**Techno India NJR Institute of Technology**



**Course File**

**Session 2023-24**

**Analog and Digital Communication (4EC4-07)**

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| **Course Overview:** |

Student will learn fundamentals of Analog and Digital communication from this 40-hour course. In this course, student will study the fundamental concepts and application of different analog and digital systems. Also, they will learn different modulation techniques used in various communication system.

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| **Course Outcomes:** |

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| **CO.NO.** | **Cognitive Level** | **Course Outcome**  |
| 1 | Knowledge | Analyze and compare different analog modulation schemes for their efficiency and bandwidth |
| 2 | Application | Analyze the behaviour of a communication system in presence of noise |
| 3 | Analysis | Investigate pulsed modulation system and analyze their system performance |
| 4 | Synthesis | Analyze different digital modulation schemes and can compute the bit error performance |
| 5 | Synthesis | Design a communication system comprised of both analog and digital modulation techniques |

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| **Prerequisites:** |

1. Fundamentals of various signal types.
2. Must have completed the course on signal and systems.
3. Student should be able to solve the problems of various transforms.

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| **Course Outcome Mapping with Program Outcome:** |

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| **Course Outcome**  | **Program Outcomes (PO’s)** |
| **CO. NO.** | **Domain Specific**  | **Domain Independent**  |
|  | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** |
| **CO1** | 3 | 3 |   | 3 |   | 1 |   |   |   | 1 |   |   |
| **CO2** | 3 | 2 |   | 3 |   | 1 |   |   |   |   |   |   |
| **CO3** | 3 | 2 |   | 3 |   | 2 |   |   |   |   |   |   |
| **CO4** | 3 | 3 |   | 3 |   | 2 |   |   |   | 1 |   |   |
| **CO5** | 3 | 2 | 3 | 3 |   | 3 |   |   | 2 | 2 |   |   |
| 1: Slight (Low) , 2: Moderate (Medium), 3: Substantial (High)  |
| **Mapping Justification** |

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| **CO** | **PO** | **Justification** |
| CO1,CO2,CO3,CO4,CO5 | **PO1** | The engineering fundamentals of analog and digital communication can be applied to solve engineering problems.The noise performance analysis can solve the problem of noise in communication field. Hence, CO1, CO2, CO3, CO4 and CO5 are strongly mapped with PO1. |
| **PO2** | To analyze analog and digital modulation schemes and their bit error performance students have basic knowledge of mathematical formula and engineering science that’s why CO1 and CO4 are strongly mapped with PO2 and CO2, CO3 and CO5 are moderately mapped with PO2.  |
| **PO3** | To design a communication system which is solution to complex engineering problems and meet the requirement of societal and environmental consideration that’s why CO5 is strongly mapped with PO3. |
| **PO4** | To analyze different modulation schemes of analog and digital communication using experimental approach and synthesis this information to generate valid conclusion that’s why all CO’s are strongly mapped with PO4. |
| **PO6** | To Design such communication system that can assess societal and safety issues and can take responsibility as per professional engineering practices that’s why CO5 is strongly mapped with PO6 and CO3 and CO4 are moderately mapped with PO6 and CO1 and CO2 are slightly mapped with PO1.  |
| **PO9** | The design approach of communication system brings students with different skills and expertise together to solve a problem that’s why CO5 is moderately mapped with PO9.  |
|  | **PO10** | The design knowledge of communication system make the students to communicate effectively on complex engineering activities with the engineering community and with society that’s why CO5 is moderately mapped with PO10 and CO1 and CO4 are slightly mapped with PO10. |

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| **Course Coverage Module Wise:** |

