CO document

Course Name: Digital Communication and Stochastic (EC 503) 5th Semester; Electronics and Communication Engineering

TABLE-1

After completion of the course students will be able to-

Module	Hr	Sub-Topic (from syllabus)	Instructional Learning Outcome(ILO) (Cognitive Process /Knowledge Dimension)	Topic Learning Outcome(TLO)	Course Outcome(CO)
I	8	**Introduction to Stochastic Processes (SPs):** Definition and examples of SPs, classification of random processes according to state space and parameter space, elementary problems. Stationary and ergodic processes, correlation coefficient, covariance, auto correlation function and its properties, random binary wave, power spectral density. Definition and examples of Markov Chains, transition probability matrix, Chapman Kolmogorov equations; calculation of n-step transition probabilities.	1.1 Explain different Stochastic Processes. P1.1.1, P1.1.2, P9.2.3, P9.2.4, P9.3.1, P10.1.1, P10.1.2, P10.1.3, P10.2.1, P10.2.2, P10.3.1, P10.3.2,P12.1.1 (U/FK) 1.2 Explain random process , stationary and ergodic processes. P1.1.1, P1.1.2, P9.2.3, P9.2.4, P9.3.1, P10.1.1, P10.1.2, P10.1.3, P10.2.1, P10.2.2, P10.3.1, P10.3.2, P12.1.1 (U/FK) 1.3 Illustrate mean, variance, uniform distribution. P1.1.1, P1.1.2, P9.2.3, P9.2.4, P9.3.1, P10.1.1, P10.1.2, P10.1.3, P10.2.1, P10.2.2, P10.3.1, P10.3.2, (U/FK) 1.4 Describe covariance, correlation functions and its properties. P1.1.1, P1.1.2, P9.2.3, P9.2.4, P9.3.1, P10.1.1, P10.1.2, P10.1.3, P10.2.1, P10.2.2, P10.3.1, P10.3.2, P12.1.1 (U/FK) 1.5 Describe Markov Chains. P1.1.1, P1.1.2, P9.2.3, P9.2.4, P9.3.1, P10.1.1, P10.1.2, P10.1.3, P10.2.1, P10.2.2, P10.3.1, P10.3.2, (U/FK) 1.6 Describe transition probability matrix, Chapman Kolmogorov equations. P1.1.1, P1.1.2, P9.2.3, P9.2.4, P9.3.1, P10.1.1,	TLO1.1: Explain different Stochastic and random process. TLO1.2: Explain covariance, correlation, Markov Chains, transition probability matrix.	CO1: Explain Stochastic Processes and different noise and error (Understand)

			P10.1.2, P10.1.3, P10.2.1, P10.2.2, P10.3.1, P10.3.2, (U/FK)		
II	6	**Signal Vector Representation:** Analogy between signal and vector, distinguishability of signal, orthogonality and orthonormality, basis function, orthogonal signal space, message point , signal constellation, geometric interpretation of signals, likelihood functions, Schwartz inequality, Gram-Schmidt orthogonalization procedure, response of the noisy signal at the receiver, maximum likelihood decision rule, decision boundary, optimum correlation receiver; probability of error, error function, complementary error function, Type-I and Type-II errors.	1.7 Explain vector representation of signals. P1.1.1, P1.1.2, P9.2.3, P9.2.4, P9.3.1, P10.1.1, P10.1.2, P10.1.3, P10.2.1, P10.2.2, P10.3.1, P10.3.2, P1.2.1 (U/CK) 1.8 Explain orthogonality and orthonormality, Schwartz inequality, Gram-Schmidt orthogonalization . P1.1.1, P1.1.2, P1.2.1, P9.2.3, P9.2.4, P9.3.1, P10.1.1, P10.1.2, P10.1.3, P10.2.1, P10.2.2, P10.3.1, P10.3.2. (U/CK) 1.9 Explain signal constellation. P1.1.1, P1.1.2, P1.2.1, P9.2.3, P9.2.4, P9.3.1, P10.1.1, P10.1.2, P10.1.3, P10.2.1, P10.2.2, P10.3.1, P10.3.2,P12.1.1 (U/CK) 1.10 Explain detection of noisy signal at the receiver, maximum likelihood decision rule. P1.1.1, P1.1.2, P9.2.3, P9.2.4, P9.3.1, P10.1.1, P10.1.2, P10.1.3, P10.2.1, P10.2.2, P10.3.1, P10.3.2, (U/FK) 1.11 Explain optimum correlation receiver, matched filter receiver, error function. P1.1.1, P1.1.2, P1.2.1, P9.2.3, P9.2.4, P9.3.1, P10.1.1, P10.1.2, P10.1.3, P10.2.1, P10.2.2, P10.3.1, P10.3.2,P12.1.1 (U/CK) 1.12 Describe complementary error function, Type-I and Type-II errors. P1.1.1, P1.1.2, P9.2.3, P9.2.4, P9.3.1, P10.1.1, P10.1.2, P10.1.3, P10.2.1, P10.2.2, P10.3.1, P10.3.2, (U/FK)	TLO1.3: Explain signal constellation with help of vectors. TLO1.4: Explain noise at receiver and different error function.	

