Ref No:

< SRI KRISHNA INSTITUTE OF TECHNOLOGY BANGALORE>

EC

Prepared by Checked by Approved

COURSE PLAN

Academic Year 2019-2020

Program:	B E – Electronics & Communication Engineering
Semester :	6
Course Code:	17EC61
Course Title:	DIGITAL COMMUNICATION
Credit / L-T-P:	4 / 4-0-0
Total Contact Hours:	50
Course Plan Author:	N S MYTHREYE

Academic Evaluation and Monitoring Cell

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Table of Contents

Note : Remove "Table of Content" before including in CP Book
Each Course 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

17EC61 : DIGITAL COMMUNICATION

A. COURSE INFORMATION

1. Course Overview

Degree:	B.E	Program:	ECE
Year / Semester :	6th	Academic Year:	2018-19
Course Title:	Digital Communication	Course Code:	17EC61
Credit / L-T-P:	50-10-0	SEE Duration:	180 Minutes
Total Contact Hours:	50	SEE Marks:	80 Marks
CIA Marks:	20	Assignment	1 / Module
Course Plan Author:	Asha B R	Sign	Dt:

2. Course Content

Module	Module Content	Teaching Hours	Module Concepts	Blooms Level
1	HilbertTransform,Pre-envelopes,Complex envelopes, Canonical representation of bandpass signals, Complex low pass representation of bandpass systems, Complex representation of band pass signals and systems. **Line codes:** Unipolar, Polar, Bipolar (AMI) and Manchester code and their power spectral densities	10	Band pass signals & Line coding methods	L3
2	Introduction, Geometric representation of signals,Gram-Schmidt Orthogonalization procedure, Conversion of the continuous AWGN channel into a vector channel, Optimum receivers using coherent detection: ML Decoding, Correlation receiver, matched filter receiver	08	Additive white Gaussian noise(AWGN) channels	L3
3	Phase shift Keying techniques using coherent detection: generation, detection and error probabilities of BPSK and QPSK, M–ary, PSK, M–ary QAM Frequency shift keying techniques using Coherent detection: BFSK generation,detection and error probability. Non coherent orthogonal modulation techniques: BFSK, DPSK Symbol representation,Block diagrams treatment of Transmitter and Receiver, Probability of error	12	Coherent & Non coherent orthogonal modulation techniques	L4
4	Digital Transmission through Band limited channels: Digital PAM Transmission through Band limited Channels,Signal design for Band limited Channels: Design of band limited signals for zero ISI –The Nyquist Criterion (statement only), Design of band limited signals with controlled ISI-Partial Response signals, Probability of error for detection of Digital PAM:Probability of error for detection of Digital PAM with Zero ISI, Symbol–by–Symbol detection of data with controlled ISI, Channel Equalization: Linear Equalizers (ZFE, MMSE), Adaptive Equalizers	12	Band limited channels	L3
5	Spread Spectrum Communication Systems: Model of a Spread Spectrum Digital Communication System, Direct Sequence Spread Spectrum Systems, Effect of De-spreading on a narrowband Interference, Probability of error (statement only), Some applications of DS Spread Spectrum Signals,Generation of PN Sequences, Frequency Hopped Spread Spectrum, CDMA based on IS-95	08	Spread spectrum	L4

3. Course Material

Module	Details	Available
1	Simon Haykin, ―Digital Communication Systems‖, John Wiley & sons, First Edition, 2014, ISBN 978-0-471-64735-5.	In Lib
2	John G Proakis and Masoud Salehi, ―Fundamentals of Communication Systems‖, 2014 Edition, Pearson Education, ISBN 978-8-131-70573-5.	In Lib
	Reference books:	
3	B.P.Lathi and Zhi Ding, ―Modern Digital and Analog communication Systems‖, Oxford University Press, 4th Edition, 2010, ISBN: 978-0-198-07380-2.	In Lib
4	Ian A Glover and Peter M Grant, ―Digital Communications‖, Pearson Education,	In Lib

	Third Edition, 2010, ISBN 978-0-273-71830-7.	
5	John G Proakis and Masoud Salehi, ―Communication Systems Engineering‖, 2nd Edition, Pearson Education, ISBN 978-93-325-5513-6.	In Lib
6	Others (Web, Videos, Notes etc.)	Not Available

4. Course Prerequisites

SNo	Course Code	Course Name	Module / Topic / Description	Sem	Remarks	Blooms Level
1	ELN	Basic electronics	1. Knowledge on Passive and Active elements	2		L1
			2. Knowledge of fundamental of maths	-	Bridge course of maths for students	L1
2	EC34	Digital electronics	1. Basics of digital concepts	3		L2

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

B. OBE PARAMETERS

1. Course Outcomes

#	COs	Teach. Hours	Concept	Instr Method	Assessment Method	Blooms' Level
17EC61.1	Understand & acquire the knowledge on representation of band pass signals.	06	Band pass signals	Lecture	CIA Assignment	L3
17EC61.2	Solve problems to new situations by applying line coding methodologies.	04	**Line coding methods**	Lecture/ PPT	CIA Oral quiz Assignment	L3
17EC61.3	Learn about signal transmission over AWGN channels	08	**Additive white** Gaussian noise(AWGN) channels	Lecture/ Video tutorial	CIA Slip Test Assignment	L3
17EC61.4	Perform coherent & Non coherent modulation techniques to analyze the channel performance.	06	Coherent modulation technique	Lecture / PPT	Assignment CIA	L4
17EC61.5	Identify the difference between coherent & non coherent orthogonal modulation techniques.	06	Non coherent orthogonal modulation technique	Lecture	CIA Slip Test Assignment	L4
17EC61.6	Demonstrate understanding of signal transmission through band limited channels.	12	Band limited channels	Lecture and Tutorial	Assignment Slip Test	L3
17EC61.7	Analyze performance of spread spectrum communication systems.	08	Spread spectrum	PPT/ Video tutorial	CIA Oral quiz Assignment	L4

-	**Total**	**50**	**-**	**-**	**-**	**-**

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

2. Course Applications

SNo	Application Area	CO	Level
1	Designing of filters	CO1	L3
2	Transmission & storage,Pulse shaping	CO2	L3
3	Analysing the performance of the communication systems	CO3	L3
4	Matched filtering to identify behavioral modulation of brain oscillations	CO3	L3
5	BPSK & QPSK is used in various cellular wireless standards such as GSM, CDMA, LTE, 802.11 WLAN, 802.16 fixed and mobile WiMAX, Satellite and CABLE TV	CO4	L4
6	DPSK is used in bluetooth,Biometric passports etc	CO5	L4
7	Band limited channels are used in inter symbol interference,	CO6	L3
8	Equalizers are used in recording studios, radio studios and production control rooms, and live sound reinforcement and in instrument amplifiers, such as guitar amplifiers, to correct or adjust the response of microphones, instrument pick-ups, loudspeakers, and hall acoustics.	CO6	L3
9	Spread spectrum applications in interference, millitary,wireless LAN security, CDMA	CO7	L4

Note: Write 1 or 2 applications per CO.

