FR. Conceicao Rodrigues College Of Engineering

Father Agnel Ashram, Bandstand, Bandra-west, Mumbai-50

Department of Computer Engineering

B.E. (Computer) (semester VII)

(2018-2019)

Course Outcomes & Assessment Plan

Subject: Digital Signal Processing (Course Code CPC701) Credits-5

Syllabus:

1. Discrete Time Signal

Introduction to Digital Signal Processing, Discrete Time Signals, Sampling and Reconstruction, Standard DT Signals, Concept of Digital Frequency, Representation of DT signal using Standard DT Signals, Signal Manipulations (shifting, addition, subtraction, multiplication),Classification of Signals, Linear Convolution formulation(without mathematical proof), Circular Convolution formulation(without mathematical proof), Matrix Representation of Circular Convolution, Linear by Circular Convolution. Auto and Cross Correlation formula
Evaluation.

2. Discrete Time System

Introduction to Discrete Time System, Classification of DT Systems (Linear/Non Linear, Causal/Non causal, Time Invariant/Time Variant Systems, Stable/ Unstable), BIBO Time Domain Stability Criteria. LTI system, Concept of Impulse Response and Step Response. Concept of IIR System and FIR System, Output of IIR and FIR DT system using Time Domain Linear Convolution formula Method

3. Discrete Fourier Transform

Introduction to DTFT, DFT, Relation between DFT and DTFT, Properties of DFT without mathematical proof (Scaling and Linearity, Periodicity, Time Shift and Frequency Shift, Time Reversal, Convolution Property and Parsevals' Energy Theorem). DFT computation using DFT properties. Transfer function of DT System in frequency domain using DFT. Linear and Circular Convolution using DFT. Response of FIR system calculation in frequency domain using DFT

4.Fast Fourier Transform

Radix-2 DIT-FFT algorithm, DIT-FFT Flowgraph for N=4, 6 & 8, Inverse FFT algorithm. Spectral Analysis using FFT, Comparison of complex and real, multiplication and additions of DFT and FFT.

5.DSP Algorithms

Carls' Correlation Coefficient Algorithm, Fast Circular Convolution Algorithm, Fast Linear Convolution Algorithm, Linear FIR filtering using Fast Overlap Add Algorithm and Fast Overlap Save Algorithm

6. DSP Processors and Application of DSP

Need for Special architecture of DSP processor, Difference between DSP processor & microprocessor, A general DSP processor TMS320C54XX series, Case study of Real Time DSP applications to Speech Signal

Processing and Biomedical Signal Processing

Text Books

1. Ashok Ambardar, 'Digital Signal Processing', Cengage Learning, 2007, ISBN : 978-81-315-0179-5.
2. Emmanuel C. Ifeachor, Barrie W. Jervis, "Digital Signal Processing: A Practical Approach", Pearson Education ISBN 0-201-59619- 9
3. S. Salivahanan, A. Vallavaraj, C. Gnanapriya, 'Digital Signal Processing' TataMcgraw Hill Publication First edition (2010). ISBN 978-0-07-066924-6.
4. Avtar Signh, S.Srinivasan,"Digital Signal Processing', Thomson Brooks/Cole

Reference Books

1. B. Venkatramani, M. Bhaskar ,"Digital Signal Processor', TataMcGraw Hill, Second Edition, (2001). ISBN : 978-0-07-070256-1.
2. Sanjit Mitra, 'Digital Signal Processing : A Computer Based Approach' , TataMcGraw Hill, Third Edition
3. Dr, Shaila Apte, "Digital Signal Processing,", Wiley India, Second Edition,2013 ISBN : 978-81-2652142-5
4. Proakis Manolakis, 'Digital Signal Processing : Principles, Algorithms and Applications' Fourth 2007, Pearson Education, ISBN 81-317-1000-9.
5. Monson H. Hayes, "Schaums Outline of Digital Signal Processing' McGraw Hill International second edition. ISBN : 978-00-7163509-7