III	10	**Digital Data Transmission:** Concept of sampling, Pulse Amplitude Modulation (PAM), interlacing and multiplexing of samples, Pulse Code Modulation (PCM), quantization, uniform and non-uniform quantization, quantization noise, binary encoding, A-Law and μ -law companding, differential PCM, delta modulation and adaptive delta modulation.	2.1 Explain the need of sampling in a digital communication system and basic building blocks of PCM. P1.1.1, P1.1.2, P1.2.1, P1.3.1, P1.4.1, P3.1.1, P3.2.1, P6.1.1, P9.2.3, P9.2.4, P9.3.1, P10.1.1, P10.1.2, P10.1.3, P10.2.1, P10.2.2, P10.3.1, P10.3.2, P12.1.1 (A/CK) 2.2 Demonstrate different types of sampling, modulation and demodulation of PAM. P1.1.1, P1.1.2, P1.4.1, P2.1.3, P2.4.1 P3.1.1, P3.2.1, P6.1.1, P12.1.1 (A/CK) 2.3 Demonstrate different types Quantization and quantization noise. P1.1.1, P1.1.2, P1.3.1, P1.4.1, P6.1.1, P9.2.3, P9.2.4, P9.3.1, P10.1.1, P10.1.2, P10.1.3, P10.2.1, P10.2.2, P10.3.1, P10.3.2,P12.1.1 (A/CK) 2.4 Demonstrate SNR in quantization and companding. P1.1.1, P1.1.2, P1.3.1, P1.4.1, P2.1.1, P2.1.2, P2.1.3, P2.4.1, P3.1.1, P3.2.1, P9.2.3, P9.2.4, P9.3.1, P10.1.1, P10.1.2, P10.1.3, P10.2.1, P10.2.2, P10.3.1, P10.3.2, P12.1.1 (A/CK) 2.5 Demonstrate transmission and reception of DPCM . P1.1.1, P1.1.2, P1.3.1 P3.1.1, P3.2.1, P9.2.3, P9.2.4, P9.3.1, P10.1.1, P10.1.2, P10.1.3, P10.2.1, P10.2.2, P10.3.1, P10.3.2, P12.1.1 (A/CK) 2.6 Illustrate delta modulation and adaptive delta modulation techniques. P1.1.1, P1.1.2, P1.3.1, P1.4.1, P2.1.3, P2.2.1, P2.4.1, P3.1.1, P3.2.1, P6.1.1 , P9.2.3, P9.2.4, P9.3.1, P10.1.1, P10.1.2, P10.1.3,	TLO2.1: Demonstrate PCM technique. TLO2.2: Demonstrate PCM , DPCM , DM and ADM .	CO2: Demonstrate different baseband modulation Techniques. (Apply)