3. Articulation Matrix

(CO – PO MAPPING)

-	Course Outcomes	Program Outcomes												
#	COs	PO1	PO2	PO3	PO4	PO5	PO 6	PO7	PO 8	PO9	PO1 0	PO1 1	PO1 2	Level
17EC61.1	Understand & acquire the knowledge on representation of band pass signals.	3	3	2	3	2	-	-	-	-	-	-	-	L3
17EC61.2	Solve problems to new situations by applying line coding methodologies.	3	2	2	1	2	-	-	-	-	-	-	-	L3
17EC61.3	Learn about signal transmission over AWGN channels	3	3	-	-	2	-	-	-	-	-	-	-	L3
17EC61.4	Perform coherent & Non coherent modulation techniques to analyze the channel performance.	3	2	3	2	2	-	-	-	-	-	-	-	L4
17EC61.5	Identify the difference between coherent & non coherent orthogonal modulation techniques.	3	3	2	-	2	-	-	-	-	-	-	-	L4
17EC61.6	Demonstrate understanding of signal transmission through band limited channels.	3	-	1	1	2	-	-	-	-	-	-	-	L3
17EC61.7	Analyze performance of spread spectrum communication systems.	3	2	-	-		-	-	-	-	-	-	-	L4
Note: Mention the mapping strength as 1, 2, or 3														

4. Mapping Justification

Mapping	Justification	Mapping Level

CO	PO	-	-
CO1	PO1	Knowledge of band pass signals is required for represenation of complex signaling system.	L3
CO1	PO2	Analyzing the signal representation requires knowledge on Band pass signals	L3
CO1	PO3	Knowledge on Band pass signal is used to design filters	L3
CO1	PO4	Prediction of signal representation based on band pass signals	L3
CO2	PO1	Understanding of line codes methodologies to solve the complex engineering problems.	L3
CO2	PO2	Identify the problems & solve that using line coding methods	L3
CO2	PO3	Line coding is used to develop solutions for complex systems	L3
CO2	PO4	Determination of errors in system using line codes.	L3
CO3	PO1	Skilling on the AWGN channels is required for performance analysis of communication systems	L3
CO3	PO2	Used to formulate the geometric represenation of signals	L3
CO4	PO1	Command on the digital modulation techniques will help to determine the behavior of various communication systems	L4
CO4	PO2	Using modulation techniques to analyze the peoblems in channel performance	L4
CO4	PO3	Understanding of digital modulation techniques helps in developing various cellular wireless standards	L4
CO4	PO4	Interpretation of probability of error for detection of digital systems	L4
CO5	PO1	Knowledge on non coherent technique will be used to differentiate system working	L4
CO5	PO2	Identify the difference between coherent & non coherent techniques	L4
CO5	PO3	Non coherent orthogonal modulation is required to design bluetooth , bio metric etc systems	L4
CO6	PO1	Mastery on band limited channels are used in inter symbol interference	L3
CO6	PO2	Skill on band limited channels are used to design controlled ISI-partial response signals	L3
CO6	PO3	Investigating the transmission of signals over band limited channels	L3
CO7	PO1	Understanding the principles of spread spectrum to design wireless LAN security systems.	L4
CO7	PO2	Knowledge on spread spectrum to analyze performance of the system	L4

Note: Write justification for each CO-PO mapping.

5. Curricular Gap and Content

SNo	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. Content Beyond Syllabus

SNo	Gap Topic	Actions Planned	Schedule Planned	Resources Person	PO Mapping

1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

Note: Anything not covered above is included here.

C. COURSE ASSESSMENT

1. Course Coverage

Module #	Title	Teaching Hours	No. of question in Exam						CO	Levels
			CIA-1	CIA-2	CIA-3	Asg	Extra Asg	SEE		
1	Basic concepts of Band pass signals & Line coding methods	10	2	-	-	1	1	2	CO1 CO2	L3
2	Transmission in AWGN channels	08	2	-	-	1	1	2	CO3	L3
3	Coherent & Non coherent orthogonal modulation techniques	12	-	2	-	1	1	2	CO4 CO5	L4
4	Transmission in band limited channels	12	-	2	-	1	1	2	CO6	L3
5	Spread Spectrum communication channels	08	-	-	4	1	1	2	CO7	L4
-	**Total**	**50**	**4**	**4**	**4**	**5**	**5**	**10**	**-**	**-**

Note: Distinct assignment for each student. 1 Assignment per chapter per student. 1 seminar per test per student.

2. Continuous Internal Assessment (CIA)

Evaluation	Weightage in Marks	CO	Levels
CIA Exam – 1	15	CO1, CO2, CO3	L3, L3
CIA Exam – 2	15	CO4, CO5, CO6	L4, L3
CIA Exam – 3	15	CO7	L4
Assignment - 1	05	CO1, CO2, CO3	L3, L3
Assignment - 2	05	CO4, CO5, CO6	L4, L3
Assignment - 3	05	CO7	L4
Other Activities – define – Slip test		CO1 to Co7	L2, L3, L4 . ..
Final CIA Marks	**20**	**-**	**-**

Note : Blooms Level in last column shall match with A.2 above.

D1. TEACHING PLAN - 1

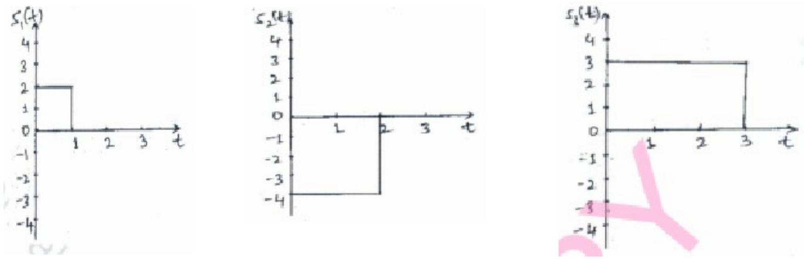
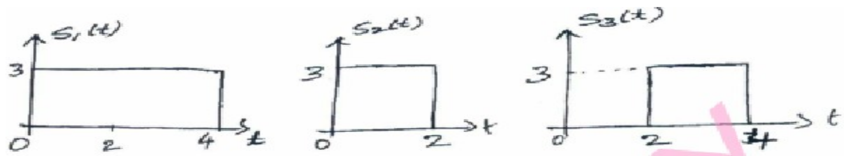
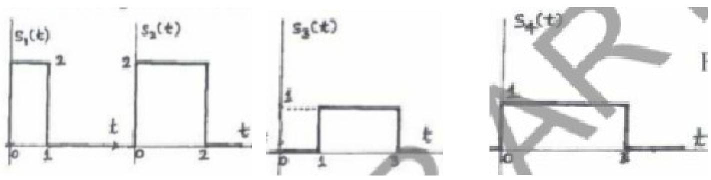
Module - 1