ON-LINE COURSE –MATERIAL-REFERRED

MIT-OPEN-COURSEWARE

https://ocw.mit.edu/resources/res-6-008-digital-signal-processing-spring-2011/

IMPERIAL COLLEGE -LONDAN

http://www.commsp.ee.ic.ac.uk/~agc/course4.htm

UNIVESCITY OF TEXAS

http://signal.ece.utexas.edu/~arslan/courses/dsp/index.html

TUTORIAL-POINT

https://www.tutorialspoint.com/digital_signal_processing/

Course Outcomes:

Upon completion of this course students will be able to:

CO.No	Course Outcome	Blooms

		Taxonomy Level
CSC701.1	**Manipulate Discrete time signal**(Demonstrate understanding of discrete signals)	**B2-Understand**
CSC701.2	**Analyze Discrete time system in time domain**(Characterizing the system)	**B4- Analyze**
CSC701.3	**Compute Discrete Fourier Transform and Fast Fourier Transform of a signal** (Understand the concept of converting a discrete signal from time domain to frequency domain)	**B2-Understand**
CSC701.4	**Apply Signal Processing concepts to solve real world problems** (Apply the knowledge of signal processing to develop an small application)	**B3- Application**

Mapping of CO and PO/PSO

Relationship of course outcomes with program outcomes: Indicate 1 (low importance), 2 (Moderate Importance) or 3 (High Importance) in respective mapping cell.

	PO1 (Engg Know)	PO2 (Ana)	PO3 (De sign)	PO4 (inve stiga)	PO5 (tools)	PO6 (engg Soci)	PO7 (Env)	PO8 (Eth)	PO9 (ind Team)	PO10 (comm.)	PO11 (PM)	PO12 (life Long)
CSC701.1	3	1										
CSC701.2	3	3										
CSC701.3	3	1										
CSC701.4	3	3	3		1				3			
Course To PO	3	2	3		1				3			

CO	PSO1	PSO2
CSC701.1	3	
CSC701.2	3	
CSC701.3	3	

CSC701.4	3	3
Course to PSO	3	3

Justification

PO1: This subject all COs are mapped to PO1 because engineering graduates will be able to apply the knowledge Digital Signal Processing fundamentals to solve engineering problems

PO2 CSC 701.1 and CSC 701.2 are mapped to PO2 because students analyze the different operations of Discrete time signals and categories Discrete time system .

CSC 701.3 is mapped to PO2 because students are analyze the flow graphs

CSC 701.4 is mapped to PO2 because student perform review of literature of real world problem to develop an application of Signal processing

PO3: CSC 701.4 is mapped to PO3 because students design an application of signal processing

PO5: CSC 701.4 is mapped to PO5 because the students use the tools like scilab and matlab to implement application of signal processing

PO9 CSC 701.4 is mapped to this PO9 because the students work in a team to develop the mini project

PSO1: All COs are mapped to PSO1 because the graduates will be able to apply fundamental knowledge of digital signal processing to solve the real world problems.

PSO2: CO701.4 is mapped to this PSO2 because students design and implement the system to meet specific requirement.

CO Assessment Tools:

CSC701.1: Perform signal manipulation		
Direct Methods	**Criteria**	**Weight**
Test1(10M)	60% of students will minimum score 65% marks	0.2
Quiz(30 Questions)	60% of students will minimum score 60% marks	0.1
Module Test1	70% of students will minimum score 70% marks	0.1
Lab(3 Expts)	65% students will score minimum 70% marks	0.3
End Semester Exam	65% of students will minimum score 65% marks	0.3

Indirect Method **Course Exit Survey**	70% students strongly agree and agree	1
Total attainment	**CSC302.1 = 0.8*CO1dm + 0.2* CO1idm**	

CSC701.1: **Direct Methods(80%):** Test 1 quiz Lab Module Test UniExamTh

CO1dm = 0.2T1 + 0.1Q +0.1ModuleTest+0.3L+ 0.3UTh

InDirect Methods(20%): Course exit survey

CO1idm

CSC302.1 = 0.8*CO1dm + 0.2* CO1idm

CSC701.2: Analyze DT system in time domain		
Direct Methods	**Target**	**weightage**
Test	70% of students will minimum score 65% marks	0.25
Assignment	70% students will score minimum 70% marks	0.25
Quiz	60% students will score minimum 60% marks	0.2
End Semester Exam	65% of students will minimum score 65% marks	0.3
Indirect Method **Course Exit survey**	70% students strongly agree and agree	1
Total attainment	**CSC302.1 = 0.8*CO1dm + 0.2* CO1idm**	