			P10.2.1, P10.2.2, P10.3.1, P10.3.2, P12.1.1 (A/PK)		
		Digital transmission components, source, multiplexer, line coder, regenerative repeater, concept of line coding – polar/unipolar/bipolar NRZ and RZ, Manchester, differential encoding and their PSDs, pulse shaping, .	3.1 Explain different transmission components like regenerative repeater , multiplexer. P1.1.1, P1.1.2, P1.3.1, P9.2.3, P9.2.4, P9.3.1, P10.1.1, P10.1.2, P10.1.3, P10.2.1, P10.2.2, P10.3.1, P10.3.2,P12.1.1 (U/CK) 3.2 Implement different line coding Techniques. P1.1.1, P1.1.2, P1.3.1 , P3.1.1, P3.2.1, P4.1.1, P4.1.2, P6.1.1 , P9.2.3, P9.2.4, P9.3.1, P10.1.1, P10.1.2, P10.1.3, P10.2.1, P10.2.2, P10.3.1, P10.3.2,P12.1.1 (A/CK) 3.3 Calculate power spectral densities of different line codes. P1.1.1, P1.1.2, P1.3.1 P1.4.1, P2.4.1, P3.1.1, P3.2.1, P4.1.1, P4.1.2, P6.1.1 , P12.1.1 (A/CK)	TLO3.1: Explain different components of digital transmission. TLO3.2: Implement different line codes and calculate power spectral densities. TLO3.3: Explain channel imperfections and solution of those.	CO3: Demonstrate different line coding and their power spectrum. (Apply)
IV	10	**Digital Modulation Techniques:** Types of Digital Modulation, coherent and non-coherent Binary Modulation Techniques, basic digital carrier modulation techniques: ASK, FSK and PSK, Coherent Binary Phase Shift Keying (BPSK), geometrical representation of BPSK	4.1 Explain digital modulation techniques. P1.1.1, P1.1.2, P1.3.1, P2.1.3, P9.2.3, P9.2.4, P9.3.1, P10.1.1, P10.1.2, P10.1.3, P10.2.1, P10.2.2, P10.3.1, P10.3.2, P12.1.1 (U/CK) 4.2 Demonstrate generation and reception of ASK. P1.1.1, P1.1.2, P1.3.1, P1.4.1, P2.1.3, P3.1.1, P3.2.1, P4.1.1, P4.1.2 , P6.1.1 , P9.2.3,	TLO4.1: Demonstrate generation and detection of different digital modulation techniques	CO4: Demonstrate different bandpass digital modulation techniques .