Title:	Basic concepts of Band pass signals & Line coding methods	Appr Time:	12 Hrs
a	***Course Outcomes***	-	**Blooms**
-	The student should be able to:	-	**Level**
1	Understand & acquire the knowledge on representation of band pass signals.	CO1	L3
2	Solve problems to new situations by applying line coding methodologies.	CO2	L3
b	***Course Schedule***	-	-
Class No	**Module Content Covered**	**CO**	**Level**
1	Introduction, Hilbert Transform	CO1	L2
2	Pre-envelopes	CO1	L2
3	Complex envelopes	CO1	L2
4	Canonical representation of bandpass signals	CO1	L3
5	Complex low pass representation of bandpass systems	CO1	L3
6	Complex representation of band pass signals and systems.	CO2	L2
7	**Line codes:** Unipolar, Polar	CO2	L3
8	Bipolar (AMI) and Manchester code and	CO2	L3
9	Bipolar (AMI) and Manchester code power spectral densities	CO2	L3
10	Class test		
c	**Application Areas**	**CO**	**Level**
1	Designing of filters	CO1	L3
2	Transmission & storage, Pulse shaping	CO2	L3
d	**Review Questions**	-	-
1	Define Hilbert transform. State the properties of it.	CO1	L2
2	Define the complex envelope of bandpass signals. Obtain the canonical representation of bandpass signals.	CO1	L3
3	Derive the power spectral density of polar NRZ signals and plot the Spectrum.	CO2	L3
4	Define the pre-envelope. Show the spectral representation of pre-envelopes for low pass signals.	CO1	L3
5	Derive the expression for the complex low pass representation of bandpass systems.	CO1	L3
6	Given the data stream 1110010100. Sketch the transmitted sequence of pulses for each of the following line code. (I) Unipolar NRZ (ii) Polar NRZ (iii) Unipolar RZ (iv) Bipolar RZ (v) Manchester code.	CO2	L3
7	Draw the digital data format for a given sequence 0 1 1 0 1 1 0 0 0 1 corresponding to i) Bipolar RZ ii) Manchester iii) Polar quarternary (natural code).	CO2	L3
8	Give the canonical and polar representations of the band pass signals?	CO1	L3
9	For a given sequence draw the digital format waveforms corresponding to Unipolar RZ and NRZ, Bipolar RZ and NRZ, Polar RZ and NRZ, and Dipolar RZ and NRZ. (001110101000001111111)	CO2	L3
10	How can we modify the frequency content of a real valued signal g(t) such that all negative frequency components are completely eliminated?	CO1	L2
11	Write short notes on the following: i) HDB3 ii) B3ZS iii) B6ZS iv) split phase manchester coding.	CO2	L3
12	Write the difference between NRZ & RZ	CO2	L3

e	Experiences	-	-
1		CO1	L2
2			
3			
4		CO3	L3
5			

Module – 2

Title:	Transmission in AWGN channels	Appr Time:	08 Hrs
a	***Course Outcomes***	-	**Blooms**
-	The student should be able to:	-	**Level**
1	Learn about signal transmission over AWGN channels	CO3	L3
b	***Course Schedule***	-	-
Class No	**Module Content Covered**	**CO**	**Level**
11	Introduction to AWGN	CO3	L3
12	Geometric representation of signals	CO3	L3
13	Gram-Schmidt Orthogonalization procedure	CO3	L3
14	Conversion of the continuous AWGN channel into a vector channel	CO3	L3
15	Optimum receivers using coherent detection: ML Decoding	CO3	L3
16	Correlation receiver	CO3	L3
17	Matched filter receiver	CO3	L3
18	Class test	CO3	L3
c	**Application Areas**	**CO**	**Level**
1	Analysing the performance of the communication systems	CO3	L3
2	Matched filtering to identify behavioral modulation of brain oscillations	CO3	L3
d	**Review Questions**	-	-
13	Explain the geometric representation of signals and express the energy of the signal in terms of the signal vector.	CO3	L1
14	Explain the Gram-Schmidt orthogonalization procedure.	CO3	L3
15	Explain the matched filter receiver with the relevant mathematical theory.	CO3	L2
16	Obtain the decision rule for maximum likelihood decoding and explain the correlation receiver.	CO3	L2
17	The waveforms of four signals S1(t),S2(t),S3(t) & S4(t) describe below. S1(t) = 1, 0< t <T/3. S2(t) = 1, 0< t < 2T/3, S3(t) = 1, T/3< t <T, S4(t) = 1, 0< t <T, and Zero otherwise. Using the Gram-Schmidt orthogonalization procedure. Find an orthogonal basis for this set of signals and construct the corresponding signal-space diagram.	CO3	L3
18	Derive an expression for Kronecker Delta Function using orthonormal basis function?	CO3	L3
19	Explain Hilbert Transforms and its properties? Explain the complex representation of band pass signals and systems?	CO3	L2
20	Explain the geometric representation of the signal using 2-D signal space with 3 symbols. Suppose S1=(3,2), S2=(-2,3), S3=(3,-3). Draw the constellation diagram and express S1(t), S2(t) and S3(t) as a linear combination of basic functions.	CO3	L3
21	Explain the detection and estimation of the signals in the receiver? What is the average probability of error of the signal. Explain?	CO3	L1,L2

22	Using the Gram-Schmidt orthogonalization procedure, find a set of orthonormal basis functions to represent the three signals si(t), s2(t) and s3(t) shown in Figure. Express each of these signals in terms of the set of basis function. 	CO3	L3
23	Derive the impulse response of a matched filter receiver and explain any two properties of matched filter.	CO3	L2
24	Explain geometric interpretation of signals.	CO3	L2
25	Three signals SI(t), S2(t) and S3(t) are shown in Fig.Q6(b). Apply Gram-Schmidt procedure to obtain an orthonormal basis for the signals. Express signals S1(t), S2(t) and S3(t) in terms of orthonormal basis functions. Also give the signal constellation diagram. 	CO3	L3
26	Using the Gram-Schmidt orthogonalization procedure, find a set of orthonormal basis functions to represent the 4 signals si(t), s2(0, s 3(t) and s4(t) shown in the Figure below. Express each of these signals in terms of the set of basis functions. 	CO3	L3
27	Explain the importance of geometric interpretation of signals. Illustrate the geometric representation of signals for the case of a 2-dimensional signal space with 3 signals.	CO3	L3
e			

E1. CIA EXAM – 1

a. Model Question Paper - 1

Crs Code:	17EC61	Sem:	VI	Marks:	30	Time:	75 minutes
Course:	Digital Communication						

