/2)$

II – Mid Assignment

Digital Signal Processing

Name:- B. Sridhar H.T.No:- 21C11A0496 Section:- ECE-B

1) Design 8-bit DIF algorithm?

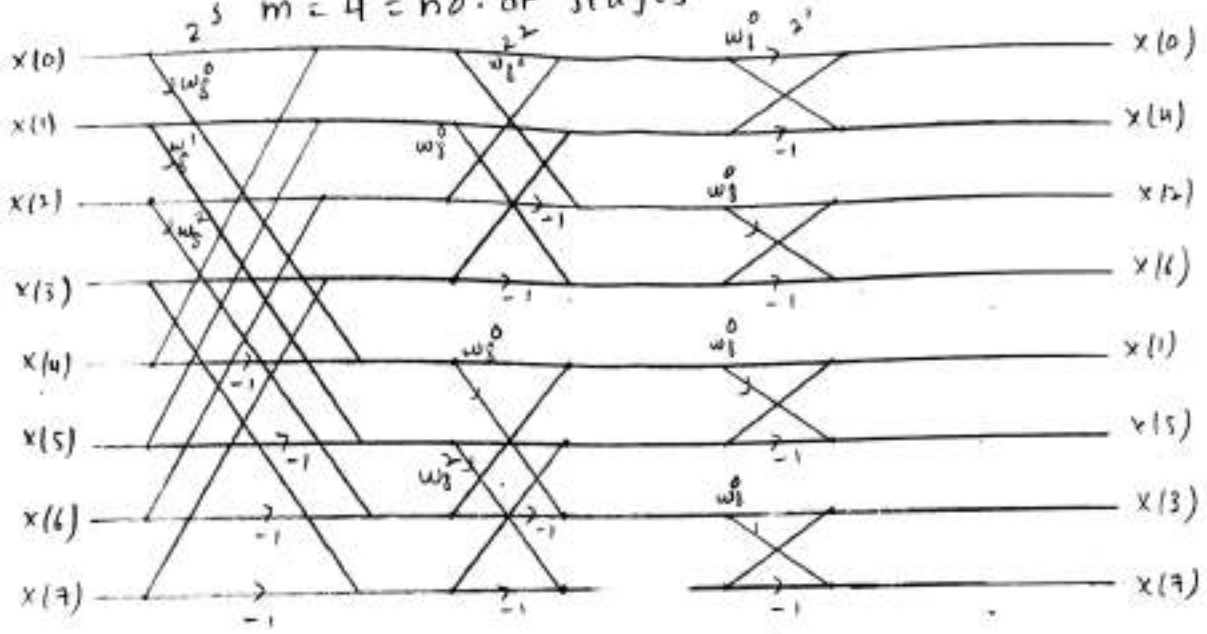
25/5 (5) deep

A) 8bit DIF:-

$N = 8$

$2^m = 2^4$

$m = 4 =$ no. of stages



Natural	Bit reversal
x(0) - 000	000 - x(0)
x(1) - 001	100 - x(4)
x(2) - 010	010 - x(2)
x(3) - 011	110 - x(6)
x(4) - 100	001 - x(1)
x(5) - 101	101 - x(5)
x(6) - 110	011 - x(3)
x(7) - 111	111 - x(7)

5

$Y(k) = \{x(0), x(1) \ldots x(7)\}$

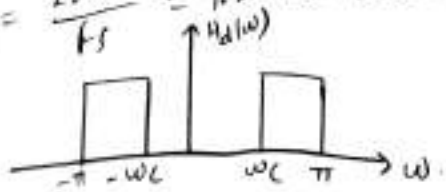
① Design a high pass Filter with hamming window with a Frequency of 1.2 rad/sec, N = 9 & realise with direct FO.