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| **Lecture No.** | **Unit** | **Topic** |
|  | **1** | **INTRODUCTION: OBJECTIVE, SCOPE AND OUTCOME OF THE COURSE** |
|  | **2** | **REVIEW OF SIGNALS AND SYSTEMS, FREQUENCY DOMAIN REPRESENTATION OF SIGNALS** |
|  | **3** | **PRINCIPLES OF AMPLITUDE MODULATION SYSTEMS** |
|  | 3 | DSB Modulation scheme |
|  | 3 | SSB Modulation scheme |
|  | 3 | VSB Modulation scheme |
|  | 3 | Angle Modulation: Representation of FM signals |
|  | 3 | Representation of PM signals |
|  | 3 | Review of probability and random process |
|  | 3 | Noise in amplitude modulation systems |
|  | 3 | Noise calculation in DSB and SSB systems |
|  | 3 | Noise in Frequency modulation systems |
|  | 3 | Pre-emphasis and Deemphasis |
|  | 3 | Threshold effect in angle modulation |
|  | **4** | **PULSE MODULATION** |
|  | 4 | Sampling |
|  | 4 | Pulse code modulation (PCM) |
|  | 4 | Quantization |
|  | 4 | SNR calculation in PCM system |
|  | 4 | Differential pulse code modulation |
|  | 4 | Delta modulation |
|  | 4 | Time Division multiplexing |
|  | 4 | Digital Multiplexers |
|  | **5** | **ELEMENTS OF DETECTION THEORY** |
|  | 5 | Optimum detection of signals in noise |
|  | 5 | Baseband Pulse Transmission- Inter symbol Interference |
|  | 5 | Nyquist criterion |
|  | 5 | Pass band Digital Modulation schemes |
|  | 5 | Amplitude Shift Keying |
|  | 5 | Phase Shift Keying |
|  | 5 | Coherent communication with waveforms- Probability of Error evaluations |
|  | 5 | Frequency Shift Keying |
|  | 5 | Probability of Error evaluations |
|  | 5 | Quadrature Amplitude Modulation |
|  | 5 | Continuous Phase Modulation and Minimum Shift Keying |
|  | **6** | **DIGITAL MODULATION TRADEOFFS** |
|  | 6 | Optimum demodulation of digital signals over band-limited channels |
|  | 6 | Maximum likelihood sequence detection (Viterbi receiver) |
|  | 6 | Equalization Techniques |
|  | 6 | Synchronization and Carrier Recovery for Digital modulation |

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| **Text/Reference Books** |

1. Principles of Communication Systems, Herbert Taub, Donald Schilling, Goutam Saha, TMH
2. An Introduction To Analog & Digital Communications, Haykins, Wiley

 Communication Systems Engineering, Proakis J. G. and Salehi M., Pearson Education

1. Principles of Communication Systems, Herbert Taub, Donald Schilling, Goutam Saha, TMH
2. An Introduction To Analog & Digital Communications, Haykins, Wiley
3. Communication Systems Engineering, Proakis J. G. and Salehi M., Pearson Education

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| **NPTEL Courses Link**  |
| https://nptel.ac.in/courses/117/101/117101051/ |

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| **Faculty Notes Link**  |
| https://drive.google.com/drive/u/0/folders/1gjMgPUIoX1LQMF1QcCs23YdbaX3JFz4z |

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| **Quiz Link**  |
| 1. <https://www.sanfoundry.com/digital-communications-questions-answers-digital-communication/>
2. [https://www.sanfoundry.com/analog-communications-questions-answers-frequency-domain-description/](https://compsciedu.com/Category/Digital-Image-Processing-%28DIP%29)
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| **Assessment Methodology:**  |

1. Practical exam using simulation in Matlab and lab instruments.
2. Two class test to estimate/identify class learning of students.
3. Two Midterm exams where student have to showcase subjective learning.
4. Final Exam (subjective paper) at the end of the semester.

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| **ASSIGNMENT#1** |

Q.1 Explain Amplitude Modulation in detail.

Q.2 Derive the expression of modulation index of AM.

Q.3 Explain the mathematical expression of frequency modulation.

Q.4 Explain the mathematical expression of phase modulation.

Q.5 Explain the methods of generation of DSB-FC.

Q.6 Prove that in Amplitude modulation the power consumption by carrier is 67% of total power.

Q.7 Explain that how SSB modulation is more advantageous than DSD-SC modulation. Explain the method of generation of SSB modulation.

Q.8 Write a short note on VSB.

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| **ASSIGNMENT#2** |

Q.1 Explain the noise performance of Frequency Modulation with suitable mathematical expressions.

Q.2 Explain the concept of pre-emphasis and de-emphasis.

Q.3 Explain the transmitter and receiver block of PCM.

Q.4 Why we use DPCM. Explain the working of DPCM.

Q.5 What is the need of adaptive delta modulation. Explain the working of it.

Q.6 Derive the expression of probability of error of optimum filter.

Q.7 Explain the working of transmitter and receiver of FSK.

Q.8 Write short note on Minimum Shift Keying (MSK).

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| **VIVA Questions** |

Q.1 Define AM.

Q.2 What is modulation index of AM.

Q.3 Define FM.

Q.4 What is modulation index of FM.

Q.5 What is the value of modulation index for proper transmission.

Q.6 What the value of power consumed by carrier signal.