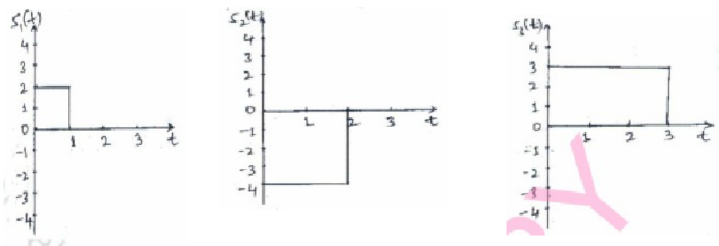
-	-	Note: Answer any 3 questions, each carry equal marks.	Marks	CO	Level
		MODULE-1			
1	a	Give the canonical and polar representations of the band pass signals?	5	CO1	L3
	b	For a given sequence draw the digital format waveforms corresponding to Unipolar RZ and NRZ, Bipolar RZ and NRZ, Polar RZ and NRZ, and Dipolar RZ and NRZ. (0011101010000011111)	10	CO1	L2
		OR			
2	a	How can we modify the frequency content of a real valued signal g(t) such that all negative frequency components are completely eliminated?	7	CO1	L3
	b	Write short notes on the following: i) HDB3 ii) B3ZS iii) B6ZS iv) split phase manchester coding.	8	CO1	L2
					L3
		MODULE-2			L2
3	a	Derive an expression for Kronecker Delta Function using orthonormal basis function?	5	CO2	L3
	b	Explain Hilbert Transforms and its properties? Explain the complex representation of band pass signals and systems?	10	CO1	L2
		OR			
4	a	Explain the geometric representation of the signal using 2-D signal space with 3 symbols. Suppose S1=(3,2), S2=(-2,3), S3=(3,-3). Draw the constellation diagram and express S1(t), S2(t) and S3(t) as a linear combination of basic functions.	7	CO2	L3
	b	Explain the detection and estimation of the signals in the receiver? What is the average probability of error of the signal. Explain?	8	CO2	L1,L2

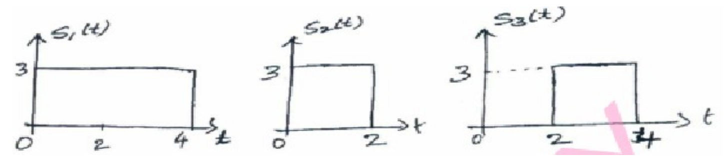
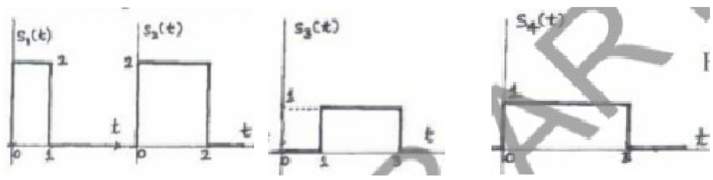
b. Assignment -1

Note: A distinct assignment to be assigned to each student.

Model Assignment Questions							
Crs Code:	17EC61	Sem:	VI	Marks:	5 / 10	Time:	90 – 120 minutes
Course:	Digital Communication						
Note: Each student to answer 2-3 assignments. Each assignment carries equal mark.							

SNo	USN	Assignment Description	Marks	CO	Level
1		Define Hilbert transform. State the properties of it.	5	CO1	L2
2		Define the complex envelope of bandpass signals. Obtain the canonical representation of bandpass signals.	5	CO1	L3
3		Derive the power spectral density of polar NRZ signals and plot the Spectrum.	5	CO2	L3
4		Define the pre-envelope. Show the spectral representation of pre- envelopes for low pass signals.	5	CO1	L3
5		Derive the expression for the complex low pass representation of bandpass systems.	5	CO1	L3
6		Given the data stream 1110010100. Sketch the transmitted sequence of pulses for each of the following line code. (I) Unipolar NRZ (ii) Polar NRZ (iii) Unipolar RZ (iv) Bipolar RZ (v) Manchester code.	5	CO2	L3
7		Draw the digital data format for a given sequence 0 1 1 0 1 1 0 0 0 1 corresponding to i) Bipolar RZ ii) Manchester iii) Polar quarternary (natural code).	5	CO2	L3
8		Give the canonical and polar representations of the band pass signals?	5	CO1	L3
9		For a given sequence draw the digital format waveforms corresponding to Unipolar RZ and NRZ, Bipolar RZ and NRZ, Polar RZ and NRZ, and Dipolar RZ and NRZ. (0011101010000011111)	5	CO2	L3

10		How can we modify the frequency content of a real valued signal g(t) such that all negative frequency components are completely eliminated?	5	CO1	L2
11		Write short notes on the following: i) HDB3 ii) B3ZS iii) B6ZS iv) split phase manchester coding.	5	CO2	L3
12		Write the difference between NRZ & RZ	5	CO2	L3
13		Explain the geometric representation of signals and express the energy of the signal in terms of the signal vector.	5	CO1	L2
14		Explain the Gram-Schmidt orthogonalization procedure.	5	CO3	L1
15		Explain the matched filter receiver with the relevant mathematical theory.	5	CO3	L3
16		Obtain the decision rule for maximum likelihood decoding and explain the correlation receiver.	5	CO3	L2
17		The waveforms of four signals S1(t),S2(t),S3(t) & S4(t) describe below. S1(t) = 1, 0< t <T/3. S2(t) = 1, 0< t < 2T/3, S3(t) = 1, T/3< t <T, S4(t) = 1, 0< t <T, and Zero otherwise. Using the Gram-Schmidt orthogonalization procedure. Find an orthogonal basis for this set of signals and construct the corresponding signal-space diagram.	5	CO3	L2
18		Derive an expression for Kronecker Delta Function using orthonormal basis function?	5	CO3	L3
19		Explain Hilbert Transforms and its properties? Explain the complex representation of band pass signals and systems?	5	CO3	L3
20		Explain the geometric representation of the signal using 2-D signal space with 3 symbols. Suppose S1=(3,2), S2=(-2,3), S3=(3,-3). Draw the constellation diagram and express S1(t), S2(t) and S3(t) as a linear combination of basic functions.	5	CO3	L2
21		Explain the detection and estimation of the signals in the receiver? What is the average probability of error of the signal. Explain?	5	CO3	L3
22		Using the Gram-Schmidt orthogonalization procedure, find a set of orthonormal basis functions to represent the three signals si(t), s2(t) and s3(t) shown in Figure. Express each of these signals in terms of the set of basis function. 	5	CO3	L1,L2
23		Derive the impulse response of a matched filter receiver and explain any two properties of matched filter.	5	CO3	L3
24		Explain geometric interpretation of signals.	5	CO3	L2
25		Three signals SI(t), S2(t) and S3(t) are shown in Fig.Q6(b). Apply Gram-Schmidt procedure to obtain an orthonormal basis for the signals. Express signals S1(t), S2(t) and S3(t) in terms of	5	CO3	L2

		orthonormal basis functions. Also give the signal constellation diagram. 			
26		Using the Gram-Schmidt orthogonalization procedure, find a set of orthonormal basis functions to represent the 4 signals si(t), s2(0, s 3(t) and s4(t) shown in the Figure below. Express each of these signals in terms of the set of basis functions. 	5	CO3	L3
27		Explain the importance of geometric interpretation of signals. Illustrate the geometric representation of signals for the case of a 2-dimensional signal space with 3 signals.	5	CO3	L3
28					
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D2. TEACHING PLAN - 2

