Nirma University
Institute of Technology
Computer Science and Engineering Department

Course Policy Document

Academic Year: 2022-23, Term: ODD

Semester: III-CSE

Course Code & Name	**:**	2CS304-Digital Communications
Credit Details	**:**	2-1-0- 3 [L-T-P-C]
Course Co-coordinator	**:**	Prof. Parita Oza
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Introduction to Course:

Mankind has always communicated, but the means of communication changes. Digital communication is a mode communication where the information is encoded digitally as discrete signals and electronically transferred to the recipients. It is one of the most commonly used modes of communication now a days. Over the past century, communication technologies have had a fundamental impact on how we carry out our daily lives. Besides using the internet and mobile phones for interpersonal communication; businesses, banking, transportation systems, TV and radio broadcasts and smart power grids rely on advanced communication technology. This course will contribute to technically aware students about communication system and technology used by industry, also student can apply concept in real life to achieve expertise in communication system.

Course Outcomes (COs):

At the end of the course, students will be able to –

1. explain data/signal transmission over communication media
2. analyze various spread spectrum, multiplexing, and modulation techniques
3. apply concepts of data communication to solve various problems

Syllabus:

Unit I **Introduction to Data Communication**: components of network, its types and topology, protocol. Network models: OSI reference model, TCP/IP protocol suite, Applications of data communications Data Communications and Networking for Today's Enterprise	7
Unit II **Data and Signal:** types of Analog and digital signals and its characteristics, transmission of digital signal, data rate limits, signals in time and frequency domain, transmission impairment, performance measurement of network	4
Unit III **Digital Transmission**: digital to digital and Analog to digital conversion, transmission modes, Analog transmission: Digital to analog and analog to analog conversion	6
Unit IV **Multiplexing and Spread Spectrum Techniques**: Switching techniques, types of switching, structure of switch, types of switches. Telephone and cable network for data communication, dial up modem, DSL lines, Cable TV.	5
Unit V **Types of Errors:** Detection versus correction, coding, block coding, cyclic codes, checksum, forward error correction.	4
Unit VI **Transmission Media**: Guided media and unguided media: radio frequency allocation, frequency reuse, propagation of radio waves, micro waves and infrared, satellite communication, cellular telephony.	4

Suggested Readings^:

1. Behrouz Forouzan, Introduction to Data Communication and Networking, Tata McGraw Hill
2. William Stallings, Data and Computer Communication, PHI
3. Schweber W.L, Data Communication, Tata McGraw Hill
4. Andrew S Tanenbaum, Computer Networks, PHI
5. B.P. Lathi, Zhi Ding, Modern Digital and Analog Communication, Oxford University Press

Self-study:

- Telephone and cable network for data communication
- Dial-up modem, DSL lines, Cable TV.
- Satellite communication, cellular telephony.

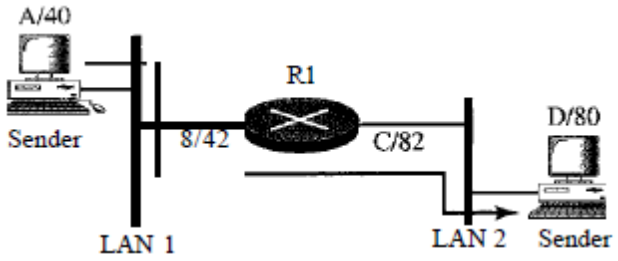
Tutorial Details:

The tutorials are planned as per the below mentioned schedule:

Tutorials	**CO Mapping**
Tutorial 1 1. Explain different transmission modes with example. 2. Why are protocols needed? 3. What are the two types of line configuration? 4. What are the three criteria necessary for an effective and efficient network? 5. What are the advantages of distributed processing? 6. List different network topologies and give the advantages and disadvantages of each. 7. What are some of the factors that determine whether a communication system is a LAN or WAN? 8. For *n* devices in a network, what is the number of cable links required for a mesh, ring, bus, and star topology? 9. For each of the following four networks, discuss the consequences if a connection fails. a. Five devices arranged in a mesh topology b. Five devices arranged in a star topology (not counting the hub) c. Five devices arranged in a bus topology d. Five devices arranged in a ring topology 10. What are the advantages of a multipoint connection over a point-to-point one? 11. How many point-to-point WANs are needed to connect *n* LANs if each LAN should be able to directly communicate with any other LAN?	**CO1**
Tutorial 2 1. Which layers in the Internet model are the network support layers? 2. Which layer in the Internet model is the user support layer? 3. What are headers and trailers, and how do they get added and removed? 4. Differentiate between a port address, a logical address, and a physical address? 5. Name some services provided by the application layer in the Internet model 6. Define: peer-to-peer process? 7. Match the following to one or more layers of the OSI model: a. Format and code conversion services b. Establishes, manages, and terminates sessions c. Ensures reliable transmission of data d. Log-in and log-out procedures e. Provides independence from differences in data representation 8. Match the following to one or more layers of the OSl model: a. Communicates directly with user's application program b. Error correction and retransmission	**CO1**

c. Mechanical, electrical, and functional interface
d. Responsibility for carrying frames between adjacent nodes

9. Performance is inversely related to delay. When we use the Internet, which of the following applications are more sensitive to delay?
   a. Sending an e-mail
   b. Copying a file
   c. Surfing the Internet
10. When a party makes a local telephone call to another party, is this a point-to-point or multi-point connection? Explain the answer.
11. In given figure computer A sends a message to computer D via LANl, router Rl, and LAN2. Show the contents of the packets and frames at the network and data link layer for each hop interface.



