Ref No:

SKIT, Bangalore

COURSE PLAN

Academic Year - 2018-2019

Program:	B E – Electrical and Electronics
Semester :	6
Course Code:	15EEL68
Course Title:	Digital signal processing Lab
Credit / L-T-P:	2 / 0-0-2
Total Contact Hours:	60
Course Plan Author:	Likhitha R

Academic Evaluation and Monitoring Cell

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INSTRUCTIONS TO TEACHERS

- Classroom / Lab activity shall be started after taking attendance.
- Attendance shall only be signed in the classroom by students.
- Three hours attendance should be given to each Lab.
- Use only Blue or Black Pen to fill the attendance.
- Attendance shall be updated on-line & status discussed in DUGC.
- No attendance should be added to late comers.
- Modification of any attendance, over writings, etc is strictly prohibited.
- Updated register is to be brought to every academic review meeting as per the COE.

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Table of Contents

Note : Remove "Table of Content" before including in CP Book
Each Laboratory Plan shall be printed and made into a book with cover page
Blooms Level in all sections match with A.2, only if you plan to teach / learn at higher levels

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A. LABORATORY INFORMATION

1. Laboratory Overview

Degree:	B.E	Program:	EE
Year / Semester :	3/6	Academic Year:	2018-19
Course Title:	Digital Signal Processing Lab	Course Code:	15EEL68
Credit / L-T-P:	1+2	SEE Duration:	180 Minutes
Total Contact Hours:	42	SEE Marks:	80 Marks
CIA Marks:	20	Assignment	-
Lab. Plan Author:	Likhitha R	Sign	Dt :
Checked By:	HOD	Sign	Dt :

2. Laboratory Content

Expt.	Title of the Experiments	Lab Hours	Concept	Blooms Level
1	Verification of Sampling Theorem both in time and frequency domains	3	sampling	L4 Analyze
2	Evaluation of impulse response of a system	3	LTI response	L4
3	To perform linear convolution of given sequences	3	convolution	L4
4	To perform circular convolution of given sequences using (a) the convolution summation formula (b) the matrix method and (c) Linear convolution from circular convolution with zero padding.	3	System analysis	L4
5	Computation of N–point DFT and to plot the magnitude and phase spectrum.	3	Frequency Response	L4
6	Linear and circular convolution by DFT and IDFT method.	3	Frequency Response	L4
7	Solution of a given difference equation.	3	Frequency Response	L4
8	Calculation of DFT and IDFT by FFT	3	Fast fourier transform	L4
9	Design and implementation of IIR filters to meet given specification (Low pass, high pass, band pass and band reject filters)	3	IIR Filter	L4
10	Design and implementation of FIR filters to meet given specification (Low pass, high pass, band pass and band reject filters) using different window functions	3	FIR Filter	L4
11	Design and implementation of FIR filters to meet given specification (Low pass, high pass, band pass and band reject filters) using frequency sampling technique.	3	Frequency sampling	L4
12	Realization of IIR and FIR filters	3	Realization	L4

3. Laboratory Material

Books & other material as recommended by university (A, B) and additional resources used by Laboratory teacher (C).

Expt.	Details	Expt. in book	Availability
A	**Text books (Title, Authors, Edition, Publisher, Year.)**	-	-
5,6,7,	Digital signal processing – Principles Algorithms &	3, 4	In Lib / In Dept

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8,9,10,11,12	Applications, Proakis & Monalakis, Pearson education, 4th Edition, New Delhi, 2007		
		2, 4	In Lib/ In dept
B	**Reference books (Title, Authors, Edition, Publisher, Year.)**	-	-
1,2,3,4	Discrete Time Signal Processing, Oppenheim & Schaffer, PHI, 2003		In Lib
1, 2,3,4	Digital Signal Processing, S. K. Mitra, Tata Mc-Graw Hill, 3rd Edition, 2010.		In Lib
3,4,5,6	Digital Signal Processing, Lee Tan: Elsevier publications, 2007.		In Lib
C	**Concept Videos or Simulation for Understanding**	-	-
c1	https://www.youtube.com/watch?v=qjeLUcCDClM -8min		
c2	https://www.youtube.com/watch?v=E3633vpoCGQ		
c3	https://www.youtube.com/watch?v=8Sx_ruSfJ0s -6min		
c4	https://www.youtube.com/watch?v=u9ZPVJt0YT4 -4min		
c5	https://www.youtube.com/watch?v=QKhy1JsdiUo -21min		
c6	https://www.youtube.com/watch?v=3FAIXEkxyBs -15min		
c7	https://www.youtube.com/watch?v=9DGjAKEB0eU -8min		
c8	https://www.youtube.com/watch?v=U3dHb2TWGJI -17min		
c9	https://www.youtube.com/watch?v=wxQFxIv2QRk -6min		
c10	https://www.youtube.com/watch?v=0xgNtsGj8G8 -5min		
D	**Software Tools for Design**	-	-
	MATLAB-17.0		
E	**Recent Developments for Research**	-	-
		?	In lib
F	**Others (Web, Video, Simulation, Notes etc.)**	-	-

4. Laboratory Prerequisites:

Refer to GL01. If prerequisites are not taught earlier, GAP in curriculum needs to be addressed. Include in Remarks and implement in B.5.

Students must have learnt the following Courses / Topics with described Content . . .

Expt.	Lab. Code	Lab. Name	Topic / Description	Sem	Remarks	Blooms Level
1	15EE35	Signals and systems	Knowledge on signals and systems	4		Understand L2
2	15MAT31	Maths -III	Knowledge on Fourier transform	3	Plan Gap Course	Understand L2

5. Content for Placement, Profession, HE and GATE

The content is not included in this course, but required to meet industry & profession requirements and help students for Placement, GATE, Higher Education, Entrepreneurship, etc. Identifying Area / Content requires experts consultation in the area.

Topics included are like, a. Advanced Topics, b. Recent Developments, c. Certificate Courses, d. Course Projects, e. New Software Tools, f. GATE Topics, g. NPTEL Videos, h. Swayam videos etc.