Module – 3

Title:	Digital Modulation Techniques	Appr Time:	12 Hrs
a	***Course Outcomes***	-	**Blooms**
-	The student should be able to:	-	**Level**
1	Perform coherent & Non coherent modulation techniques to analyze the channel performance.	CO4	L2
2	Identify the difference between coherent & non coherent orthogonal modulation techniques.	CO5	L3

b	***Course Schedule***		
Class No	**Module Content Covered**	**CO**	**Level**
1	Phase shift Keying techniques using coherent detection: generation	CO4	L2
2	Detection and error probabilities of BPSK and QPSK	CO4	L4
3	Detection and error probabilities of QPSK	CO4	L4
4	M–ary, PSK	CO4	L3
5	M–ary QAM Frequency shift keying techniques using Coherent detection introduction	CO4	L3
6	BFSK generation	CO4	L3
7	Detection and error probability.	CO4	L4
8	Non coherent orthogonal modulation techniques: BFSK	CO5	L4
9	DPSK Symbol representation	CO5	L4
10	Block diagrams treatment of Transmitter and Receiver	CO5	L4
11	Probability of error	CO5	L4
12	Class test		
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14			
15			
16			
c	**Application Areas**	**CO**	**Level**
1	BPSK & QPSK is used in various cellular wireless standards such as GSM, CDMA, LTE, 802.11 WLAN, 802.16 fixed and mobile WiMAX, Satellite and CABLE TV	CO4	L4
2	DPSK is used in bluetooth,Biometric passports etc	CO5	L4
d	**Review Questions**	-	-
1	Explain the BPSK system with the help of the transmitter and receiver. Derive an expression for the spectrum of BPSK system and hence calculate the bandwidth.	CO4	L4
2	Sketch the signal using QPSK for the given sequence 01101000 and hence draw the diagram for the same.	CO4	L4
3	With the help of a block diagram and relevant expressions and waveforms explain the QPSK transmitter and receiver. Define the M-ary PSK relative to the QPSK	CO4	L3
4	Explain coherent BFSK transmitter and receiver.	CO4	L2
5	Obtain the expression for probability of symbol error of coherent binary FSK.	CO4	L4
6	Explain coherent BPSK Generation, detection & error probabilities.	CO4	L3
7	Explain generation & coherent detection of QPSK.	CO4	L3
8	Derive an expression for Error probability of QPSK.	CO4	L4
9	Explain generation & coherent detection of BFSK.	CO4	L3
10	Explain the power spectra of BFSK.	CO4	L3
11	Write a Note on Non-Coherent orthogonal modulation techniques.	CO5	L4
12	Obtain the expression for probability of symbol error of Non-coherent orthogonal modulation techniques.	CO5	L4
13	With a neat block diagram, explain the differential phase shift keying. Illustrate the generation of differentially encoded sequence for the binary data 11 00100010.	CO5	L4
14	What is M-ary PSK. Explain with suitable derivation.	CO5	L4
15	Explain M-ary QAM with suitable expression & example.	CO5	L3
16	Derive an expression for average probability of error for M-ary QAM using 4-ary PAM.	CO5	L4
e	**Experiences**	-	-
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4		CO3	L3
5			

Module – 4

Title:	Communication through Band Limited Channels	Appr Time:	12 Hrs
a	***Course Outcomes***	-	**Blooms**
-	The student should be able to:	-	**Level**
1	Demonstrate understanding of signal transmission through Band limited channels.	CO6	L3
b	***Course Schedule***		
Class No	**Module Content Covered**	**CO**	**Level**
1	Introduction to Digital Transmission through Band limited channels	CO6	L2
2	Digital PAM Transmission through Band limited Channels	CO6	L3
3	Signal design for Band limited Channels	CO6	L3
4	Design of band limited signals for zero ISI –The Nyquist Criterion (statement only)	CO6	L3
5	Design of band limited signals with controlled ISI-Partial Response signals	CO6	L3
6	Probability of error for detection of Digital PAM	CO6	L3
7	Probability of error for detection of Digital PAM with Zero ISI	CO6	L3
8	Symbol–by–Symbol detection of data with controlled ISI	CO6	L3
9	Channel Equalization: Linear Equalizers ZFE, MMSE)	CO6	L3
10	Linear Equalizers MMSE	CO6	L3
11	Adaptive Equalizers	CO6	L3
12	Class test		
13			
14			
15			
16			
c	**Application Areas**	**CO**	**Level**
1	Band limited channels are used in inter symbol interference,	CO6	L3
2	Equalizers are used in recording studios, radio studios and production control rooms, and live sound reinforcement and in instrument amplifiers, such as guitar amplifiers, to correct or adjust the response of microphones, instrument pick-ups, loudspeakers, and hall acoustics.	CO6	L3
d	**Review Questions**	-	-
1	With a neat block diagram explain the digital PAM transmission through band limited base band channels and Obtain the expression for ISI.	CO6	L2
2	What are adaptive equalizers? Explain the linear adaptive equalizer based on the MSE criterion.	CO6	L3
3	The binary sequence 10010110010 is the input to the precoder whose output is used to modulate a duobinary transmitting filter. Obtain the precoded sequence, transmitted amplitude levels, the received signal levels and the decoded sequence.	CO6	L3
4	What is eye pattern? What is the Nyquist criterion for Zero ISI? Given an example of the pulse with Zero ISI.	CO6	L2
5	Explain the design of band Limited signals with controlled ISI. Describe the time domain & frequency domain characteristics of a duobinary signal.	CO6	L3
6	What is channel eualization? With a neat diagram explain the concept of	CO6	L3

	equalization using a linear transversal filter.		
7	Design a Band limited signals with controlled ISI-partial response signals.	CO6	L2
8	Derive the Nyquist criterion for distortion less base band binary transmission	CO6	L3
9	What is eye pattern? Explain in detail.	CO6	L2
10	With a neat filter structure, explain the concept of adaptive equalization process.	CO6	L3
11	Write a note on Duobinary signaling.	CO6	L2
e	**Experiences**	-	-
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E2. CIA EXAM – 2

a. Model Question Paper - 2

Crs Code:	17EC61	Sem:	VI	Marks:	30	Time:	75 minutes
Course:	Design and Analysis of Algorithms						

-	-	Note: Answer any 2 questions, each carry equal marks.	Marks	CO	Level
		Module-3			
1	a	Explain the BPSK system with the help of the transmitter and receiver. Derive an expression for the spectrum of BPSK system and hence calculate the bandwidth.	10	CO4	L4
	b	Sketch the signal using QPSK for the given sequence 01101000 and hence draw the diagram for the same.	05	CO4	L4
		OR			
2	a	Write a Note on Non-Coherent orthogonal modulation techniques.	10	CO5	L4
	b	Explain coherent BFSK transmitter and receiver	05	CO4	L3
		Module - 4			
3	a	With a neat block diagram explain the digital PAM transmission through band limited base band channels and Obtain the expression for ISI.	08	CO6	L2
	b	What are adaptive equalizers? Explain the linear adaptive equalizer based on the MSE criterion.	07	CO6	L3
	c				
	d				
		OR			
4	a	Design a Band limited signals with controlled ISI-partial response signals.	10	CO6	L3
	b	Derive the Nyquist criterion for distortion less base band binary transmission.	05	CO6	L3
	c				
	d				

b. Assignment – 2

Note: A distinct assignment to be assigned to each student.

