B. P. Poddar Institute of Management & Technology

Department of Electronics & Communication Engineering

Course Data Sheet

Academic Year: 2018-2019, Even Sem

Program: ECE	Degree: B.Tech
Course: Digital Signal Processing	Semester: 6th Credits: 3
Course Code: EC602	Course Type: Core
Course Area/Domain: Signals	Contact Hours: 3L/Week.
Corresponding Lab Course Code: EC692	Lab Course Name: Digital Signal Processing Lab

MAKAUT Syllabus:

MODULE	Topic	HOURS
I	***Discrete-time signals:(3)*** Concept of discrete-time signal, basic idea of sampling and reconstruction of signal, sampling theorem, sequences – periodic, energy, power, unit sample, unit-step, unit-ramp, real & complex exponentials, arithmetic operations on sequences.	9
	LTI Systems:(6) Definition, representation, impulse response, derivation for the output sequence, concept of convolution, graphical, analytical and overlap-add methods to compute convolution supported with examples and exercises, properties of convolution, interconnections of LTI systems with physical interpretations, stability and causality conditions, recursive and non-recursive systems.	
II	***Z-Transform:(6)*** Definition, mapping between s-plane and z-plane, unit circle, convergence and ROC, properties of Z-transform, Z-transform on sequences with examples and exercises, characteristic families of signals along with ROCs, convolution, correlation and multiplication using Z-transform, initial value theorem, Perseval's relation, inverse Z-transform by contour integration, power series & partial-fraction expansions with examples and exercises.	15
	Discrete Fourier Transform:(5) Concept and relations for DFT/IDFT, Twiddle factors and their properties, computational burden on direct DFT, DFT/IDFT as linear transformations, DFT/IDFT matrices, computation of DFT/IDFT by matrix method, multiplication of DFTs, circular convolution, computation of circular convolution by graphical, DFT/IDFT and matrix methods, linear filtering using DFT, aliasing error, filtering of long data sequences – Overlap-Save and Overlap-Add methods with examples and exercises.	
	Fast Fourier Transform:(4) Radix-2 algorithm, decimation-in-time, decimation-in-frequency algorithms, signal flow graphs, Butterflies, computations in one place, bit reversal, examples for DIT & DIF FFT Butterfly computations and exercises.	

III	***Filter Design:(5)*** Basic concepts of IIR and FIR filters, difference equations, design of Butterworth IIR analog filter using impulse invariant and bilinear transforms, design of linear phase FIR filters, no. of taps, rectangular, Hamming and Blackman windows.	5
IV	***Digital Signal Processor:(4)*** Elementary idea about the architecture and important instruction sets of TMS320C 5416/6713 processor, writing of small programs in Assembly Language.	7
	FPGA:(3) Architecture, different sub-systems, design flow for DSP system design, mapping of DSP algorithms onto FPGA.	
	TOTAL HOURS	36

Course Pre-Requisites:

Course Code	Course Name	Description	Sem
EC303	Signals &Systems	Basic Signals, Laplace, Fourier,Z transforms.	3

Course Objectives:

The purpose of this course is to

1	Students will be able to acquire the knowledge of Digital Signal Processing fundamentals to apply that for LTI system.
2	Students can master the various transformation techniques so that the students become proficient in implementing the same in various applications.
3	Students can learn the basic forms of FIR and IIR filters and how to design filters with desired frequency response.
4	Elementary idea about TMS320C 5416/6713 processor, FPGA will be taught to the students.

Course Outcomes:

CO	Description	Cognitive Level
CO1	**Explain** the basic concepts related to discrete signals and their properties.	Understand
CO2	Able to **understand** the basic concepts of convolution and **apply** their properties for LTI System.	Apply
CO3	To **Apply** Z-transform and its properties for the analysis of Digital Signal & System	Apply
CO4	**Understand** basic concept of frequency transformation for filtering.	Understand
CO5	To **Apply** DFT and FFT for frequency domain analysis of signal.	Apply
CO6	To **design** FIR and IIR Filter and understand DSP processor, FPGA fundamental.	Create

Course Outcomes (CO) to Program Outcomes (PO) & Program Specific Outcomes (PSO) mapping:

S.NO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C602.1	3											1	3	2
C602.2	3	2										1	3	2
C602.3	3	2										1	3	2
C602.4	3											1	3	2
C602.5	3	2										1	3	2
C602.6	3	1	2									2	3	2
	3	1.75	2									1.17	3	2

Note: Correlation levels are as defined: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High).
If there is no correlation, put "-"

POs & PSO Reference:

PO1	Engineering knowledge	PO7	Environment and sustainability	PSO1	Students will acquire knowledge in Advance Communication Engineering, Signal and Image Processing, Embedded and VLSI System Design.
PO2	Problem analysis	PO8	Ethics		
PO3	Design/development of solutions	PO9	Individual and team work:		
PO4	Conduct investigations of complex problems	PO10	Communication	PSO2	Students will qualify in various competitive examinations for successful employment, higher studies and research.
PO5	Modern tool usage	PO11	Project management and finance		
PO6	The engineer and society	PO12	Life-long learning		

GAPS WITHIN THE SYLLABUS:

Sl. No.	Topic	Proposed Actions	CO	PO	PSO
1	Application of DSP to Speech & Radar	Topics to be covered Topics to be covered within the syllabus	CO5	PO1,PO2,PO12	PSO2

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN:

Sl. No.	Topic	Proposed Actions	PO	PSO
1	Basics of Adaptive Signal Processing	Topics to be covered beyond the syllabus	PO1,PO2, PO3,PO4, PO12	PSO2

WEB SOURCE REFERENCES:

1	http://nptel.ac.in/courses
2	https://ocw.mit.edu/resources
3	https://www.tutorials.com/digital signal processing.
4	https://www.dspguide.com

LESSON PLAN

Lecture No.	Module	Topics to be covered	References	Teaching Aid	Teaching Methodology
		Class of course objective & course outcome		GGB, Chalk & Duster, Projector	Chalk & talk, Discussion, PPT
1.	I	Introduction to Digital Signal Processing	T1,T2, T3	GGB, Chalk & Duster	Chalk & talk, Discussion
2.		Continuous & discrete valued signals, some elementary discrete time signals, classification & simple manipulations of discrete time signals.	T1, T2,T3	GGB, Chalk & Duster	Chalk & talk, Discussion
3.		Sampling & reconstruction of signals, sampling theorem	T1,T4	GGB, Chalk & Duster	Chalk & talk, Discussion
4.		Periodic, energy, power signals, concept of stability & causality	T2,T3	GGB, Chalk & Duster	Chalk & talk, Discussion
5.		Classification of discrete time signals, unit impulse, step & ramp signals, real& complex exponentials, arithmetic operations of discrete time signals.	T1, T2	GGB, Chalk & Duster	Chalk & talk, Discussion
6.		Definition of linear time invariant system, technique for analysis of LTI systems	T1,T2, T3	GGB, Chalk & Duster	Chalk & talk, Discussion
7.		Resolution of discrete time signals onto impulse, impulse response & convolution sum	T1,T2, T3	GGB, Chalk & Duster	Chalk & talk, Discussion
8.		Concept of convolution, graphical, analytical & matrix method exercises	T1,T3	GGB, Chalk & Duster	Chalk & talk, Discussion
9.		Properties of convolution, application, correlations, auto correlations & cross correlations.	T1,T 2,T3	GGB, Chalk & Duster	Chalk & talk, Discussion
10.		Input-output description and block diagram description, Interconnection of LTI system with physical interpretations	T1,T2	GGB, Chalk & Duster	Chalk & talk, Discussion
11.		Stability and causality conditions, recursive and non-recursive systems.	T1	GGB, Chalk & Duster	Chalk & talk, Discussion
12.	II	Definition of Z-transform & inverse z-transform, and region of convergence, relation between s-plane & z-plane, unit circle	T1,T2, T3	GGB, Chalk & Duster	Chalk & talk, Discussion
11.		Properties of z-transform, theorems	T1,T2, T3	GGB, Chalk & Duster	Chalk & talk, Discussion
12.		Rational z-transform, poles & zeros, system functions, convolution, correlation& multiplication using z-transform	T1	GGB, Chalk & Duster	Chalk & talk, Discussion
13.		Inverse z-transform by power series & partial fraction expansion, example & exercises	T1,T3	GGB, Chalk &	Chalk & talk,