Expt.	Topic / Description	Area	Remarks	Blooms

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				Level
1	Filter design	Design of filters	Filter design by using MATLAB simulink simulation tool	Understa nd L2

B. Laboratory Instructions

1. General Instructions

SNo	Instructions	Remarks
1	Observation book and Lab record are compulsory.	
2	Students should report to the concerned lab as per the time table.	
3	After completion of the program, certification of the concerned staff in-charge in the observation book is necessary.	
4	Student should bring a notebook of 100 pages and should enter the readings /observations into the notebook while performing the experiment.	
5	The record of observations along with the detailed experimental procedure of the experiment in the Immediate last session should be submitted and certified staff member in-charge.	
6	Should attempt all problems / assignments given in the list session wise.	
7	It is responsibility to create a separate directory to store all the programs, so that nobody else can read or copy.	
8	When the experiment is completed, should disconnect the setup made by them, and should return all the components/instruments taken for the purpose.	
9	Any damage of the equipment or burn-out components will be viewed seriously either by putting penalty or by dismissing the total group of students from the lab for the semester/year	
10	Completed lab assignments should be submitted in the form of a Lab Record in which you have to write the algorithm, program code along with comments and output for various inputs given	

2. Laboratory Specific Instructions

SNo	Specific Instructions	Remarks
1	Start computer	
2	Open the text editor	
3	Select new file.	
4	Write the program	
5	Save the program with .m extension.	
6	Compile the program F9	
7	Execute the program F5	

C. OBE PARAMETERS

1. Laboratory Outcomes

Expt.	Lab Code #	COs / Experiment Outcome	Teach. Hours	Concept	Instr Method	Assessment Method	Blooms' Level
-	-	**At the end of the experiment, the student should be able to . . .**	-	-	-	-	-
1	15EEL68.1	Verification of sampling theorem	3	sampling	Demon strate	Slip Test	L4
2	15EEL68.2	Impulse response of first order and second order system	03	LTI response	Demon strate		L4
3	15EEL68.3	Linear convolution of two sequences	03	convolution	Demon strate	Slip test	L4
4	15EEL68.4	Circular convolution of two	03	System	Demon	Slip test	L4

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		sequences		analysis	strate		
5	15EEL68.5	N–point DFT and to plot the magnitude and phase spectrum.	03	Frequency Response	Demon strate	Slip test	L4
6	15EEL68.6	Solution of a given difference equation	03	Frequency Response	Demon strate	Slip test	L4
7	15EEL68.7	Calculation of DFT and IDFT by FFT	03	Frequency Response	Demon strate	Slip test	L4
8	15EEL68.8	Design and implementation of IIR filter to meet given specifications	03	Fast fourier transform	Simulat ion	Slip test	L4
9	15EEL68.9	Design and implementation of FIR filter to meet given specifications	03	IIR Filter	simulati on	Slip test	L4
10	15EEL68.10	Design and implementation of FIR filters using different window	03	FIR Filter	simulati on	Slip test	L4
11	15EEL68.11	Design and implementation of FIR filters using frequency sampling technique.	03	Frequency sampling	Simulat ion	Slip test	L4
12	15EEL68.12	Realization of IIR and FIR filters	03	Realization	Simulat ion	Slip test	L4

Note: Identify a max of 2 Concepts per unit. Write 1 CO per concept.

2. Laboratory Applications

Expt.	Application Area	CO	Level
1	A to D converter	CO1	L4
2	Statistics and probability	CO2	L4
3	Signal detection and pattern recognition	CO3	L4
4	Quantum mechanics and electrodynamics	CO4	L4
5	Frequency analysis	CO5	L4
6	Spectral analysis	CO6	L4
7	Signal selection using FIR filter	CO7	L4
8	Signal selection using IIR filter	CO8	L4
9	Radar	CO9	L4
10	sonar	CO10	L4
11	Filter	CO11	L4
12	Filter design	CO12	L4

Note: Write 1 or 2 applications per CO.

3. Mapping And Justification

CO – PO Mapping with mapping Level along with justification for each CO-PO pair.
To attain competency required (as defined in POs) in a specified area and the knowledge & ability required to accomplish it.

Expt.	Mapping		Mapping Level	Justification for each CO-PO pair	Level
-	**CO**	**PO**	-	**'Area': 'Competency' and 'Knowledge' for specified 'Accomplishment'**	-
1	CO1	PO1		Applies basic mathematics and science knowledge for solution to engineering problems	
1	CO1	PO2		Identify, formulate and review complex engineering problems	
1	CO1	PO3		Design digital system components	
1	CO1	PO5		Specific tool available for simulation and implementation	
1	CO1	PO9		Applies to individual and team work for project, internship and miniproject	
2	CO2	PO1		Applies basic mathematics and science knowledge for solution to engineering problems	
2	CO2	PO2		Identify, formulate and review complex engineering problems	
2	CO2	PO3		Design digital system components	
2	CO2	PO5		Specific tool available for simulation and implementation	
2	CO2	PO9		Applies to individual and team work for project, internship and miniproject	
3	CO3	PO1		Applies basic mathematics and science knowledge for solution to engineering problems	