A. Here Given $\Omega c = 1.2$ rad/sec

As Sampling frequency is not given

Assume $fs = 1117$

$$\omega c = \frac{2\Omega c}{fs} = 1.2 \text{ rad/sample.}$$



$$1.\ h_d(n) = \frac{1}{2\pi}\int_{-\pi}^{\pi} H_d(\omega)\, e^{j\omega n}\, d\omega \quad [\because \omega = e^{j\omega n}]$$

$$= \frac{1}{2\pi}\left[\int_{-\pi}^{-1.2} e^{j\omega n}\, d\omega + \int_{1.2}^{j} e^{j\omega n}\, d\omega\right]$$

$$= \frac{1}{2\pi}\left[\left(\frac{e^{j\omega n}}{jn}\right)^{-1.2} + \left(\frac{e^{j\omega n}}{jn}\right)_{1.2}^{\pi}\right]$$

$$= \frac{1}{2\pi}\left[\left(\frac{e^{-j1.2n} - e^{-j\pi n}}{jn}\right) + \left(\frac{e^{j\pi n} - e^{+j\pi n}}{jn}\right)\right]$$

$$h_d(n) = \left[\left(\frac{e^{j\pi n} - e^{-j\pi n}}{2\pi jn}\right) - \left(\frac{e^{j1.2n} - e^{-j1.2n}}{2\pi jn}\right)\right]$$

$$h_d(n) = \frac{\sin\pi n}{\pi n} - \frac{\sin(1.2)n}{\pi n}$$

Given $N = 9 \Rightarrow -\left[\frac{N-1}{2}\right] \le n \le \left[\frac{N-1}{2}\right] \Rightarrow -\left[\frac{8}{2}\right] \le n \le \left[\frac{8}{2}\right]$

$$h_d(0) = \lim_{n\to 0} \frac{\sin\pi n}{\pi} - \lim_{n\to 0} \frac{\sin(1.2)n}{\pi n}$$

by hospital rule $\lim_{\theta\to 0} \frac{\sin\theta}{\theta} = n$

$$= 1 - \frac{1.2}{\pi}$$

$$h_d(0) = 0.6180$$

$$h_d[1] = h_d[-1] = \frac{\sin\pi - \sin(1.2)}{\pi}$$

$= 0 - 0.29667$

$= -0.29667$

$h_d[2] = h_d[-2] = \frac{\sin 2\pi}{2\pi} - \frac{\sin(1.2\times 2)}{2\pi} = -0.1075$

