Birla Institute of Technology & Science, Pilani
Hyderabad Campus

FIRST SEMESTER 2024-2025

Course Handout Part II

Date: 22-07-2024

In addition to part-I (General Handout for all courses appended to the time table) this portion gives further specific details regarding the course.

Course No.	: **ECE F311 / EEE F311**
Course Title	: **Communication Systems**
Instructor-in-Charge	: **Prof. Prasant Kumar Pattnaik**
Other Instructors	: **Dr. Pranay Agrawal, Dr. Nitish Kumar Gupta, Dr. Prashant Wali and Dr. Subhradeep Pal**

Course Description:

Analysis and design of communication systems; analog and digital modulation and demodulation, frequency conversion, multiplexing, noise and distortion; spectral and signal-to-noise ratio analysis, probability of error in digital systems, spread spectrum. Introduction to the basic principles of the design and analysis of modern digital communication systems. Topics include source coding, channel coding, baseband and passband modulation techniques, receiver design, and channel equalization.

Scope and Objective of the Course:

This course intends to cover the basic understanding of functionalities of various block-sets involved in communication system. The topics like Analog to Digital conversion, Pulse coding, Modulation (Analog and Digital, Baseband and Bandpass), source coding, channel coding, Multiple access, Multiplexing techniques, Spread spectrum will be covered with appropriate detail and mathematical description. Important topic like Information theory and its fundamental limits will be emphasized to appreciate the concepts of digital communication. Students will be introduced to the functioning of modern communication systems and how they perform in the presence of noise. Students will be given assignments on communication system modeling using MATLAB. The laboratory component involves system design and simulation exercises using MATLAB and Simulink and experiments based on HW boards. Advance/application areas like wireless, optical, satellite, acoustic communication will be covered towards the end. Students are expected to have sound understanding of Signals and systems, Mathematics, Electromagnetic Field theory

Textbooks:

T1 B.P. Lathi and Zhi Ding, Modern Digital and Analog Communication Systems, 3rd OR 4th Edition, Oxford University Press, 2010

T2 Simon Haykin & Michael Moher, Communication Systems, 4th OR 5th Edition, John Wiley & Sons, 2010

Reference books

R1. Proakis John, Digital Communications, 5th Edition, TMH

R2. K. Sam Shanmugam, Digital and Analog communication systems, John Wiley & Sons

R3. DIGITAL COMMUNICATIONS Fundamentals and Applications: ERNARD SKLAR and Pabitra Kumar Ray; Pearson Education 2009, 2/e
R4: Wireless Communications by Andrea Goldsmith, Cambridge University Press
R5: Elements of Information Theory by Thomas M. Cover and Joy A. Thomas, Wiley

Course Plan:

Sl. No	Topics to be covered	Learning Objectives	Ref. to Book	No. of Lectures
1	Overview of the course, introduction to communication systems.	History of electronic communications, blocks of a typical communication system, Electronic Communication Channels, twisted pair, cable, wave guide, wireless channels, need for modulation, concept of a carrier, analog and digital communication concepts.	T1& T2:Chapter 1	1
2	Deterministic and random signals and their properties	Signals, nature of signals, Review of energy and power signals, correlation functions, power and energy spectral densities, Fourier series and Fourier Transforms, signal distortions. Real world signals, pure, distorted and noise corrupted signal examples, typical BW of various signals.	T1: Chapters 2 & 3 T2:Chapter 2	2
3	Transmission and reception of analog Signals: Amplitude modulation (AM)	Different Amplitude Modulation Techniques: DSB-SC, SSB-SC, VSB, AM with carrier: BW requirements of above modulation schemes. Circuits for Generation and demodulation. Noise performance of different AM systems. Frequency Division multiplexing, Super heterodyne Receivers, Practical circuits	T1:Chapter 4 T2:Chapter 3,6 R2:Chapter 7	5
4	Transmission and reception of analog Signals: Angle Modulation Phase & Frequency modulation	Angle modulation, FM transmitter and receivers, interference and bandwidth considerations, comparison of AM and FM, FM generation and demodulation, Noise performance of different Angle Modulation systems.	T1:Chapter 5 T2:Chapter 4,6 R2:Chapter 7	4
5	Digital Representation of Analog Signals and Pulse Modulation	Sampling theorem, aliasing, quantization and encoding, PAM, TDM, PPM, PWM, Quantization, PCM, Delta Modulation	T1:Chapter 6 T2:Chapter 7 R2:Chapter 10	4
6	Random Variables and Stochastic Processes, Noise	Recap of Random variables & processes, statistical averages, Power spectral density, Gaussian process, Noise, Nature of noise, Sources of Noise, white noise, KTB, Noise Figure and Noise temperature, calculations, Signal-to-Noise ratio.	T1:Chapter 8,9 T2:Chapter 5 R3:Chapter 5	4
7	Baseband Transmission of Digital Signals	Line codes, NRZ etc, Inter Symbol Interference (ISI), eye diagram, Nyquist Criterion for Distortion less transmission, pulse shaping, equalization	T1:Chapter 7 T2:Chapter 8	4