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3	CO3	PO2		Identify, formulate and review complex engineering problems	
3	CO3	PO3		Design digital system components	
3	CO3	PO5		Specific tool available for simulation and implementation	
3	CO3	PO9		Applies to individual and team work for project, internship and miniproject	
4	CO4	PO1		Applies basic mathematics and science knowledge for solution to engineering problems	
4	CO4	PO2		Identify, formulate and review complex engineering problems	
4	CO4	PO3		Design digital system components	
4	CO4	PO5		Specific tool available for simulation and implementation	
4	CO4	PO9		Applies to individual and team work for project, internship and miniproject	
5	CO5	PO1		Applies basic mathematics and science knowledge for solution to engineering problems	
5	CO5	PO2		Identify, formulate and review complex engineering problems	
5	CO5	PO3		Design digital system components	
5	CO5	PO5		Specific tool available for simulation and implementation	
5	CO5	PO9		Applies to individual and team work for project, internship and miniproject	
6	CO6	PO1		Applies basic mathematics and science knowledge for solution to engineering problems	
6	CO6	PO2		Identify, formulate and review complex engineering problems	
6	CO6	PO3		Design digital system components	
6	CO6	PO5		Specific tool available for simulation and implementation	
6	CO6	PO9		Applies to individual and team work for project, internship and miniproject	
7	CO7	PO1		Applies basic mathematics and science knowledge for solution to engineering problems	
7	CO7	PO2		Identify, formulate and review complex engineering problems	
7	CO7	PO3		Design digital system components	
7	CO7	PO5		Specific tool available for simulation and implementation	
7	CO7	PO9		Applies to individual and team work for project, internship and miniproject	
8	CO8	PO1		Applies basic mathematics and science knowledge for solution to engineering problems	
8	CO8	PO2		Identify, formulate and review complex engineering problems	
8	CO8	PO3		Design digital system components	
8	CO8	PO5		Specific tool available for simulation and implementation	
8	CO8	PO9		Applies to individual and team work for project, internship and miniproject	
9	CO9	PO1		Applies basic mathematics and science knowledge for solution to engineering problems	
9	CO9	PO2		Identify, formulate and review complex engineering problems	
9	CO9	PO3		Design digital system components	
9	CO9	PO5		Specific tool available for simulation and implementation	
9	CO9	PO9		Applies to individual and team work for project, internship and miniproject	
10	CO10	PO1		Applies basic mathematics and science knowledge for solution to engineering problems	
10	CO10	PO2		Identify, formulate and review complex engineering problems	
10	CO10	PO3		Design digital system components	
10	CO10	PO5		Specific tool available for simulation and implementation	
10	CO10	PO9		Applies to individual and team work for project, internship and miniproject	
11	CO11	PO1		Applies basic mathematics and science knowledge for solution to engineering problems	
11	CO11	PO2		Identify, formulate and review complex engineering problems	
11	CO11	PO3		Design digital system components	
11	CO11	PO5		Specific tool available for simulation and implementation	
11	CO11	PO9		Applies to individual and team work for project, internship and miniproject	
12	CO12	PO1		Applies basic mathematics and science knowledge for solution to engineering problems	
12	CO12	PO2		Identify, formulate and review complex engineering problems	
12	CO12	PO3		Design digital system components	
12	CO12	PO5		Specific tool available for simulation and implementation	
12	CO12	PO9		Applies to individual and team work for project, internship and miniproject	

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4. Articulation Matrix

CO – PO Mapping with mapping level for each CO-PO pair, with course average attainment.

-	-	Experiment Outcomes	Program Outcomes															-
Expt.	CO.#	**At the end of the experiment student should be able to . . .**	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	Lev el
1	15EEL68.1	Verification of sampling theorem	√	√	√		√				√							L4
2	15EEL68.2	Impulse response of first order and second order system	√	√	√		√				√							L4
3	15EEL68.3	Linear convolution of two sequences	√	√	√		√				√							L4
4	15EEL68.4	Circular convolution of two sequences	√	√	√		√				√							L4
5	15EEL68.5	N–point DFT and to plot the magnitude and phase spectrum.	√	√	√		√				√							L4
6	15EEL68.6	Solution of a given difference equation	√	√	√		√				√							L4
7	15EEL68.7	Calculation of DFT and IDFT by FFT	√	√	√		√				√							L4
8	15EEL68.8	Design and implementation of IIR filter to meet given specifications	√	√	√		√				√							L4
9	15EEL68.9	Design and implementation of FIR filter to meet given specifications	√	√	√		√				√							L4
10	15EEL68.10	Design and implementation of FIR filters using different window	√	√	√		√				√							L4
11	15EEL68.11	Design and implementation of FIR filters using frequency sampling technique.	√	√	√		√				√							L4
12	15EEL68.12	Realization of IIR and FIR filters	√	√	√		√				√							L4
-	**15EEL68**	**Average attainment (1, 2, or 3)**																**-**
-	*PO, PSO*	*1.Engineering Knowledge; 2.Problem Analysis; 3.Design / Development of Solutions; 4.Conduct Investigations of Complex Problems; 5.Modern Tool Usage; 6.The Engineer and Society; 7.Environment and Sustainability; 8.Ethics; 9.Individual and Teamwork; 10.Communication; 11.Project Management and Finance; 12.Life-long Learning; S1.Software Engineering; S2.Data Base Management; S3.Web Design*																

5. Curricular Gap and Experiments

Topics & contents not covered (from A.4), but essential for the course to address POs and PSOs.

Expt	Gap Topic	Actions Planned	Schedule Planned	Resources Person	PO Mapping
1					
2					
3					
4					
5					

Note: Write Gap topics from A.4 and add others also.

6. Experiments Beyond Syllabus

Topics & contents required (from A.5) not addressed, but help students for Placement, GATE, Higher Education, Entrepreneurship, etc.

Expt	Gap Topic	Actions Planned	Schedule Planned	Resources Person	PO Mapping

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1					
2					
3					
4					
5					

D. COURSE ASSESSMENT

1. Laboratory Coverage

Assessment of learning outcomes for Internal and end semester evaluation. Distinct assignment for each student. 1 Assignment per chapter per student. 1 seminar per test per student.