$h_d[3] = h_d[-3] = \frac{\sin 3\pi}{3\pi} - \frac{\sin(1.2\times 3)}{3\pi}$

$= 0.04895$

$h_d[4] = h_d[-4] = \frac{\sin 4\pi}{4\pi} - \frac{\sin(1.2\times 4)}{4\pi}$

$= 0.07927$

2. Hamming window:

$$w_H(n) = 0.54 + 0.46\cos\left[\frac{2\pi n}{N-1}\right]$$

$$-\frac{(N-1)}{2} \le n \le \left(\frac{N-1}{2}\right)$$

$w_H[0] = 1$

$w_H[1] = w_H[-1] = 0.54 + 0.46\cos[2\pi/8]$

$= 0.8652$

$w_H[2] = w_H[-2] = 0.54 + 0.46\cos[4\pi/8]$

$= 0.54$

$w_H[3] = w_H[-3] = 0.54 + 0.46\cos\left[\frac{6\pi}{8}\right]$

$= 0.2147$

$w_H[4] = w_H[-4] = 0.54 + 0.46\cos[8\pi/8]$

$= 0.08$

3. $h[n] = h_d[n] \cdot w_H[n]$

$h[0] = h_d[0] w_H[0] = 0.6180 \times 1$

$= 0.6180$

$h[-1] = h[1] = h_d[1] w_H[1] = (-0.29667)(0.8652)$

$= -0.25667$

$h[-2] = h[2] = h_d[2] w_H[2] = (-0.1075)(0.54)$

$= -0.05805$

$h[-3] = h[3] = h_d[3] w_H[3] = (0.04695)(0.214$

$= 0.01008$

$h[-4] = h[4] = h_d[4] w_H[4] = (0.07927)(0.08)$

$= 0.00634$

$h[n] = \{0.00634, 0.01008, -0.05805, -0.25667,$

$0.6180, -0.25667, -0.05805, 0.01008, 0.006$

4. Transfer function:

$$H(z) = \sum_{n=-\infty}^{\infty} h(n) z^{-n}$$

$$= \sum_{n=-b}^{\infty} h(n) z^{-n}$$

$$= \sum_{n=-4}^{-1} h(n) z^{-n} + h(0) + \sum_{n=1}^{4} h(n) z^{-n}$$

as $h(n) = h(-n)$

$$H(z) = h(0) + \sum_{n=1}^{4} h(n) [z^n + z^{-n}]$$

$$= 0.618 - 0.25667(z + z^{-1}) - 0.05805(z^2 + z^{-2}) + 0.01008(z^3 + z^{-3})$$

$$+ 0.00634(z^4 + z^{-4})$$

Now to make it causal.

$$h'(n) = h(n-4) \xrightarrow{z} z^{-4} H(z)$$

$$H'(z) = z^{-4} H(z)$$

$$H'(z) = [0.618 - 0.2566(z + z^{-1}) - 0.05805(z^2 + z^{-2})$$

$$+ 0.01808(z^3 + z^{-3}) + 0.00634(z^4 + z^{-4})] z$$

4) Design and draw band pass filter with $H_d(e^{j\omega}) = 1$ for $\pi/2 \le \omega \le 3\pi/4$ $= 0$ otherwise. using rectangular window for $N = 5$

$H_d(e^{j\omega}) = 1$, for $\pi/2 \le |\omega| \le 3\pi/4$

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

$$= \frac{1}{2\pi}\left[\int_{-3\pi/4}^{-\pi/2} e^{j\omega n}\, d\omega + \int_{\pi/2}^{3\pi/4} e^{j\omega n}\, d\omega\right]$$

$$= \frac{1}{2\pi}\left[\left[\frac{e^{j\omega n}}{jn}\right]_{-3\pi/4}^{-\pi/2} + \left[\frac{e^{j\omega n}}{jn}\right]_{\pi/2}^{3\pi/4}\right]$$

$$= \frac{1}{2\pi}\left[\frac{e^{-j\pi/2 n} - e^{-3\pi/2 jn}}{jn}\right] + \left[\frac{e^{j3\pi/4} - e^{j\pi/2 n}}{jn}\right]$$

$$= \frac{1}{\pi n}\left[\frac{e^{j3\pi/4 n} - e^{j3\pi/4 n}}{2j}\right] + \left[\frac{e^{j\pi/2 n} - e^{-j\pi/2}}{2j}\right.$$

$$h_d(n) = \frac{1}{\pi n}\left[\sin\frac{3\pi}{4}n - \sin\frac{\pi}{2}n\right]$$

$h(n) = h_d(n)$ for $|n| \le 2$

$= 0$ otherwise.

The filter coefficient are symmetrical $n = 0$

$h(n) = h(-n)$

$$h(0) = \frac{1}{2\pi}\left[\int_{-3\pi/4}^{-\pi/2} d\omega + \int_{\pi/2}^{3\pi/4} d\omega\right]$$

$$= \frac{1}{2\pi}\left[-\pi/2 + \frac{3\pi}{4} + \frac{3\pi}{4} - \frac{\pi}{2}\right]$$

$$= \frac{1}{2\pi}\left[\frac{1}{2}\pi\right]$$

$$= \frac{1}{2\pi}\left[\pi/2\right]$$

$$= \frac{1}{4} = 0.25$$

$$h(1) = h(-1) = \frac{\sin\frac{3\pi}{4} - \sin\pi/2}{\pi} = -0.093$$

$$h(2) = h(-2) = \frac{\sin\frac{3\pi}{2} - \sin\pi}{2\pi}$$

$$h(2) = h(-2) = -0.159$$

$$h(n) = h_d(n) * w_n(n)$$

$$h(0) = h_d(1) * 1$$

$$h(0) = 0.25$$

$$h(1) = -0.0234 \qquad w_R(n) = 1.$$

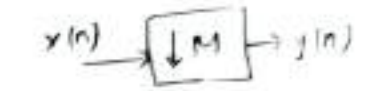
$$h(2) = -0.159$$

$$h(n) = \{0.25, -0.093, -0.154\}$$

Illustrate the decimation process with a factor of D and derive the Expression for spectrum of decimator output