Model Assignment Questions							
Crs Code:	17EC61	Sem:	VI	Marks:	5 / 10	Time:	90 – 120 minutes
Course:	Digital Communication						
Note: Each student to answer 2-3 assignments. Each assignment carries equal mark.							

SNo	USN	Assignment Description	Marks	CO	Level
1		Explain the BPSK system with the help of the transmitter and receiver.	5	CO4	L4

		Derive an expression for the spectrum of BPSK system and hence calculate the bandwidth.			
2		Sketch the signal using QPSK for the given sequence 01101000 and hence draw the diagram for the same.	5	CO4	L4
3		With the help of a block diagram and relevant expressions and waveforms explain the QPSK transmitter and receiver. Define the M-ary PSK relative to the QPSK	5	CO4	L3
4		Explain coherent BFSK transmitter and receiver.	5	CO4	L2
5		Obtain the expression for probability of symbol error of coherent binary FSK.	5	CO4	L4
6		Explain coherent BPSK Generation, detection & error probabilities.	5	CO4	L3
7		Explain generation & coherent detection of QPSK.	5	CO4	L3
8		Derive an expression for Error probability of QPSK.	5	CO4	L4
9		Explain generation & coherent detection of BFSK.	5	CO4	L3
10		Explain the power spectra of BFSK.	5	CO4	L3
11		Write a Note on Non-Coherent orthogonal modulation techniques.	5	CO5	L4
12		Obtain the expression for probability of symbol error of Non-coherent orthogonal modulation techniques.	5	CO5	L4
13		With a neat block diagram, explain the differential phase shift keying. Illustrate the generation of differentially encoded sequence for the binary data 11 00100010.	5	CO5	L4
14		What is M-ary PSK. Explain with suitable derivation.	5	CO5	L4
15		Explain M-ary QAM with suitable expression & example.	5	CO5	L3
16		Derive an expression for average probability of error for M-ary QAM using 4-ary PAM.	5	CO5	L4
17		With a neat block diagram explain the digital PAM transmission through band limited base band channels and Obtain the expression for ISI.	5	CO6	L2
18		What are adaptive equalizers? Explain the linear adaptive equalizer based on the MSE criterion.	5	CO6	L3
19		The binary sequence 10010110010 is the input to the precoder whose output is used to modulate a duobinary transmitting filter. Obtain the precoded sequence, transmitted amplitude levels, the received signal levels and the decoded sequence.	5	CO6	L3
20		What is eye pattern? What is the Nyquist criterion for Zero ISI? Given an example of the pulse with Zero ISI.	5	CO6	L2
21		Explain the design of band Limited signals with controlled ISI. Describe the time domain & frequency domain characteristics of a duobinary signal.	5	CO6	L3
22		What is channel eualization? With a neat diagram explain the concept of equalization using a linear transversal filter.	5	CO6	L3
23		Design a Band limited signals with controlled ISI-partial response signals.	5	CO6	L2
24		Derive the Nyquist criterion for distortion less base band binary transmission	5	CO6	L3
25		What is eye pattern? Explain in detail.	5	CO6	L2
26		With a neat filter structure, explain the concept of adaptive equalization process.	5	CO6	L3
27		Write a note on Duobinary signaling.	5	CO6	L2
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D3. TEACHING PLAN - 3

Module – 5

Title:	Principles of Spread Spectrum	Appr Time:	08Hrs
a	***Course Outcomes***	-	**Blooms**
-	The student should be able to:	-	**Level**
1	Analyze performance of spread spectrum communication systems.	CO7	L4
b	***Course Schedule***		
Class No	**Module Content Covered**	**CO**	**Level**
1	Spread Spectrum Communication Systems: Model of a Spread Spectrum Digital Communication System	CO7	L4
2	Direct Sequence Spread Spectrum Systems	CO7	L4
3	Effect of De-spreading on a narrowband Interference	CO7	L4
4	Probability of error (statement only)	CO7	L4
5	Some applications of DS Spread Spectrum Signals	CO7	L4
6	Generation of PN Sequences	CO7	L4
7	Frequency Hopped Spread Spectrum, CDMA based on IS-95	CO7	L4
8	Class test		
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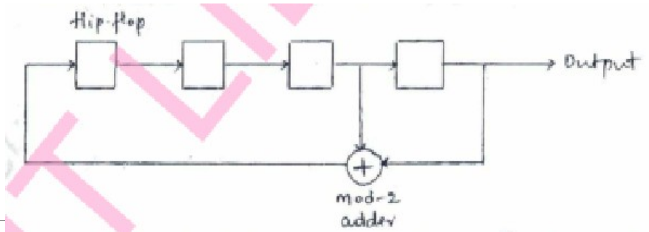
c	**Application Areas**	**CO**	**Level**
1	Spread spectrum applications in interference, millitary,wireless LAN security, CDMA	CO7	L4
2			
d	**Review Questions**	-	-
1	Draw the 4 stage linear feedback shift register with 1st and 4th stage is connected to Modulo-2 adder. Output of Modulo-2 is connected to 1st stage input. Find the output PN sequence and obtain the autocorrelation sequence.	CO7	L2

2	With a neat block diagram explain the frequency hopped spread spectrum.	CO7	L3
3	Explain the effect of dispreading on narrowband interference.	CO7	L3
4	Explain the generation of direct sequence spread spectrum signal with the relevant waveforms and spectrums.	CO7	L4
5	With a neat block diagram explain the CDMA system based on IS-95.	CO7	L4
6	Write a short note on application of spread spectrum in wireless LANs.	CO7	L4
7	Explain frequency hoop spread m-ary frequency shift keying with a neat block diagram and illustrate the slow frequency hopping.	CO7	L2
8	Write the applications of Frequency Hooped spread spectrum.	CO7	L3
9	Find the output sequence of the shift register shown in Figure below. The initial state of the register is 1000. Demonstrate the balance property and run property of a PN sequence. Calculate and plot the autocorrelation function of the PN sequence. 	CO7	L4
10	What is spread spectrum technique? Explain the working of direct sequence transmitter and receiver.	CO7	L3
11	Explain the properties of PN sequence.	CO7	L4
12	Compare slow and fast frequency Hopping.	CO7	L3
13	Write the applications of Detectability signal spread spectrum.	CO7	L2
14	The direct sequence spread spectrum communication system has following parameters: Data sequence bit Tb = 4.095 ms Pin chip duration;Tc = 1 pis El' =10 for average probability of error less than 10-x. N Calculate processing gain and jamming margin.	CO7	L4
15	Explain the principle of slow frequency hopping, and list advantages and disadvantages of FH-SS system	CO7	L3
16	A DS spread-spectrum signal is designed so that the power ratio P_R/P_N at the intended receiver is 10^{-2}. If the desired Eb/No=10 for acceptable performance, determine the minimum value of the processing gain.	CO7	L4
e	**Experiences**	-	
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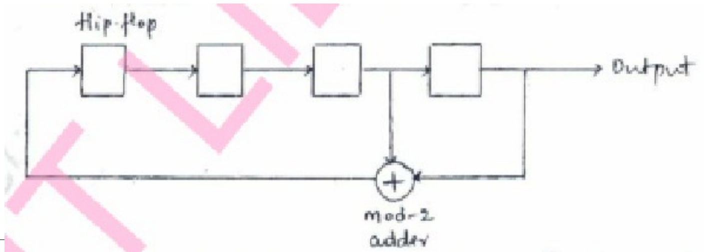
E3. CIA EXAM – 3

a. Model Question Paper - 3

Crs Code:	17EC61	Sem:	VI	Marks:	30	Time:	75 minutes
Course:	Digital Communication						