Unit	Title	Teaching Hours	No. of question in Exam							CO	Levels
			CIA-1	CIA-2	CIA-3	Asg-1	Asg-2	Asg-3	SEE		
1	Verification of Sampling Theorem both in time and frequency domains	03	1	-	-	-	-	-	1	CO1	L2
2	Evaluation of impulse response of a system	03	1	-	-	-	-	-	1	CO2	L3
3	To perform linear convolution of given sequences	03	1	-	-	-	-	-	1	CO3	L3
4	To perform circular convolution of given sequences using (a) the convolution summation formula (b) the matrix method and (c) Linear convolution from circular convolution with zero padding.	03	1	-	-	-	-	-	1	CO4	L3
5	Computation of N–point DFT and to plot the magnitude and phase spectrum.	03	-	1	-	-	-	-	1	CO5	L4
6	Linear and circular convolution by DFT and IDFT method.	03	-	1	-	-	-	-	1	CO6	L4
7	Solution of a given difference equation.	03	-	1	-	-	-	-	1	CO7	L4
8	Calculation of DFT and IDFT by FFT	03	-	1		-	-	-	1	CO8	L4
9	Design and implementation of IIR filters to meet given specification (Low pass, high pass, band pass and band reject filters)	03	-		1	-	-	-	1	CO9	L4
10	Design and implementation of FIR filters to meet given specification (Low pass, high pass, band pass and band reject filters) using different window functions	03	-	-	1	-	-	-	1	CO10	L4
11	Design and implementation of FIR filters to meet given specification (Low pass, high pass, band pass and band reject filters) using frequency sampling technique.	03	-	-	1	-	-	-	1	CO11	L4
12	Realization of IIR and FIR filters	03	-	-	1	-	-	-	1	CO12	L4
-	**Total**	**60**	**7**	**8**	**5**	**5**	**5**	**5**	**20**	**-**	**-**

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2. Continuous Internal Assessment (CIA)

Assessment of learning outcomes for Internal exams. Blooms Level in last column shall match with A.2.

Evaluation	Weightage in Marks	CO	Levels
CIA Exam – 1	20	CO1, CO2, CO3, CO4	L1,L2, L3,L4
CIA Exam – 2	20	CO5, CO6, CO7,CO8	L1,L2, L3,L4
CIA Exam – 3	20	CO9,CO10,CO11,CO12	L1,L2, L3,L4
Assignment - 1	-	-	-
Assignment - 2	-	-	-
Assignment - 3	-	-	-
Seminar - 1	-	-	-
Seminar - 2	-	-	-
Seminar - 3	-	-	-
Other Activities – define – Slip test			
Final CIA Marks	**20**	**-**	**-**

-

SNo	Description	Marks
1	Observation and Weekly Laboratory Activities	10 Marks
2	Record Writing	10 Marks for each Expt
3	Internal Exam Assessment	20 Marks
4	Internal Assessment	40 Marks
5	SEE	600 Marks
-	**Total**	**100 Marks**

E. EXPERIMENTS

Experiment 01 : Sampling theorem

-	Experiment No.:	1	Marks		Date Planned		Date Conducted	
1	Title	Verification of Sampling Theorem both in time and frequency domains						
2	Course Outcomes	Reconstruction of the signal						
3	Aim	Verification of sampling theorem.						
4	Material / Equipment Required	Lab Manual						
5	Theory, Formula, Principle, Concept	Nyquist rate						
6	Procedure, Program, Activity, Algorithm, Pseudo Code	• step 1: start • step 2: write programming • step 3: save the program						

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		• step 4: compile • step 5:if error then correct the errors • step 6:run • step 7:stop

7	Block, Circuit, Model Diagram, Reaction Equation, Expected Graph	clc;
		clear all;
		t = 0:0.001:1;
		fm = input('Enter the modulating signal frequency = ');
		x = sin(2*pi*fm*t);
		subplot(4,2,1);
		plot(t,x);
		xlabel('Time ----->');
		ylabel('Amplitude ----->');
		title('Message Signal');
		fs1 = input('Enter Sampling Frequency < Modulating Signal Frequency = ');
		fs2 = input('Enter Sampling Frequency = Modulating Signal Frequency = ');
		fs3 = input('Enter Sampling Frequency > Modulating Signal Frequency = ');
		%Sampling at fs<<2fm
		n = 0:1/fs1:1;
		x1 = sin(2*pi*fm*n);
		subplot(4,2,2);
		stem(n,x1);
		xlabel('Time ----->');
		ylabel('Amplitude ----->');
		title('Undersampled fs<<2fm Signal');
		subplot(4,2,3);
		plot(n,x1);
		xlabel('Time ----->');
		ylabel('Amplitude ----->');
		title('Reconstructed Undersampled fs<<2fm Signal');
		%Sampling at fs=2fm
		n = 0:1/fs2:1;
		x2 = sin(2*pi*fm*n);
		subplot(4,2,4);
		stem(n,x2);
		xlabel('Time ----->');
		ylabel('Amplitude ----->');
		title('Sampled at Nyquist Rate fs=2fm Signal');
		subplot(4,2,5);
		plot(n,x2);
		xlabel('Time ----->');
		ylabel('Amplitude ----->');
		title('Reconstructed Nyquist Rate fs=2fm Signal');
		%Sampling at fs>>2fm
		n = 0:1/fs3:1;
		x3 = sin(2*pi*fm*n);
		subplot(4,2,6);
		stem(n,x3);
		xlabel('Time ----->');
		ylabel('Amplitude ----->');
		title('Oversampled fs>>2fm Signal');
		subplot(4,2,7);
		plot(n,x3);
		xlabel('Time ----->');
		ylabel('Amplitude ----->');
		title('Reconstructed Oversampled fs>>2fm Signal');

8	Observation Table, Look-up Table, Output	• - • - • -
9	Sample Calculations	•

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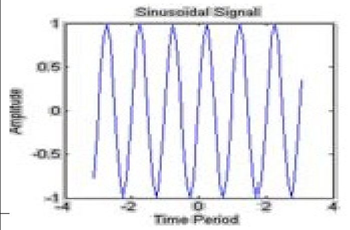
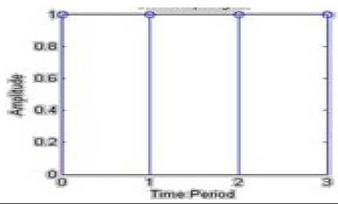
		•
10	Graphs, Outputs	 
11	Results & Analysis	-
12	Application Areas	Analog to Digital Converter
13	Remarks	-
14	Faculty Signature with Date	-