Down sampling :- reduces the no. of samples or reduces the sampling rate the sampling rate of a discrete time signal $x(n)$ can be reduced by a factor M by taking every M^{th} value of signal the output signal $y(n)$ is down sampled signal of the input signal $x(n)$ and can be represented by

$$y(n) = x(Mn)$$

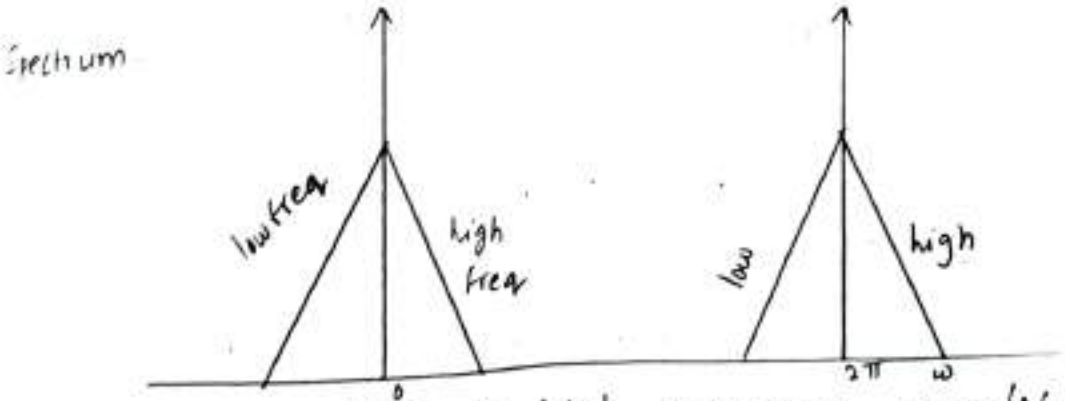


$$x(n) = \{1, 2, 4, 6, 7, 9, 2, 3, 5\}$$

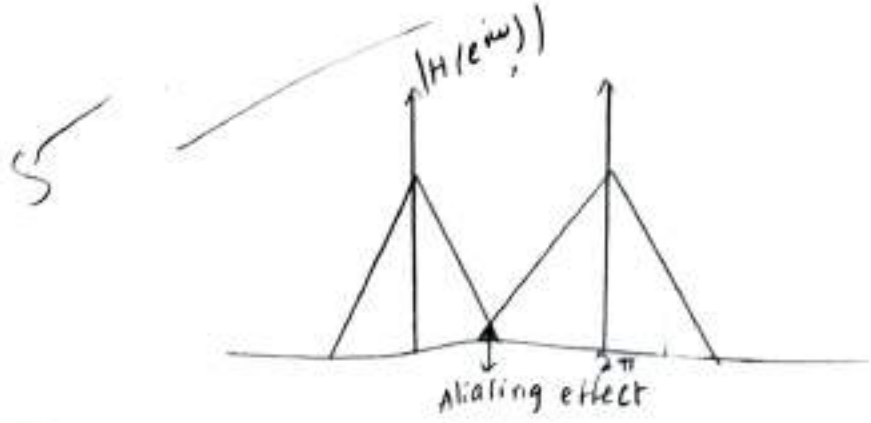
M = down sample rate from $x(n)$ we need to pickup the multiple of 2 data.