-	-	Note: Answer any 2 questions, each carry equal marks.	Marks	CO	Level
		Module -5			
1	a	Explain the generation of direct sequence spread spectrum signal with the relevant waveforms and spectrums.	10	CO7	L3

	b	A DS spread-spectrum signal is designed so that the power ratio P_R/P_N at the intended receiver is 10^{-2}. If the desired Eb/N0=10 for acceptable performance, determine the minimum value of the processing gain.	05	CO7	L4
	c				
	d				
2	a	With a neat block diagram explain the frequency hopped spread spectrum.	09	CO7	L3
	b	Draw the 4 stage linear feedback shift register with 1st and 4th stage is connected to Modulo-2 adder. Output of Modulo-2 is connected to 1st stage input. Find the output PN sequence and obtain the autocorrelation sequence.	06	CO7	L4
	c				
	d				
3	a	With a neat block diagram explain the CDMA system based on IS-95.	09	CO7	L3
	b	Find the output sequence of the shift register shown in Figure below. The initial state of the register is 1000. Demonstrate the balance property and run property of a PN sequence. Calculate and plot the autocorrelation function of the PN sequence.	06	CO7	L4



	c				
	d				
4	a	Explain the properties of PN sequence.	06	CO7	L3
	b	Write a short note on Low-detectability signal transmission.	04	CO7	L3
	c	The direct sequence spread spectrum communication system has following parameters: Data sequence bit Tb = 4.095 ms Pin chip duration;Tc = 1 pis El' =10 for average probability of error less than 10-x. N Calculate processing gain and jamming margin.	05	CO7	L4
	d				L3

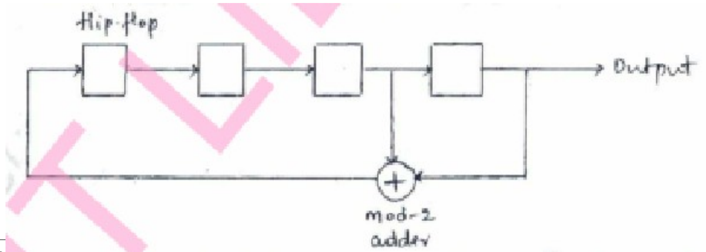
b. Assignment – 3

Note: A distinct assignment to be assigned to each student.

Model Assignment Questions							
Crs Code:	17EC61	Sem:	VI	Marks:	5 / 10	Time:	90 – 120 minutes
Course:	Digital Communication						

Note: Each student to answer 2-3 assignments. Each assignment carries equal mark.

SNo	USN	Assignment Description	Marks	CO	Level
1		Draw the 4 stage linear feedback shift register with 1st and 4th stage is connected to Modulo-2 adder. Output of Modulo-2 is connected to 1st stage input. Find the output PN sequence and obtain the autocorrelation sequence.	5	CO7	L2
2		With a neat block diagram explain the frequency hopped spread spectrum.	5	CO7	L3
3		Explain the effect of dispreading on narrowband interference.	5	CO7	L3
4		Explain the generation of direct sequence spread spectrum signal with the relevant waveforms and spectrums.	5	CO7	L4

5		With a neat block diagram explain the CDMA system based on IS-95.	5	CO7	L4
6		Write a short note on application of spread spectrum in wireless LANs.	5	CO7	L4
7		Explain frequency hoop spread m-ary frequency shift keying with a neat block diagram and illustrate the slow frequency hopping.	5	CO7	L2
8		Write the applications of Frequency Hooped spread spectrum.	5	CO7	L3
9		Find the output sequence of the shift register shown in Figure below. The initial state of the register is 1000. Demonstrate the balance property and run property of a PN sequence. Calculate and plot the autocorrelation function of the PN sequence. 	5	CO7	L4
10		What is spread spectrum technique? Explain the working of direct sequence transmitter and receiver.	5	CO7	L3
11		Explain the properties of PN sequence.	5	CO7	L4
12		Compare slow and fast frequency Hopping.	5	CO7	L3
13		Write the applications of Detectability signal spread spectrum.	5	CO7	L2
14		The direct sequence spread spectrum communication system has following parameters: Data sequence bit Tb = 4.095 ms Pin chip duration;Tc = 1 pis El' =10 for average probability of error less than 10-x. N Calculate processing gain and jamming margin.	5	CO7	L4
15		Explain the principle of slow frequency hopping, and list advantages and disadvantages of FH-SS system	5	CO7	L3
16		A DS spread-spectrum signal is designed so that the power ratio P_R/P_N at the intended receiver is 10^{-2}. If the desired Eb/N0=10 for acceptable performance, determine the minimum value of the processing gain.	5	CO7	L4
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F. EXAM PREPARATION

1. University Model Question Paper

Course:	Digital Communication					Month / Year	May /2018
Crs Code:	17EC61	Sem:	VI	Marks:	100	Time:	180 minutes

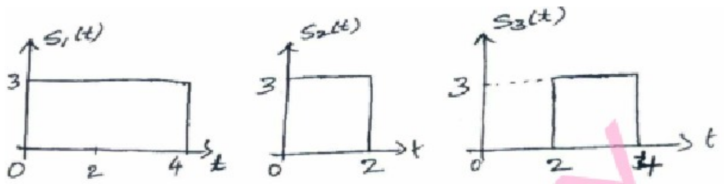
-	Note	Answer all FIVE full questions. All questions carry equal marks.	Marks	CO	Level
1	a	Define Hilbert Transform. State the properties of it.	4	CO1	L2
	b	Define the complex envelope of bandpass signals. Obtain the canonical representation of bandpass signals	6	CO1	L3
	c	Derive the power spectral density of polar NRZ signals and plot the spectrum	6	CO2	L3
	d				
		OR			
-	a	Define the Pre-envelope. Show the spectral representations of pre-envelopes for low pass signals.	4	CO1	L2
	b	Derive the expression for the complex low pass representation of bandpass systems.	7	CO1	L3
	c	Given the data stream 1110010100. Sketch the transmitted sequence of pulses for each of the following line code. (i) Unipolar NRZ (ii) Polar NRZ (iii) Unipolar RZ (iv) bipolar RZ (v) Manchester code	5	CO2	L3
	d				
2	a	Explain the Geometric representation of signals and express the energy of the signal in terms of the signal vector.	5	CO3	L3
	b	Explain the Gram-Schmidt orthogonalization procedure.	5	CO3	L3
	c	Explain the matched filter receiver with the relevant mathematical theory.	6	CO3	L3
	d				
		OR			
-	a	Obtain the decision rule for Maximum likelihood decoding and explain the correlation receiver.	7	CO3	L3
	b	The waveforms of four signals s1(t), s2(t), s3(t), and s4(t) described below. s1(t) = 1, $0 < t < T/3$, s2(t) = 1, $0 < t < 2T/3$, s3(t) = 1, $T/3 < t < T$, s4(t) = 1, $0 < t < T$, and zero otherwise. Using the Gram-Schmidt orthogonalization procedure, find an orthonormal basis for this set of signals and construct the corresponding signal-space diagram.	9	CO3	L3
	c				
	d				
3	a	Define binary phase shift keying. Derive the probability of error of BPSK.	7	CO4	L3
	b	Define M-ary QAM. Obtain the constellation of QAM for M=4 and draw the signal space diagram.	4	CO4	L4
	c	Given the input binary sequence 1100100001. Sketch the waveforms of	5	CO4	L4