CSC701.2: **Direct Methods(80%):** Test 1 quiz Lab Module Test UniExamTh

CO1dm = 0.2T1 + 0.2 A+0.1Q +0.1MT+ 0.3UTh

InDirect Methods(20%): Course exit survey

CO1idm

CSC302.1 = 0.8*CO1dm + 0.2* CO1idm

CSC701.3: Compute DFT and FFT of a signal		
Direct Methods	**Criteria**	**weightage**
Test2(20M)	70% of students will minimum score 65% marks	0.25
Assignment2	70% students will score minimum 70% marks	0.15
Lab	70% students will score minimum 70% marks	0.3
End semester Exam	65% of students will minimum score 65% marks	0.3
Course Exit survey	70% students strongly agree and agree	1
Total attainment	**CSC302.1 = 0.8*CO1dm + 0.2* CO1idm**	

CSC701.3: **Direct Methods(80%):** Test2 Assignments Lab UniExamTh

CO3dm = 0.25Test2+0.15A + 0.3L + 0.3UTh

InDirect Methods(20%): Course exit survey

CO3idm

CSC302.3 = 0.8*CO3dm + 0.2* CO3idm

CSC701.4: Develop an application of Signal Processing		
Direct Methods	**Criteria**	**Weightage**
Mini Project	60% of Students with minimum score 70% marks	0.8
Report Writing	60% of Students with minimum score 70% marks	0.2
Indirect method **Course Exit survey**	70% students strongly agree and agree	1

Total attainment	**CSC302.1 = 0.8*CO1dm + 0.2* CO1idm**

CSC701.4: **Direct Methods(80%):** MiniProject UniExamTh

CO4dm = 0.8MP + 0.2Report

InDirect Methods(20%): Course exit survey

CO4idm

CSC302.4 = 0.8*CO4dm + 0.2* CO4idm

Course Outcomes Target:

Upon completion of this course students will be able to:

CSC701.1: Perform signal manipulation

Target level: 2.20

CSC701.2: Analyze DT system in time domain

Target level: 2.20

CSC701.3: Apply properties of Fourier transform in mathematical problem solving

Target level: 2.20

CSC701.4: Develop an application of Signal Processing

Target level: 2.20

COs	Year 15_16	Year16_17	Year17_18
CO1	2.04	2.12	1.72
CO2	1.56	2.16	1.92
CO3	1.8	1.92	1.65
CO4	1.88	2.2	2.04

List of Experiments and Plan

Sr.No	Title	Mapped to CO	Planned Week
1	Sampling and reconstruction	CO1	Week1
2	Discrete Correlation	CO1	Week2
3	Discrete Convolution	CO1	Week3
4	Discrete Fourier Transform	CO3	Week4

5	Fast Fourier Transform	CO3	Week5
6	Filtering of Long data sequence	CO3	Week6
7	Case study on DSP Processor	CO4	Week7
8	Apply transform on 2-D signal	CO3	Week8
9	Mini Project	CO4	Week9

Curriculum Gap and Content Beyond Syllabus:

In order understand current applications, trends and new directions in DSP following topics will be covered

Sr.No.	Curriculum gap contents	Action Plan	Mapped to PO
1	Cool edit open source Tool for Speech Processing	Online resource	Po5, PO12 (Life long learning)
2.	Role of DSP in Mobile phones	Power Point Presentation	PO12 (Life long learning)

Mini Project Plan:

Students will work in a group of 2-3 students. Decide one DSP application of their choice. Collect the information related to the application from the published granted patents. Download the related published papers from the standard refereed journals and conferences. Develop a block diagram of the proposed system and flowchart of proposed system algorithm, implement it using Scilab/C, C++ language and obtain the appropriate results. Prepare the three to four pages report on the mini project in IEEE paper format. Report should include Abstract, Introduction, Related Theory, Proposed System Design/Algorithm, Experimentation & Result Analysis, Conclusion, and References. Finally at the time of submission the students will present the demonstration of their project along with report.