$$y(n) = x(2n) = \{1, 4, 7, -2, 5\}$$

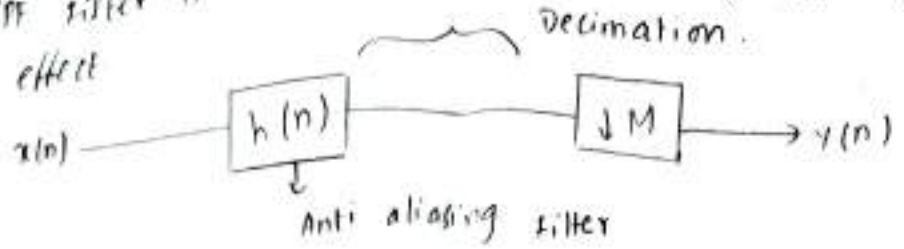
∴ that is, we left in general $M-1$ samples in blw sample of $x(n)$ to generate $y(n)$



Due to down sampling the high frequency samples overlap with low frequency signals it causes to the aliasing effect



To avoid the aliasing effect we use the anti-aliasing filter. BPF filter is used. So we are limiting the frequency to aliasing effect



Before giving to the down sampler, First wee need to limit the ba of the filter by using anti aliasing filter and then given it to down sampler.

Frequency response of down sampling

$$y(n) = x(Mn)$$

in Z-transform $Y(z) = \frac{1}{M} \sum_{k=0}^{M-1} \left[X \left[e^{-j2\pi \frac{k}{M}} z^{1/M} \right] \right]$

$z = e^{j\omega}$

$$Y(e^{j\omega}) = \frac{1}{M} \sum_{k=0}^{M-1} X \left[e^{-j\pi k/M} e^{j\omega/M} \right]$$

$$Y(e^{j\omega}) = \frac{1}{M} \sum_{k=0}^{M-1} X \left[e^{j(\omega - 2\pi k/M)} \right]$$

(2) Consider the signal $x(n) = a^n u(n)$ for $|a| < 1$

(i) Determine the spectrum of the signal

(ii) Determine the spectrum of the signal if it is applied to an interpolator that increases the sampling rate by 2.

A. Given that, $x(n) = a^n u(n) \quad |a| < 1$

taking Z-transform

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

$$X(z) = \sum_{n=0}^{\infty} (az^{-1})^n$$

z , $|z| > a$.

Sub $z = e^{j\omega}$

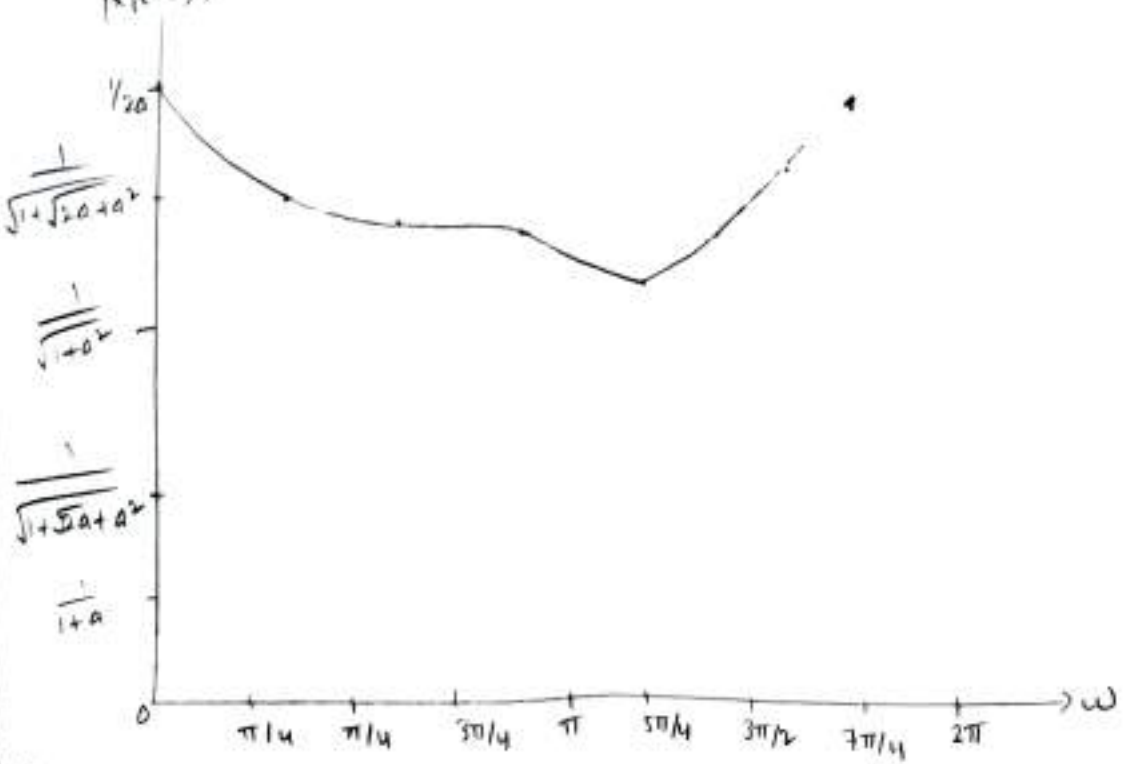
$$X(e^{j\omega}) = \frac{e^{j\omega}}{e^{j\omega} - a} = \frac{\cos\omega + j\sin\omega}{\cos\omega + j\sin\omega - a}$$