		the inphase and quadrature components of a modulated wave and next sketch the QPSK signal.			
	d				
		OR			
-	a	Describe the QPSK signal with its signal space characterization. With a neat block diagram explain the generation and detection of QPSK signals.	6	CO4	L3
	b	Obtain the expression probability of symbol error of coherent binary FSK.	7	CO4	L4
	c	Illustrate the operation of DPSK for the binary sequence 10010011.	3	CO5	L4
	d				
4	a	With a neat block diagram Explain the digital PAM transmission through bandlimited baseband channels and obtain the expression for ISI.	5	CO6	L2
	b	What are adaptive equalizers? Explain the linear adaptive equalizer based on the MSE criterion.	6	CO6	L3
	c	The binary sequence 10010110010 is the input to the precoder whose output is used to modulate a duobinary transmitting filter. Obtain the precoded sequence, transmitted amplitude levels, the received signal levels and the decoded sequence.	5	CO6	L3
	d				
		OR			
-	a	What is eye pattern? What is the Nyquist criterion for zero ISI? Given an example of the pulse with zero ISI.	5	CO6	L2
	b	Explain the design of bandlimited signals with controlled ISI. Describe the time domain and frequency domain characteristics of a duobinary signal.	5	CO6	L3
	c	What is channel equalization? With a neat diagram explain the concept of equalization using a linear transversal filter.	6	CO6	L3
	d				
5	a	Draw the 4 stage linear feedback shift register with 1st and 4th stage is connected to Modulo-2 adder. Output of Modulo-2 is connected to 1st stage input. Find the output PN sequence and obtain the autocorrelation sequence.	6	CO7	L4
	b	With a neat block diagram explain the frequency hopped spread spectrum.	7	CO7	L3
	c	Explain the effect of dispreading on narrowband interference.	3	CO7	L3
	d				
		OR			
	a	Explain the generation of direct sequence spread spectrum signal with the relevant waveforms and spectrums.	6	CO7	L3
	b	With a neat block diagram explain the CDMA system based on IS-95.	7	CO7	L3
	c	Write a short note on application of spread spectrum in wireless LANs.	3	CO7	L3
	d				

2. SEE Important Questions

Course:	Digital Communication					Month / Year	May /2018
Crs Code:	17EC61	Sem:	6	Marks:	100	Time:	180 minutes

	Note	Answer all FIVE full questions. All questions carry equal marks.	-	-	
Module	Qno.	Important Question	**Marks**	**CO**	**Year**
1	1	Define Hilbert Transform. State the properties of it.	03	CO1	2017
	2	A binary data seq is 0110011.... Sketch the waveform for the following formats: i) NRZ unipolar ii) RZ polar iii) NRZ bipolar (iv) Manchester format	05	CO2	2014, 2013
	3	Obtain expression for power spectral density of NRZ polar wave form.	07	CO2	2014, 2013

	4	Define the complex envelope of bandpass signals. Obtain the canonical representation of bandpass signals	06	CO1	2017
	5	Define the Pre-envelope. Show the spectral representations of pre-envelopes for low pass signals.	04	CO1	2017
	6	Derive the expression for the complex low pass representation of bandpass systems.	07	CO1	2017
2	1	Write a short note on Gram-Schmidt orthogonalization	06	CO3	2009
	2	Explain geometric interpretation of signals.	06	CO3	2010
	3	Derive the expression for SNR for a matched filter.	10	CO3	2009
	4	Three signals SI(t), S2(t) and S3(t) are shown in Fig.Q6(b). Apply Gram-Schmidt procedure to obtain an orthonormal basis for the signals. Express signals S1(t), S2(t) and S3(t) in terms of orthonormal basis functions. Also give the signal constellation diagram. 	10	CO3	2011
	5	The waveforms of four signals S1(t),S2(t),S3(t) & S4(t) describe below. S1(t) = 1, 0< t <T/3. S2(t) = 1, 0< t < 2T/3, S3(t) = 1, T/3< t <T, S4(t) = 1, 0< t <T, and Zero otherwise. Using the Gram-Schmidt orthogonalization procedure. Find an orthogonal basis for this set of signals and construct the corresponding signal-space diagram.	10	CO3	2012
3	1	With block diagrams, explain the QPSK transmitter and receiver.	08	CO4	2011
	2	Explain the coherent binary FSK system, with the help of a signal space diagram. Indicate the decision boundary.	06	CO4	2011
	3	Calculate the bandwidth efficiency of an M-ary signaling scheme.	06	CO4	2009
	4	Explain the non-coherent DPSK system.	06	CO5	2010
	5	For a given input binary sequence 0 1 1 0 1 0 0 0 , sketch the inphase and quadrature phase components of QPSK. Then by adding these two waveforms, draw the final QPSK waveform.		CO4	2010
4	1	What is meant by 'eye pattern' in the data transmission system? Explain.	06	CO6	2010
	2	Write a note on adaptive equalization.	05	CO6	2010
	3	What is the Nyquist criterion for zero ISI? Given an example of the pulse with zero ISI	06	CO6	2012
	4	Explain the design of bandlimited signals with controlled ISI. Describe the time domain and frequency domain characteristics of a duobinary signal	07	CO6	2011
	5	What is channel equalization? With a neat diagram explain the concept of equalization using a linear transversal filter.	05	CO6	2009
5	1	With a neat block diagram explain the frequency hopped spread spectrum	05	CO7	2009
	2	Explain the generation of direct sequence spread spectrum signal with the relevant waveforms and spectrums.	06	CO7	2012
	3	With a neat block diagram explain the CDMA system based on IS-95	08	CO7	2011
	4	Draw the 4 stage linear feedback shift register with 1st and 4th stage is connected to Modulo-2 adder. Output of Modulo-2 is connected to 1st stage input. Find the output PN sequence and obtain the autocorrelation sequence.	06	CO7	2014

	5	Write a short note on application of spread spectrum in wireless LANs.	05	CO7	2017