8	Band-Pass transmission of Digital signals	Band-Pass Transmission Model, Binary PSK ,FSK and QAM, M-Array Data Transmission Systems, Noise performance of PSK & FSK Systems	T2:Chapter 9 T1:Chapter 10 R1: Ch. 3 R3:Ch. 4 R2:Chapter 8	5
9.	Baseband Reception of Digital Signals and Noise performance	AWGN Channel, Different Receivers – ML and MAP, Matched Filter, Likelihood Ratio and Detection Regions, Error performance of M-PAM, M-PSK, M-QAM, M-ary Orthogonal Signaling, Union Bound on Error Probability	T1:Chapter 10 R1: Chapter 4 R3:Chapter 3	4
10	Digital receiver design & performance analysis.	Spectrum and Power Efficiency of Different Modulation Schemes, Goals of Communication system designer, Error probability plane, Nyquist bandwidth, Shannon-Hartley capacity theorem, Modulation & coding trade-offs, Designing digital communication systems, Modulation & coding for Bandwidth limited channels	R1: Chapter 4 R3:Chapter 9	3
11	Introduction to Wireless Communications	Wireless Communications: A brief overview of fading – definition, types, and impact on performance, introduction to OFDM	T1: Chapter 11 R3:Chapter 12 R4: Chapter 3	2
12	Introduction to Information Theory	Basic definition of entropy, mutual information, capacity, importance of source coding and channel coding	R5: Chapter 2	2
		Total Number of Lectures		40

Laboratory component: Laboratory exercises will involve simulations using MATLAB. Also, experiments will be conducted using HW boards, Signal Sources, Oscilloscopes & spectrum analyzer.

Evaluation Scheme:

Component	Duration	Weightage	Marks	Date & Time	Remarks
Mid-Sem Exam	90 min	20 %	60	As per Timetable	Closed Book
Quizzes	30 min (each)	10%	30		Closed Book
Home Assignment		5%	15		Open Book (MATLAB Simulink based communication system design)
Regular Lab Component		15%	45		Open Book (Lab attendance and performance)
Final Lab Exam		10%	30		Closed Book (Experiment to be performed & viva-voce)

Comprehensive Exam	3 Hrs	40%	120	12th December 2024 (AN)	Closed Book
Total		**100%**	**300**		

Chamber Consultation Hour: Will be announced in the class.

Notices: Notices concerning this course will be on CMS.

Make-up Policy: Make-up will be given on genuine grounds only with prior permission from the course IC. No make-up will be given for the quizzes. For lab, only one makeup is allowed.

Academic Honesty and Integrity Policy: Academic honesty and integrity should be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

Prof. Prasant Kumar Pattnaik
INSTRUCTOR-IN-CHARGE