Indicator	Poor	Average	Good	Excellent
Timeline Maintains project deadline (2)	More than two session late (0.5)	Two sessions late (1)	One session late (1.5)	Early or on time (2)
Analysis and System Design (5) Review of Literature and Block Diagram	Review of Literature not done (0)	Review literature is done but Block Diagram is not present (2)	Both are done but not clear(3)	Review of literature done with Correct Block Diagram(5)

Implementation Complete all parts of project (10)	Failed to apply correct methodology, technique or algorithm that leads to achieve objectives of the project (0-2)	Apply appropriate methodology, technique or algorithm that leads to achieve objectives of the project. (3-5)	Apply appropriate methodology, technique or algorithm that leads to achieve objectives of the project and also demonstrates clear understanding of the same. (6-8)	Apply appropriate methodology, technique or algorithm with clear understanding and justification for the same. (9-10)
Team Work(3)	Never works towards group goals or contributes(0)	Usually works towards groups goals and contributes. Is usually sensitive to the feelings of others.(1)	Works towards group goals and contributes. Sensitive to feelings of others. Helps to identify needed changes and action.(2)	Consistently works towards group goals, is sensitive to feelings of others and values of all members. Encourages group actions for change.(3)

Rubrics for report Writing

Criterion	Excellent	Good	Satisfactory	Unsatisfactory
Contents and Details (3)	Content is very informative and accurate. Report has many supporting details (3)	Content is informative and mostly accurate. Report has adequate supporting details (2)	Content is not always related to topic. Many inaccuracies. Few supporting details.(1)	Content is not relevant or accurate. Important details are missing.(0)
Use of Diagrams (1)	Report has many supporting diagrams which are accurate and gives clear understanding of the work (1)	Report has most supporting diagrams which are correct and gives adequate understanding of the work(0.5)	NA	Report doesn't have supporting diagrams . (0)
Use of references and Citations (1)	Report has many supporting references mentioned in correct format and cited at appropriate places. (1)	NA	Report has very few supporting references mentioned in correct format and cited at adequate places (0.5)	Report lacks supporting references and citations. (0)

Mini Project Submission Plan

Stages of mini project	Date of submission
Project topic submission	20th August
Abstract submission	25th August
Partial demo	15th September
Final demonstration	30th September

Rubrics for the Assignments :

Indicator	Very Poor	Poor	Average	Good	Excellent
Timeline (2)	Assignment not submitted (0)	More than two session late (0.5)	Two sessions late (1)	One session late (1.5)	Early or on time (2)
Organization (2)	N/A	Very poor readability and not structured (0.5)	Poor readability and somewhat structured (1)	Readable with one or two mistakes and structured (1.5)	Very well written and structured without any mistakes (2)
Solution (4)	NA	Partially correct Solution with minor mistakes(2)	Correct solution but some of the specifications or steps in solution missing (3)	Correct and detailed solution (4)	NA
Depth and breadth discussion (2)	N/A	None in evidence; superficial at most (0.5)	Minor points/information may be missing and discussion is minimal (1)	Discussion centers on some of the points and covers them adequately (1.5)	Information is presented in depth and is accurate (2)

Rubrics for the Lab Experiments:

Sr. No	Performance Indicator	Parameters			
1	On time Submission (2)	Submitted after deadline (1)		Early or on time submission(2)	
2	Coding efficiency (2)	The code is structured but not efficient(1)		The code is structured and efficient.(2) -	
3	Experiment Analysis and Conclusion(4)	Conclusion Not matching with experiment analysis (1)	Conclusion Partially matching with analysis (2)	Correctly matching with analysis (3)	Final Conclusion done to match all test cases. Presentable and easy to follow (4)
4	Knowledge about the topic (2)	Able to answer few questions (1)		Answered all the questions with relevant examples (2)	

Test Papers

TEST1:

Fr. Conceicao Rodrigues College of Engineering
Fr. Agnel Ashram , Bandstand , Bandra (W), Mumbai 400050

TEST2:

Fr. Conceicao Rodrigues College of Engineering
Fr. Agnel Ashram , Bandstand , Bandra (W), Mumbai 400050

II UNIT TEST

Semester/Branch: VII/COMP
Subject: DSP **Max Marks**: 20
Date: **Timing:** 10-11

C02 : Analyze the Discrete time system
C0 3: Compute Discrete Fourier Transform

Q1. Define impulse response of a system. How stability and causality can be described in terms of impulse response? **Analyze** it for the system having following equation. **Mapped to CO2** **(4M)**

y(n)= x(n) + 3 x(n-4)

Q2. a) In a LTI system the input x(n)={1,2,3} and the impulse response h(n)={-1,-1}.

Compute the response of the LTI system by radix 2 DIT FFT **Mapped to CO3** **(10M)**

OR

Compute the response of the LTI system by radix 2 DIF FFT

b) Given x(n)= { 1,1,1,1,0,0,0,0}. Let X[K] be 8 point DFT of x[n] . **Compute** DFT of the following sequences in terms of X [K]. **Mapped to CO3** **(6M)**

a) A[n]= { 0,0,0,0,1,1,1,1}
b) B[n]={1,0,0,0,0,1,1,1}

c) C[n]={1,0,0,0,-1,0,0,0}

Assignments:

Assignment1 Date 01-08-18 Submission Date – 21-08-18

1) Compute linear convolution of following two signals graphically & using basic basic eguation of convolution **Mapped to C01**

$$x(n) = \begin{cases} \alpha^n & , -3 \leq n \leq 5 \\ 0 & , \text{elsewhere} \end{cases}$$

$$h(n) = \begin{cases} 1 , & 0 \leq n \leq 4 \\ 0 , & \text{elsewhere} \end{cases}$$

2) Consider the analog signal , $x(t)= 6\cos 50\pi t + 3\sin 200\pi t - 3\cos 100\pi t$
Determine minimum sampling frequency and sampled version of analog signal at this frequency. Sketch the waveform and show the sampling points . Comment on results when sampled at Nyquist rate.

Mapped to C01

3) Analyze the given systems : **Mapped to C02**

a)Y(n)= cos[x(n)]
b) Y(n)= nx(n)

c) Y(n) = n$x^2(n)$

For the properties given below :

i. Static or dynamic
ii. Linear or non-linear
iii. Shift variant or invariant
iv. Casual or non-casual
v. Stable or unstable

4) Determine the range of values of 'a' and 'b' for which LTI system with impulse response **h(n)= a^n , n ≥ 0**

b^n , n < 0 is stable. : **Mapped to C02**

Assignment 2 Date 28-09-18 Submission Date – 10-10-18

1) **What is correlogram ? Explain positively , negatively & uncorrelated signals .**
2) **Explain in detail the application based on convolution & correlation concept in signals & systems.**
3) **Explain the significance of Carl's Correlation Coefficient Algorithum in digital signal processing. Evaluate Carl's Coefficient for two causual sequences x[n] = {2,4,4,8} and y[n] = { 1,1,2,2 }**
4) **Compute linear convolution of the causual sequences x[n] = {2,-3,1,-4,3,-2,4,-1 } and h[n] = {2,-1} using overlap save method**

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Modes of Content Delivery:

i	Class Room Teaching	V	Self Learning Online Resources	Ix	Industry Visit
ii	Tutorial	Vi	Slides	X	Group Discussion
iii	Remedial Coaching	Vii	Simulations/Demonstrations	xi	Seminar
iv	Lab Experiment	Viii	Expert Lecture	xii	Case Study