Experiment 02 : Impulse Response

-	Experiment No.:	2	Marks		Date Planned		Date Conducted	
1	Title	Evaluation of impulse response of a system						
2	Course Outcomes	Use Impulse response of first order and second order system						
3	Aim	To evaluate the impulse response for the given order of the sequence						
4	Material / Equipment Required	Lab Manual						
5	Theory, Formula, Principle, Concept	Multiply and add						
6	Procedure, Program, Activity, Algorithm, Pseudo Code	Step 1: start Step 2: Assign the variables to the input sequence and impulse sequence. Step 3: Assign the lower and upper limits for both input and impulse sequence Step 4: Perform convolution using the function 'conv' Step 5: Give the x label and y label and title it. Save and run the program step 6: stop						

7	Block, Circuit, Model Diagram, Reaction Equation, Expected Graph	x=input('enter the sequence for x(n):')
		h=input('enter the sequence for h(n):')
		u1=input('enter the upper limit for x(n):')
		l1=input('enter the lower limit for x(n):')
		u2=input('enter the upper limit for h(n):')
		l2=input('enter the lower limit for h(n):')
		a=l1:1:u1
		subplot(2,2,1);
		stem(a,x);
		xlabel('time');
		ylabel('amplitude');
		title('x(n)');
		b=l2:1:u2;
		subplot(2,2,2);
		stem(b,h);
		xlabel('time');
		ylabel('amplitude');						

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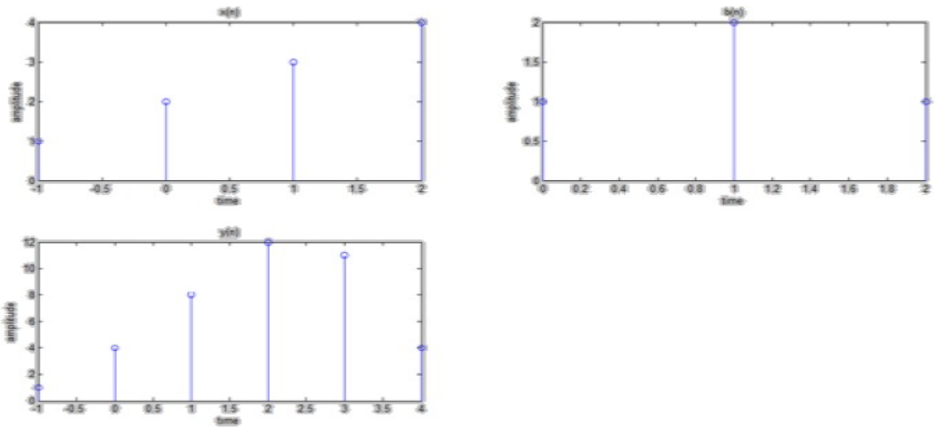
		title('b(n)');
		y=conv(x,h);
		c=(l1+l2):1:(u1+u2);
		subplot(2,2,3);
		stem(c,y);
		xlabel('time');
		ylabel('amplitude'
		title('y(n)');

8	Observation Table, Look-up Table, Output	
9	Sample Calculations	
10	Graphs, Outputs	
11	Results & Analysis	
12	Application Areas	
13	Remarks	Probability and statistics
14	Faculty Signature with Date	

Experiment 03 :Linear convolution

-	Experiment No.:	3	Marks		Date Planned		Date Conducted	
1	Title	To perform linear convolution of given sequences						
2	Course Outcomes	Similarity Analysis of two discrete sequences						
3	Aim	Auto and cross correlation of two sequences and verification of their properties						
4	Material / Equipment Required	Lab Manual						
5	Theory, Formula, Principle, Concept	Compare the sequences						
6	Procedure, Program, Activity, Algorithm, Pseudo Code	Step 1: start Step 2: read first discrete sequence Step 3: read second discrete sequence Step 4: compare Step 5: print the result step 6: stop						

7	Block, Circuit, Model Diagram, Reaction Equation, Expected Graph	x= input ('Enter any sequence');
		subplot(3,2,1);
		stem(x);
		xlabel('Time period');
		ylabel('Amplitude');						

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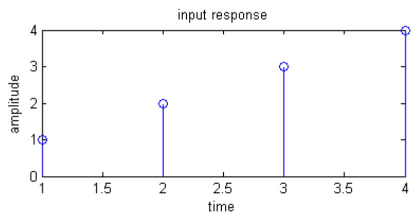
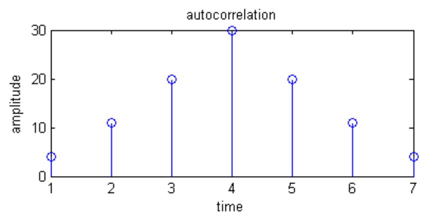
		title('Input sequence');
		y=xcorr(x);
		subplot(3,2,2);
		xlabel('Time period');
		ylabel('Amplitude');
		title('Auto correlation');
		x=input('Enter any sequence');
		subplot(3,2,1);
		stem(x);
		xlabel('Time period');
		ylabel('Amplitude');
		title('Input sequence');
		h=input('Enter any sequence');
		subplot(3,2,2);
		stem(h);
		xlabel('Time period');
		ylabel('Amplitude');
		title('Impulse sequence');
		y=xcorr(x,h);
		subplot(3,2,3);
		stem(y);
		xlabel('Time period');
		ylabel('Amplitude');
		title('Cross correlation');

8	Observation Table, Look-up Table, Output	
9	Sample Calculations	
10	Graphs, Outputs	 
11	Results & Analysis	
12	Application Areas	
13	Remarks	Signal detection and pattern recognition
14	Faculty Signature with Date	

Experiment 04 : Discrete Fourier transform

-	**Experiment No.:**	4	**Marks**		**Date Planned**		**Date Conducted**	
1	Title	Computation of N –point DFT and to plot the magnitude and phase spectrum						
2	Course Outcomes	Frequency synthesis						
3	Aim	Computation of N point DFT of a given sequence and to plot magnitude and phase spectrum						
4	Material / Equipment Required	Lab Manual						
5	Theory, Formula, Principle, Concept	Calculating impulse response of the system						
6	Procedure,	Step 1: start						