				Duster	Discussion
14.		Inverse z-transform by contour integrals expansion, example& exercises	T2,T3	GGB, Chalk & Duster	Chalk & talk, Discussion
15.		Initial & final value theorem, perseval's relations, solution of difference equations using z-transform	T1,T2, T3	GGB, Chalk & Duster	Chalk & talk, Discussion
16.		Frequency analysis continuous time signals, power density spectrum of periodic signals, Fourier series & Fourier transform, frequency& time domain signal properties	T1	GGB, Chalk & Duster	Chalk & talk, Discussion
17.		Frequency domain sampling & reconstruction of discrete time signals	T1,T3	GGB, Chalk & Duster	Chalk & talk, Discussion
18.		DFT &IDFT, definitions, examples & exercises	T1,T2	GGB, Chalk & Duster	Chalk & talk, Discussion
19.		Twiddle factors & their properties, computational burden on discrete DFT	T2	GGB, Chalk &Duster	Chalk & talk, Discussion
20.		DFT as linear transformation, relationship of DFT with z-transform	T2,T3	GGB, Chalk & Duster	Chalk & talk, Discussion
21.		Circular symmetry, circular shift, circular convolution	T2,T3	GGB, Chalk & Duster	Chalk & talk, Discussion
22.		DFT/IDFT matrices, computation of DFT/IDFT by matrix method, multiplication of DFTs	T1,T3	GGB, Chalk & Duster	Chalk & talk, Discussion
23.		Computation of circular convolution by graphical, matrix& concentric circle method, examples	T1,T2, T3	GGB, Chalk & Duster	Chalk & talk, Discussion
24.		Linear filtering using DFT, Aliasing error, examples	T1,T2	GGB, Chalk & Duster	Chalk & talk, Discussion
25.		Filtering of long data sequences, overlap-add & overlap-save methods, examples	T1	GGB, Chalk & Duster	Chalk & talk, Discussion
26.		Divide & conquer approach to computation of DFT,Radix-2 algorithm,	T1	GGB, Chalk & Duster	Chalk & talk, Discussion
27.		signal flow graphs, Butterflies, computation in place, bit reversal	T1	GGB, Chalk & Duster	Chalk & talk, Discussion
28.		Decimation in time algorithm for FFT	T2,T3	GGB, Chalk & Duster	Chalk & talk, Discussion
29.		Decimation in frequency algorithm for FFT	T2,T3	GGB, Chalk & Duster	Chalk & talk, Discussion
30.		Examples & exercises of FFT algorithm	T1,T2, T3	GGB, Chalk &	Chalk & talk,

				Duster	Discussion
31.	III	Direct form, cascade form, frequency sampling & lattice structures of FIR filters of FIR filter	T1,T2, T3	GGB, Chalk & Duster	Chalk & talk, Discussion
32.		Direct form, cascade form, parallel form & lattice & ladder form structures of IIR filter	T1,T 2,T3	GGB, Chalk &Duster	Chalk & talk, Discussion
33.		Difference equations, Design Butterworth IIR analog filter	T2,T3	GGB, Chalk & Duster	Chalk & talk, Discussion
34.		IIR filter design using Impulse Invariant & Bilinear transformation	T1,T2, T3	GGB, Chalk & Duster	Chalk & talk, Discussion
35.		Design of linear phase FIR filter ,no. of taps, rectangular, Hamming and Blackman windows	T2,T4, T3	GGB, Chalk & Duster	Chalk & talk, Discussion
36.	IV	Architecture of the TMS320C5416 processor	T3,T4	GGB, Chalk & Duster	Chalk & talk, Discussion
37.		Elementary idea of important instruction sets of TMS320C5416/6713	T3,T4	GGB, Chalk & Duster	Chalk & talk, Discussion
38.		Small programs of convolution, signal processing, DFT& filter design using TMS320C5416	T3,T4	GGB, Chalk & Duster	Chalk & talk, Discussion
39.		Architecture, different sub-systems,	T3,T4	GGB, Chalk & Duster	Chalk & talk, Discussion
40.		Design flow for DSP system design, mapping of DSP algorithms onto FPGA.	T3,T4	GGB, Chalk & Duster	Chalk & talk, Discussion

L= Lecture T= Tutorial GGB= Green Glass Board *Gap

Text Books:

T1.John G. Proakis,Dimitris G. Manolakis,Digital Signal Processing principles, algorithms, and applications,4th edition.
T2. Boylestad P.R.Babu,Digital signal processing,4th edition.
T3.S Salivahanan,A Vallavaraj, C.Ganapriya,Digital signal processing,2nd edition.
T4. A. Nagoor Kani, Digital signal processing,2nd edition.

REFERENCE BOOKS:

1. Digital Signal Processing, P. Rameshbabu, Scitech Publications (India).
2. Digital Signal Processing, S.Salivahanan, A.Vallabraj & C. Gnanapriya, TMH Publishing Co.
3. Digital Signal Processing; A Hands on Approach, C. Schuler & M.Chugani, TMH Publishing Co.
4. Digital Signal Processing, A. Nagoor Kani, TMH Education
5. Digital Signal Processing S. Poornachandra & B. Sasikala, MH Education
6. Digital Signal Processing; Spectral Computation and Filter Design Chi-Tsong Chen, Oxford University Press
7. Texas Instruments DSP Processor user manuals and application notes.
8. Xilinx FPGA user manuals and application notes.