Lect. No.	Portion to be covered	Planned date	Actual date	Content Delivery Method/Learning Activities
Module 1:				
1.	Introduction to Digital Signal Processing, Discrete Time Signals	4/7/18		Class Room Teaching
2	Discrete Time Signals, Standard DT Signal, Representation of DT signal using Standard DT Signals	5/7/18		Class Room Teaching
3	Classification of Signal	6/7/18		Class Room Teaching
4	Classification of Signal	7/7/18		Class Room Teaching
5	Concept of Digital Frequency, Sampling and Reconstruction	11/7/18		Class Room Teaching
6	Concept of Digital Frequency, Sampling and Reconstruction	12/7/18		Class Room Teaching
7	Linear Convolution formulation(without mathematical proof	13/7/18		Class Room Teaching
8	Linear Convolution formulation(without mathematical proof	14/7/18		Class Room Teaching
9	Circular Convolution formulation(without mathematical proof)	18/7/18		Class Room Teaching
10	Circular Convolution formulation(without mathematical proof)	19/7/18		Class Room Teaching
11	Matrix Representation of Circular Convolution , Linear by Circular Convolution	20/7/18		Class Room Teaching, Lab Experiment
12	Auto and Cross Correlation formula Evaluation	21/7/18		Class Room Teaching , Lab Experiment

Module 2				
13	Introduction to Discrete Time System, Classification of DT Systems	25/7/18		Class Room Teaching
14	(Linear/Non Linear, Causal/Non Causal	26/7/18		Class Room Teaching
15	Time Invariant/Time Variant Systems,	27/7/18		Class Room Teaching
16	Stable/ Unstable), BIBO Time Domain Stability Criteria	28/7/18		Class Room Teaching
18	LTI system, Concept of Impulse Response and Step Response.	1/8/18		Class Room Teaching
18	Concept of IIR System and FIR System, Output of IIR and FIR DT system using Time Domain	2/8/18		Class Room Teaching
19	Linear Convolution formula Method	3/8/18		Class Room Teaching
20	Additional Numericals	4/8/18		Class Room Teaching
Module 3				
21	**DFT:** Introduction to DTFT, DFT, Relation between DFT and DTFT,	8/8/18		Class Room Teaching
22	Properties of DFT without mathematical proof	9/8/18		Class Room Teaching
23	DFT computation using DFT properties.	10/8/18		Class Room Teaching
24	DFT computation using DFT properties.	11/8/18		Class Room Teaching
25	Transfer function of DT System in frequency domain using DFT	22/8/18		Class Room Teaching
26	Linear and Circular Convolution using DFT.	23/8/18		Class Room Teaching
27	Linear and Circular Convolution using DFT.	24/8/18		Class Room Teaching
28	Response of FIR system calculation in frequency domain using DFT	29/8/18		Class Room Teaching
Module 4				
29	**Fast Fourier Transform,** Radix-2 DIT-FFT algorithm	30/8/18		Class Room Teaching
30	DIT-FFT Flowgraph for N=4, 6 & 8,	31/8/18		Class Room Teaching
31	DIT-FFT Flowgraph for N=4, 6 & 8,	5/9/18		Class Room Teaching
32	Inverse FFT algorithm	6/9/18		Class Room Teaching
33	Inverse FFT algorithm Examples	7/9/18		Class Room Teaching

34	Comparison of complex and real, multiplication and additions of DFT and FFT	8/9/18		Class Room Teaching
35	Practice Problems	12/9/18		Class Room Teaching
Module 5				
36	Carls' Correlation Coefficient Algorithm	13/9/18		Class Room Teaching
37	Fast Circular Convolution Algorithm	14/9/18		Class Room Teaching
38	Fast Linear Convolution Algorithm	15/9/18		Class Room Teaching
39	Linear FIR filtering using Fast Overlap Add Algorithm and Fast Overlap Save Algorithm	19/9/18		Class Room Teaching
Module 6				
40	Need for Special architecture of DSP processor, Difference between DSP processor & microprocessor	20/9/18		Class Room Teaching, Slides
41	A general DSP processor TMS320C54XX Series	21/9/18		Class Room Teaching, Slides/online recourse
42	Case study of Real Time DSP applications to Speech Signal Processing	22/9/18		Class Room Teaching, Slides/ online resourse
43	Case study of Biomedical Signal Processing	26/9/18		Class Room Teaching, Slides
44	Case study on Applications of DSP	27/9/18		Case Study , Slides
45	University paper solution	28/9/18		Case Study , Slides
46	University paper solution	Extra Lecture		Class Room Teaching
47	Seminar current trends in DSP	Extra Lecture		Class Room Teaching, Slides
48	Practice Numericals	Extra Lecture		Class Room Teaching