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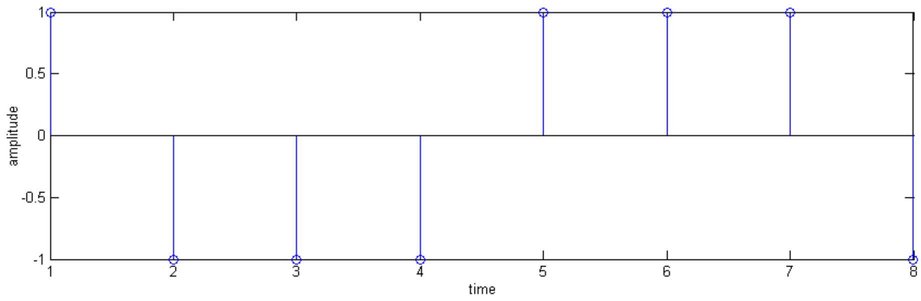
	Program, Activity, Algorithm, Pseudo Code	Step 2: read input sequence Step 3: calculate impulse response Step 4: find out system coefficients Step 5: print the result step 6: stop

7	Block, Circuit, Model Diagram, Reaction Equation, Expected Graph	PROGRAM: (Spectrum Analysis Using DFT)
		N=input('type length of DFT= ');
		T=input('type sampling period= ');
		freq=input('type the sinusoidal freq= ');
		k=0:N-1;
		f=sin(2*pi*freq*1/T*k);
		F=fft(f);
		stem(k,abs(F));
		grid on;
		xlabel('k');
		ylabel('X(k)');
		INPUT:
		type length of DFT=32
		type sampling period=64
		type the sinusoidal freq=11

8	Observation Table, Look-up Table, Output	
9	Sample Calculations	
10	Graphs, Outputs	
11	Results & Analysis	
12	Application Areas	
13	Remarks	Quantum mechanics and electrodynamics
14	Faculty Signature with Date	

Add required experiments

Experiment 05: Difference equation

-	**Experiment No.:**	5	**Marks**		**Date Planned**		**Date Conducted**	
1	Title	To perform circular convolution of given sequences using (a) the convolution summation formula (b) the matrix method and (c) Linear convolution from circular convolution with zero padding.						
2	Course Outcomes	System design						
3	Aim	Solving a given difference equation						
4	Material / Equipment Required	Lab Manual						

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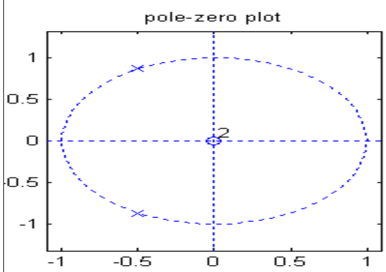
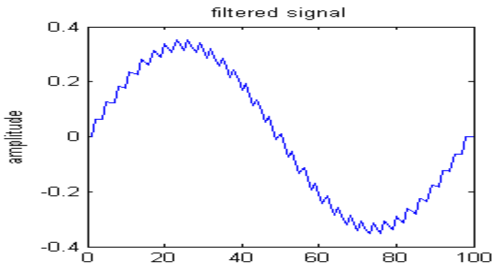
5	Theory, Formula, Principle, Concept	Calculating impulse response of the system
6	Procedure, Program, Activity, Algorithm, Pseudo Code	Step 1: start Step 2: read input sequence Step 3: calculate impulse response Step 4: find out system coefficients Step 5: print the result step 6: stop

7	Block, Circuit, Model Diagram, Reaction Equation, Expected Graph	a=input('enter the input');
		b=input('enter the input');
		x=linspace(0,2*pi,100);
		y=sin(x);
		subplot(2,3,1);
		plot(y);
		xlabel('time period');
		ylabel('amplitude');
		title('sine wave');
		e=rand(size(x));
		subplot(2,3,2);
		plot(e);
		xlabel('time period');
		ylabel('amplitude');
		title('noise signal');
		subplot(2,3,3);
		t=y+e;
		plot(x,t);
		xlabel('time period');
		y(n)+y(n-1)+y(n-2)=x(n)

8	Observation Table, Look-up Table, Output	
9	Sample Calculations	
10	Graphs, Outputs	 
11	Results & Analysis	
12	Application Areas	
13	Remarks	Quantum mechanics and electrodynamics
14	Faculty Signature with Date	

Experiment 09

-	Experiment No.:		Marks		Date		Date	

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					Planned		**Conducted**	
1	Title	Linear and circular convolution by DFT and IDFT method.						
2	Course Outcomes	Frequency synthesis						
3	Aim	Verification of DFT properties						
4	Material / Equipment Required	Lab Manual						
5	Theory, Formula, Principle, Concept	Linearity and Parseval's theorem						
6	Procedure, Program, Activity, Algorithm, Pseudo Code	Step 1: start Step 2: read input sequence Step 3: calculate impulse response Step 4: find out system coefficients Step 5: print the result step 6: stop						

7	Block, Circuit, Model Diagram, Reaction Equation, Expected Graph	PROGRAM: (Spectrum Analysis Using DFT)
		N=input('type length of DFT= ');
		T=input('type sampling period= ');
		freq=input('type the sinusoidal freq= ');
		k=0:N-1;
		f=sin(2*pi*freq*1/T*k);
		F=fft(f);
		stem(k,abs(F));
		grid on;
		xlabel('k');
		ylabel('X(k)');
		INPUT:
		type length of DFT=32
		type sampling period=64
		type the sinusoidal freq=11
		OUTPUT: (Spectrum Analysis Using DFT)						

8	Observation Table, Look-up Table, Output							
9	Sample Calculations							
10	Graphs, Outputs							
11	Results & Analysis	Enter the x sequence ==>[2 4 6 8] Enter the h sequence ==>[10 3 5 2 5 7] ftx = Columns 1 through 4 20.0000 2.1061 -15.4082i -6.9436 + 0.9369i 5.0000 + 1.7321i Columns 5 through 8 -1.1625 - 4.4396i -1.1625 + 4.4396i 5.0000 - 1.7321i -6.9436 - 0.9369i Column 9 2.1061 +15.4082i						
12	Application Areas							
13	Remarks	Quantum mechanics and electrodynamics						
14	Faculty Signature with Date							