$$X(e^{j\omega}) = \frac{\cos\omega + j\sin\omega}{(\cos\omega - a) + j\sin\omega}$$

$$|X(e^{j\omega})| = \sqrt{(\cos\omega - a)^2 + \sin^2\omega} = \sqrt{1 - 2a\cos\omega + a^2}$$

ω	0	$\pi/4$	$\pi/2$	$3\pi/4$	π	$5\pi/4$	$3\pi/2$	$7\pi/4$	2π
$\lvert X(e^{j\omega})\rvert$	$\frac{1}{1-a}$	$\frac{1}{\sqrt{1-\sqrt{2}a+a^2}}$	$\frac{1}{\sqrt{1+a^2}}$	$\frac{1}{\sqrt{1+\sqrt{2}a+a^2}}$	$\frac{1}{1+a}$	$\frac{1}{\sqrt{1+\sqrt{2}a+a^2}}$	$\frac{1}{\sqrt{1+a^2}}$	$\frac{1}{\sqrt{1+\sqrt{2}a+a^2}}$	$\frac{1}{1-a}$

The Frequency spectrum of the signal $x(n)$ as shown in Fig



ii) The interpolated signal $x(n)$ is obtained by increasing the sampling rate by a factor of '2'

$$x(n) = x(n/2) = a^{n/2} u(n)$$

$$Y(z) = \sum_{n=0}^{\infty} a^{n/2} z^{-n} = \sum_{n=0}^{\infty} (a^{1/2} z^{-1})^n$$

$$Y(z) = \frac{1}{1 - \sqrt{a} z^{-1}} = \frac{z}{z - \sqrt{a}} \quad |z| > \sqrt{a}$$

$z = e^{j\omega}$

$$Y(e^{j\omega}) = \frac{e^{j\omega}}{e^{j\omega}\sqrt{a}} = \frac{\cos\omega + j\sin\omega}{(\cos\omega - \sqrt{a}) + j\sin\omega}$$

$$Y(e^{j\omega}) = \frac{1}{\sqrt{(\cos\omega - \sqrt{a})^2 + \sin^2\omega}}$$

$$= \frac{1}{\sqrt{1 + a - 2\sqrt{a}\cos\omega}}$$

ω	0	$\pi/4$	$\pi/2$	$3\pi/4$	π	$5\pi/4$	$3\pi/2$	$7\pi/4$	2π
$\lvert Y(e^{j\omega})\rvert$	$\frac{1}{1-\sqrt{a}}$	$\frac{1}{\sqrt{1-\sqrt{2}a+a}}$	$\frac{1}{\sqrt{1+a^2}}$	$\frac{1}{\sqrt{1+\sqrt{2}a+a}}$	$\frac{1}{1+\sqrt{a}}$	$\frac{1}{\sqrt{1+\sqrt{2}a+a}}$	$\frac{1}{\sqrt{1+a}}$	$\frac{1}{\sqrt{1+\sqrt{2}a+a}}$	$\frac{1}{\sqrt{1+\sqrt{a}}}$