Q.7. Which transmission method is good and why?

Q.8 Define DSB-FC modulation.

Q.9 Why DSB-SC is good than DSB-SC?

Q.10 What is the difference between DSB and SSB?

Q.11 What is VSB?

Q.12 What are the advantages of SSB modulation.

Q.13 What are the applications of SSB?

Q.14 What is the difference between PM and FM?

Q.15 What white noise?

Q.16What is the value of power spectral density of white noise?

Q.17 Define sampling theorem.

Q.18 Define Nyquist rate and Nyquist interval.

Q.19What are the advantages of DPCM

Q.20 Define optimum filter or receiver.

Q.21 Which digital modulation scheme is best and why?

Q.22 What is the need of MSK?

Q.23 What is synchronization in communication?

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| **QUIZ** |

1. Digital communication is \_\_\_\_\_\_\_ to environmental changes?
a) Less sensitive
b) More sensitive
c) Does not depend
d) None of the mentioned

2. Advantages of digital communication are
a) Easy multiplexing
b) Easy processing
c) Reliable
d) All of the mentioned

3. What is necessary for digital communication?
a) Precision timing
b) Frame synchronization
c) Character synchronization
d) All of the mentioned

4. What are the disadvantages of digital communication?
a) Needs more bandwidth
b) Is more complex
c) Needs more bandwidth & Is more complex
d) None of the mentioned

5. Examples of digital communication are
a) ISDN
b) Modems
c) Classical telephony
d) All of the mentioned

6. Which system uses digital transmission?
a) ISDN
b) LANs
c) ISDN & LANs
d) None of the mentioned

7. The interval of frequencies outside which the spectrum is zero is called as \_\_\_\_\_\_\_\_
a) null to null bandwidth
b) normalized bandwidth
c) absolute bandwidth
d) none of the mentioned

8. Synchronization available in digital communication are
a) Symbol synchronization
b) Frame synchronization
c) Carrier synchronization
d) All of the mentioned

9. Digital system includes
a) Better encryption algorithm
b) Difficult data multiplexing
c) All of the mentioned
d) None of the mentioned

10. Analog to digital conversion includes
a) Sampling
b) Quantization
c) Sampling & Quantization
d) None of the mentioned

11. What are the main features of a transmitter?
a) Higher clock speed
b) Linear power amplifier
c) Directional antennas
d) All of the mentioned

12. What is Amplitude Modulation?
a) Change in amplitude of carrier according to modulating signal amplitude
b) Change in frequency of carrier according to modulating signal amplitude
c) Change in amplitude of carrier according to modulating signal frequency
d) Change in amplitude of modulating signal according to carrier signal amplitude

13. In amplitude modulation frequency and phase of carrier \_\_\_\_\_\_\_\_
a) varies simultaneously
b) varies alternately
c) initially varies but become same after sometime
d) remains constant

14. Why the Synchronous detection of AM signals is considered as a disadvantage?
a) Needs additional system for synchronization of carrier
b) Receiver is available at cheap prices
c) Needs less number of system as estimated for generation of carrier
d) Receiver is not complex

15. Square Law modulators \_\_\_\_\_\_\_\_
a) used for amplitude modulation
b) have non linear current-voltage characteristics
c) have non linear current-voltage characteristics as well as used for Amplitude Modulation
d) used for frequency modulation

16. Why AM is used for broadcasting?
a) More immune to noise
b) Less transmitting power is required
c) It has high fidelity
d) Avoids Receivers Complexity

17. AM spectrum consists of \_\_\_\_\_\_\_\_
a) Carrier frequency
b) Upper sideband
c) Lower sideband
d) Carrier frequency with both upper and lower sideband

18. The minimum channel Bandwidth is used by which modulation technique?
a) VSB
b) SSB-SC
c) DSB-SC
d) AM

19. Amplitude Modulated wave is \_\_\_\_\_\_\_\_
a) Sum of carrier and modulating wave
b) Product of carrier and modulating wave
c) Difference of carrier and modulating wave
d) Sum of carrier and its product with modulating wave

20. For 100% modulation, power in each sideband is \_\_\_\_\_\_\_\_ of that of carrier.
a) 50%
b) 70%
c) 60%
d) 25%

**QUIZ Answer Key:**

**1.a 2.d 3.d 4.c 5.d 6.c 7.c 8.d 9.a 10.c 11.d 12.a 13.d 14.a 15.c 16.d 17.d 18.b 19.a 20.d**

 