		signalgeneration and detection of BPSK Signal, power spectrum of BPSK. Concept of M-ary Communication, M-ary phase shift keying, the average probability of symbol error for coherent M-ary PSK, power spectra of MPSK, Quadrature Phase Shift Keying (QPSK), generation and detection of QPSK signals, power spectra of QPSK signals, Offset Quadrature Phase shift Queuing (QPSK), Coherent Frequency Shift Keying (FSK), Binary FSK, error probability of BFSK signals, generation and detection of Coherent Binary FSK signals, power spectra of BFSK signal, Minimum Shift Keying (MSK), signal constellation of MSK waveforms.	P9.2.4, P9.3.1, P10.1.1, P10.1.2, P10.1.3, P10.2.1, P10.2.2, P10.3.1, P10.3.2,P12.1.1 (A/CK) 4.3 Demonstrate generation and reception of BPSK. P1.1.1, P1.1.2, P1.3.1, P1.4.1, P2.1.3, P3.1.1, P3.2.1, P4.1.1, P4.1.2, P6.1.1, P9.2.3, P9.2.4, P9.3.1, P10.1.1, P10.1.2, P10.1.3, P10.2.1, P10.2.2, P10.3.1, P10.3.2,P12.1.1 (A/CK) 4. Demonstrate generation and reception of BFSK. P1.1.1, P1.1.2, P1.3.1, P1.4.1, P2.1.3, P3.1.1, P3.2.1, P4.1.1, P4.1.2, P6.1.1, P9.2.3, P9.2.4, P9.3.1, P10.1.1, P10.1.2, P10.1.3, P10.2.1, P10.2.2, P10.3.1, P10.3.2,P12.1.1 (A/CK) 4.5 Demonstrate generation reception of QPSK. P1.1.1, P1.1.2, P1.3.1, P1.4.1, P2.1.3, P2.2.1, P3.1.1, P3.2.1, P4.1.1, P4.1.2 , P6.1.1, P9.2.3, P9.2.4, P9.3.1, P10.1.1, P10.1.2, P10.1.3, P10.2.1, P10.2.2, P10.3.1, P10.3.2, P12.1.1 (A/CK) 4.6 Demonstrate generation reception of DPSK. P1.1.1, P1.1.2, P1.3.1, P1.4.1, P2.1.3, P2.1.3, P3.1.1, P3.2.1, P4.1.1, P4.1.2 , P6.1.1, P9.2.3, P9.2.4, P9.3.1, P10.1.1, P10.1.2, P10.1.3, P10.2.1, P10.2.2, P10.3.1, P10.3.2, P12.1.1 (A/CK) 4.7 Demonstrate generation and reception of MSK. GMSK. P1.1.1, P1.1.2, P1.3.1, P1.4.1 P2.1.3, P3.1.1, P3.2.1, P4.1.1, P4.1.2, P6.1.1, P9.2.3, P9.2.4, P9.3.1, P10.1.1, P10.1.2, P10.1.3, P10.2.1, P10.2.2, P10.3.1, P10.3.2,P12.1.1 (A/CK)	TLO4.2: Implement different modulation techniques with signal-constellation diagram	(Apply)

			4.8 Implement BASK, BPSK, BFSK, DPSK with signal-space representation. P1.1.1, P1.1.2, P1.3.1, P1.4.1, P2.1.2, P2.1.3, P2.4.1, P3.1.1, P3.2.1, P4.1.1, P4.1.2 , P6.1.1, P9.2.3, P9.2.4, P9.3.1, P10.1.1, P10.1.2, P10.1.3, P10.2.1, P10.2.2, P10.3.1, P10.3.2,P12.1.1 (A/PK) 4.9 Demonstrate signal-space representation of QPSK. P1.1.1, P1.1.2, P1.2.1, P1.3.1, P1.4.1, P2.1.2, P2.1.3, P2.2.1, P2.4.1, P3.1.1, P3.2.1, P4.1.1, P4.1.2, P6.1.1, P9.2.3, P9.2.4, P9.3.1, P10.1.1, P10.1.2, P10.1.3, P10.2.1, P10.2.2, P10.3.1, P10.3.2, P12.1.1 (A/PK)		
		Error probability of BPSK, error probability of MSK signal, error probability of QPSK signal, Gaussian Minimum Shift Keying: GMSK, basic concept of OFDM, constellation diagram, Some performance issues for different digital modulation techniques - Error Vector Magnitude (EVM), Eye Pattern and Relative Constellation Error (RCE), Conceptual idea for Vector Signal Analyzer (VSA) Inter Symbol Interference (ISI), Eye pattern, Nyquist criterion for zero ISI, equalizer, zero forcing equalizer, timing extraction.	5.1 Implement concept of bit error probability of BASK , BPSK, BFSK . P1.1.1, P1.1.2, P1.3.1, P1.4.1, P2.1.2, P2.1.3, P2.2.3, P2.4.1, P3.1.1, P3.2.1 , P4.1.1, P4.1.2, P12.1.1 (A/PK) 5.2 Calculate error probability of QPSK, MSK, GMSK . P1.1.1, P1.1.2, P1.3.1, P1.4.1, P2.1.2, P2.1.3, P3.1.1, P3.2.1 , P4.1.1, P4.1.2, P9.2.3, P9.2.4, P9.3.1, P10.1.1, P10.1.2, P10.1.3, P10.2.1, P10.2.2, P10.3.1, P10.3.2, P12.1.1 (A/CK) 5.3 Implement OFDM with constellation diagram. P1.1.1, P1.1.2, P1.3.1, P1.4.1, P3.1.1, P3.2.1, P4.1.1, P4.1.2, P9.2.3, P9.2.4, P9.3.1,	TLO5.1: Implement error probability to different modulation techniques. TLO5.2: Explain performance issues of transmitter and receiver for different digital modulation techniques .	CO5: Demonstrate bit error rate of modulation techniques and explain parameters affecting digital modulation. (Apply)