Experiment 11 / Design and Implementation of IIR filter

-	**Experiment No.:**	1	**Marks**		**Date Planned**		**Date Conducted**	
1	Title	Design of IIR filter						
2	Course Outcomes	Design and Implementation of IIR filter						
3	Aim	Design and Implementation of IIR filter						
4	Material / Equipment Required	Lab Manual						
5	Theory, Formula, Principle, Concept	For Given specifications						

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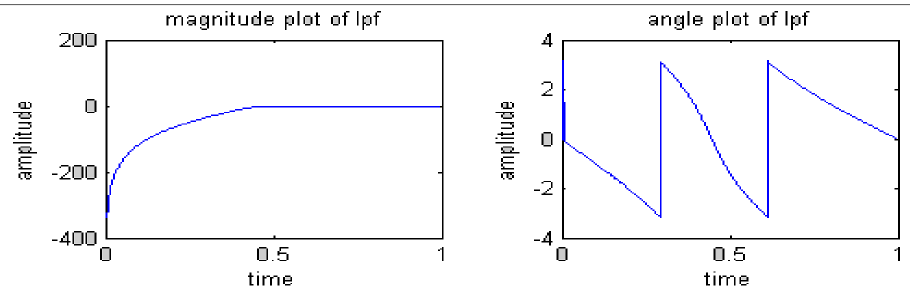
6	Procedure, Program, Activity, Algorithm, Pseudo Code	Step1: Start the mat lab software Step2: Assign the variable for pass band ripple ,stop band ripple, pass band and stop band frequency Step3: Determine the order of filter using the required formula. Step4: Find the filter co-efficient a and b Step5: Assign the time and amplitude Step6: Plot the magnitude and phase angle. Step7: Give the x label and y label and title it Step8: Save and run the program

7	Block, Circuit, Model Diagram, Reaction Equation, Expected Graph	%LPF%
		rp=input('enter the pass band ripple');
		rs=input('enter the stop band ripple');
		wp=input('enter the pass band frequency');
		ws=input('enter the stop band frequency');
		fs=input('enter the sampling frequency');
		w1=2*(wp/fs);
		w2=2*(ws/fs);
		[n,wn]=cheb1ord(w1,w2,rp,rs);
		[b,a]=cheby1(n,rp,wn);
		w=0:0.01/pi:pi;
		[h,om]=freqz(b,a,w);
		m=20*log10(abs(h));
		an=angle(h);
		subplot(2,2,1);
		plot((om/pi),m);
		xlabel('time');
		ylabel('amplitude');
		title('magnitude plot of lpf');
		subplot(2,2,2);
		plot((om/pi),an);
		xlabel('time');
		ylabel('amplitude');
		title('angle plot of lpf');

8	Observation Table, Look-up Table, Output	
9	Sample Calculations	
10	Graphs, Outputs	
11	Results & Analysis	
12	Application Areas	
13	Remarks	Quantum mechanics and electrodynamics
14	Faculty Signature with Date	

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Experiment 12 / Design and Implementation of FIR filter

-	Experiment No.:	1	Marks		Date Planned		Date Conducted	
1	Title	Solution of a given difference equation.						
2	Course Outcomes	Design and Implementation of FIR filter						
3	Aim	Design and Implementation of FIR filter						
4	Material / Equipment Required	Lab Manual						
5	Theory, Formula, Principle, Concept	Window Technique						
6	Procedure, Program, Activity, Algorithm, Pseudo Code	Step 1: Assign the variable for pass band ripple ,stop band ripple, pass band and stop Step 2 :band frequency Determine the order of filter using the required formula. Step 3 :Find the filter co-efficient b Step 4 :Assign the time and amplitude Plot the magnitude and phase angle for LPF.HPF,BPF&BSF. Step 5 : Give the x label and y label and title it						

7	Block, Circuit, Model Diagram, Reaction Equation, Expected Graph	%Hamming window%
		rp=input('enter the PB ripple');
		rs=input('enter the SB ripple');
		fp=input('enter PB frequency');
		fs=input('enter SB frequency');
		f=input('enter sampling frequency');
		wp=2*(fp/f);
		ws=2*(fs/f);
		num=-20*log10(sqrt(rp*rs))-13;
		den=14.6*(fs-fp)/f;
		n=ceil(num/den);
		n1=n+1;
		if(rem(n,2)~=0);
		n1=n;
		n=n-1;
		end;
		y=hamming(n1);
		%LPF
		b=fir1(n,wp,y);
		[h,o]=freqz(b,1,256);
		M=20*log10(abs(h));
		subplot(2,2,1);
		plot(o/pi,M);
		ylabel('gain indB');
		xlabel('(a) normal frequency');
		%HPF
		b=fir1(n,wp,'high',y);
		[h,o]=freqz(b,1,256);
		m=20*log10(abs(h));
		subplot(2,2,2);
		plot(o/pi,m);
		ylabel('gain in dB');
		xlabel('(b) normal frequency');
		%BPF
		wn=[wp,ws];
		b=fir1(n,wn,y);
		[h,o]=freqz(b,1,256);
		m=20*log10(abs(h));
		subplot(2,2,3);
		plot(o/pi,m);
		ylabel('gain in dB');
		xlabel('(c) normal frequency');						

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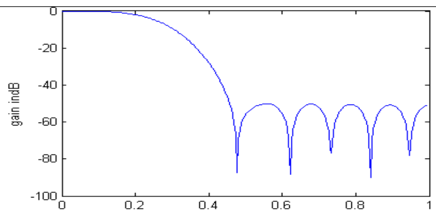
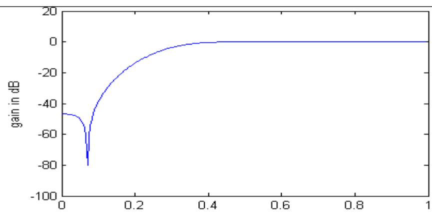
		%BSF
		b=fir1(n,wn,'stop',y);
		[h,o]=freqz(b,1,256);
		m=20*log10(abs(h));
		subplot(2,2,4);
		plot(o/pi,m);
		ylabel('gain in dB')
		
		Enter the PB ripple: 0.05
		Enter the SB ripple: 0.04
		Enter PB frequency: 1200
		Enter SB frequency: 1700
		Enter sampling frequency: 9000
		.