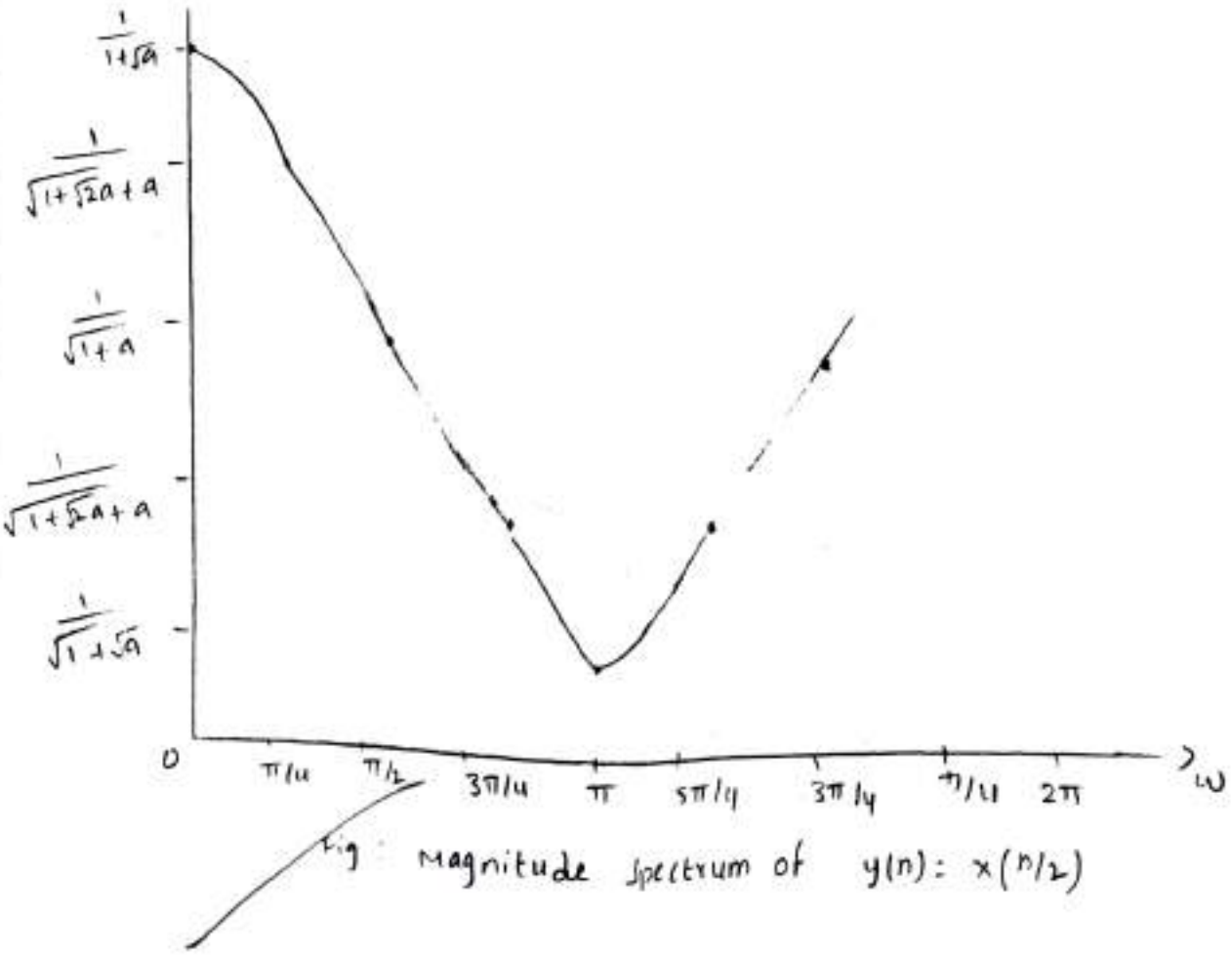


Fig Magnitude spectrum of $y(n) = x(n/2)$