			P10.1.1, P10.1.2, P10.1.3, P10.2.1, P10.2.2, P10.3.1, P10.3.2, P12.1.1 (A/CK) 5.4 Explain Error Vector Magnitude (EVM), Eye Pattern. P1.1.1, P1.1.2, P1.3.1, P9.2.3, P9.2.4, P9.3.1, P10.1.1, P10.1.2, P10.1.3, P10.2.1, P10.2.2, P10.3.1, P10.3.2, P12.1.1 (U/CK) 5.5 Explain Relative Constellation Error (RCE), Vector Signal Analyzer (VSA) P1.1.1, P1.1.2, P1.3.1 P9.2.3, P9.2.4, P9.3.1, P10.1.1, P10.1.2, P10.1.3, P10.2.1, P10.2.2, P10.3.1, P10.3.2, (U/CK) 5.6 Illustrate eye pattern, ISI, pulse shaping , equalizer. P1.1.1, P1.1.2, P1.3.1, P3.1.1, P3.2.1, P4.1.1, P4.1.2, P9.2.3, P9.2.4, P9.3.1, P10.1.1, P10.1.2, P10.1.3, P10.2.1, P10.2.2, P10.3.1, P10.3.2, P12.1.1 (A/CK)	TLO5: Explain channel imperfections and solution of them.	

Summary of sub topic of CO-PO of CO and POs relation

CO	No of ILOs	NO of PI associated with POs	% of ILOs related with POs
CO1	12	PO1: 05 , PO12: 6	PO1 – 3 60(%), PO9 -5(71.4%), PO10 -7(100%), PO12 – 1 (16.66%)
CO2	6	PO1: 05 , PO2: 13 , PO3: 13 , PO12: 6	PO1 – 5 (100%), PO2 – 3 (15.3%), PO3-2(15.38%), PO9 -5(71.4%), PO10 -7(100%), PO12 – 1 (16.66%)
CO3	3	PO1: 05 , PO2: 13 , PO3: 13 , PO4:10 , PO6: 2 , PO12: 6	PO1 – 4 (80%), PO2 – 1 (7.69%), PO3-2(15.38%), PO4 – 2 (%), PO6 – 1 (%),PO9 - 5(71.4%), PO10 -7(100%), PO12 – 1 (16.66%)
CO4	9	PO1: 05 , PO2: 13 , PO3: 13 , PO4:10 , PO6: 2 , PO12: 6	PO1 – 4 (80%), PO2 – 3 (15.3%), PO3-2(15.38%), PO4 – 2 (20%), PO6 – 1 (50%), PO9 -5(71.4%), PO10 -7(100%), PO12 – 1 (16.66%)
CO5	6	PO1: 05 , PO2: 13 , PO3: 13 , PO4:10 , PO12: 6	PO1 – 4 (80%), PO2 – 3 (15.3%), PO3-2(15.38%), PO4 – 2 (20%) , PO9 -5(71.4%), PO10 -7(100%), PO12 – 1 (16.66%)

CO-PO mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1							1	1		1	3	2
CO2	3	2	1						1	1		1	3	2
CO3	3	2	1	1		1			1	1		1	3	2
CO4	3	2	1	1		1			1	1		1	3	2
CO5	3	2	1	1					1	1		1	3	2
Course	**3**	**1.8**	**0.8**	**0.6**		**0.4**			**1**	**1**		**1.00**	**3.00**	**2.00**