8	Observation Table, Look-up Table, Output	
9	Sample Calculations	
10	Graphs, Outputs	
11	Results & Analysis	 
12	Application Areas	
13	Remarks	Quantum mechanics and electrodynamics
14	Faculty Signature with Date	

F. Content to Experiment Outcomes

1. TLPA Parameters

Table 1: TLPA – Example Course

Expt-#	Course Content or Syllabus (Split module content into 2 parts which have similar concepts)	Content Teaching Hours	Blooms' Learning Levels	Final Blooms'	Identified Action Verbs for	Instruction Methods	Assessment Methods to Measure

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			for Content	Level	Learning	for Learning	Learning
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*
1	Verification of Sampling Theorem both in time and frequency domains	3	-L3 -L4	L4	-Apply -Analyze	Demonstration	- Slip Test
2	Evaluation of impulse response of a system	3	-L3 -L4	L4	-Apply -Analyze	Demonstration	- Slip Test
3	To perform linear convolution of given sequences	3	-L3 -L4	L4	-Apply -Analyze	Demonstration	- Slip Test
4	To perform circular convolution of given sequences using (a) the convolution summation formula (b) the matrix method and (c) Linear convolution from circular convolution with zero padding.	3	-L3 -L4	L4	-Apply -Analyze	Demonstration	- Slip Test -
5	Computation of N–point DFT and to plot the magnitude and phase spectrum.	3	-L3 -L4	L4	-Apply -Analyze	Demonstration	- Slip Test
6	Linear and circular convolution by DFT and IDFT method.	3	-L3 -L4	L4	-Apply -Analyze	Demonstration	Slip Test
7	Solution of a given difference equation.	3	-L3 -L4	L4	-Apply -Analyze	Demonstration	Slip Test
8	Calculation of DFT and IDFT by FFT	3	-L3 -L4	L4	-Apply -Analyze	Demonstration	Slip Test
9	Design and implementation of IIR filters to meet given specification (Low pass, high pass, band pass and band reject filters)	3	-L3 -L4	L4	-Apply -Analyze	Demonstration	Slip Test
10	Design and implementation of FIR filters to meet given specification (Low pass, high pass, band pass and band reject filters) using different window functions	3	-L3 -L4	L4	-Apply -Analyze	Demonstration	Slip Test
11	Design and implementation of FIR filters to meet given specification (Low pass, high pass, band pass and band reject filters) using frequency sampling technique.	3	-L3 -L4	L4	-Apply -Analyze	Demonstration	Slip Test
12	Realization of IIR and FIR filters	3	-L3 -L4	L4	-Apply -Analyze	Demonstration	Slip Test

2. Concepts and Outcomes:

Table 2: Concept to Outcome – Example Course

Expt - #	Learning or Outcome from study of the Content or Syllabus	Identified Concepts from Content	Final Concept	Concept Justification (What all Learning Happened from the study of Content / Syllabus. A short word for learning or outcome)	CO Components (1.Action Verb, 2.Knowledge, 3.Condition / Methodology, 4.Benchmark)	Course Outcome **Student Should be able to ...**
A	*I*	*J*	*K*	*L*	*M*	*N*
1	Verification of Sampling Theorem both in time and frequency domains	-verification -sampling	sampling	Under sampling uniquest sampling and over sampling conditions were understood	- Understand - Analyze	Verification of sampling theorem
2	Evaluation	LTI	LTI response	Impulse response	- Evaluate	Impulse response of

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	of impulse response of a system	response -Impulse response		of LTI system were evaluated and analyzed	- Analyze	first order and second order system
3	To perform linear convolution of given sequences	Convolution -linear	convolution	Linear convolution between two sequence were analyzed	- Perform - Analyze	Linear convolution of two sequences
4	To perform circular convolution of given sequences using (a) the convolution summation formula (b) the matrix method and (c) Linear convolution from circular convolution with zero padding.	-System analysis -circular convolution	System analysis	circular convolution between two sequence were analyzed	- Evaluate -Analyze	Circular convolution of two sequences
5	Computation of N–point DFT and to plot the magnitude and phase spectrum.	Frequency Response - magnitude and phase spectra	Frequency Response	Phase spectra and magnitude spectra were analyzed	- Calculate -Analyze	N–point DFT and to plot the magnitude and phase spectrum.
6	Linear and circular convolution by DFT and IDFT method.	- Frequency Response -Fourier transform	Frequency Response	Convolution of DFT and IDFT were analyzed	- calculate -Analyze	Solution of a given difference equation
7	Solution of a given difference equation.	Frequency Response - Difference equation	Frequency Response	Solution of differene equation can be analyzed	- calculate -Analyze	Calculation of DFT and IDFT by FFT
8	Calculation of DFT and IDFT by FFT	Fast fourier transform	Fast fourier transform	From FFT analysis of time domain signal can be done	-calculate - Analyze	Design and implementation of IIR filter to meet given specifications
9	Design and implementation of IIR filters to meet given specification (Low pass, high pass, band pass and band reject filters)	IIR Filter	IIR Filter	Design and implementation of IIR filter can be understood	-implement - Design	Design and implementation of FIR filter to meet given specifications

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	Design and implementation of FIR filters to meet given specification (Low pass, high pass, band pass and band reject filters) using different window functions	FIR Filter	FIR Filter	Design and implementation of FIR filter can be understood	-Analyze	Design and implementation of FIR filters using different window
	Design and implementation of FIR filters to meet given specification (Low pass, high pass, band pass and band reject filters) using frequency sampling technique.	Frequency sampling	Frequency sampling		-Analyze	Design and implementation of FIR filters using frequency sampling technique.
	Realization of IIR and FIR filters	Realization	Realization	Realization of filters can be Analyze	Analyze	Realization of IIR and FIR filters

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