Tutorial 3 **CO1,3**

1. How can a composite signal be decomposed into its individual frequencies?
2. Name three types of transmission impairment.
3. Distinguish between baseband transmission and broadband transmission.
4. What does the Nyquist theorem have to do with communications?
5. What does the Shannon capacity have to do with communications?
6. Is the frequency domain plot of a voice signal discrete or continuous?
7. We send a voice signal from a microphone to a recorder. Is this baseband or broadbandtransmission?
8. We send a digital signal from one station on a LAN to another station. Is this baseband or broadband transmission?
9. We modulate several voice signals and send them through the air. Is this baseband or broadband transmission?
10. What is the bandwidth of a signal that can be decomposed into five sine waves with frequencies at 0, 20, 50, 100, and 200 Hz? All peak amplitudes are the same. Draw the spectrum.
11. What does the amplitude of a signal measure? What does the frequency of a signal measure? What does the phase of a signal measure?
12. Demonstration on Scilab.
13. Distinguish between baseband transmission and broadband transmission. Distinguish between a low-pass channel and a band-pass channel.
14. Can we say whether a signal is periodic or nonperiodic by just looking at its frequency domain plot? How?

Tutorial 4 **CO1,3**

1. A periodic composite signal with a bandwidth of 2000 Hz is composed of two sine waves. The first one has a frequency of 100 Hz with a maximum amplitude of 20 V; the second one has a maximum amplitude of 5 V. Draw the bandwidth.
2. Which signal has a wider bandwidth, a sine wave with a frequency of 100 Hz or a sine wave with a frequency of 200 Hz?
3. A device is sending out data at the rate of 1000 bps.
   b. How long does it take to send out a single character ?
   c. How long does it take to send a file of 100,000 characters?
4. The attenuation of a signal is -10 dB. What is the final signal power if it was originally 5 W?
5. We measure the performance of a telephone line (4 KHz of bandwidth). When the signal is 10 V, the noise is 5 mV. What is the maximum data rate supported by this telephone line?
6. A file contains 2 million bytes. How long does it take to download this file using a 56-Kbps

channel? 1-Mbps channel? 7. What is the phase shift for the following? **a.** A sine wave with the maximum amplitude at time zero **b.** A sine wave with maximum amplitude after 1/4 cycle **c.** A sine wave with zero amplitude after 3/4 cycle and increasing 8. A signal has a wavelength of 1 μm in air. How far can the front of the wave travel during 1000 periods?	
Tutorial 5 1. Distinguish between a signal element and a data element. 2. Distinguish between data rate and signal rate. 3. Define a DC component and its effect on digital transmission. 4. Calculate the value of the signal rate for each of following case if the data rate is 1 Mbps and c = 1/2. a. 1 signal element, 1 data element b. 2 signal element, 1 data element c. 1 signal element, 2 data element d. 3 signal element, 4 data element 5. Draw the graph of the NRZ-L and NRZ-I scheme using each of the following data streams. a. 00000000 b. 11111111 c. 01010101 d. 00110011 6. Repeat Exercise 5 for 2B 1Q scheme, using following data streams. a. 0000000000000000 b. 1111111111111111 c. 0101010101010101 d. 0011001100110011 7. Repeat Exercise 5 for the MLT-3 scheme, using following data streams. a. 00000000 b. 11111111 c. 01010101 d. 00011000 8. Define the characteristics of a self-synchronizing signal 9. How many invalid (unused) code sequences can we have in 5B/6B encoding? How many in 3B/4B encoding?	**CO2**
Tutorial 6 1. We have a baseband channel with a I-MHz bandwidth. What is the data rate for this channel if we use one of the following line coding schemes? a. NRZ-L b. Manchester c. MLT-3 d. 2B1Q 2. We want to transmit 1000 characters with each character encoded as 8 bits. **a.** Find the number of transmitted bits for synchronous transmission. **b.** Find the number of transmitted bits for asynchronous transmission. **c.** Find the redundancy percent in each case. 3. What is the result of scrambling the sequence 11100000000000 using one of the following scrambling techniques? Assume that the last non-zero signal level has been positive. a. B8ZS b. HDB3 (The number of nonzero pules is odd after the last substitution) 4. What is the number of bits per baud for the following techniques? a. ASK with four different amplitudes b. FSK with 8 different frequencies c. PSK with four different phases d. QAM with a constellation of 128 points 5. Draw the constellation diagram for the following: a. BPSK, with a peak amplitude value of 2 b. QPSK, with a peak amplitude value of 3 c. 8-QAM with two different peak amplitude values, I and 3, and four different phases. 6. An analog signal has a bandwidth of 20 KHz. If we sample this signal and send it through a 30 Kbps channel, what is the SNRdB? 7. What are the two components of a signal when the signal is represented on a constellation diagram? Which component is shown on the horizontal axis? Which is shown on the	**CO2**

vertical axis?

8. Assume that sampled signal consists of the amplitudes ranging from -20 V to +20 V if 8 quantization levels are used. Find out normalized PAM values, quantized error and quantized code for given samples.

Time	T1	T2	T3	T4	T5	T6	T7	T8
Amplitude	-6.2	6.1	14.2	18.3	10.0	-5.4	-7.6	-8.2

Tutorial 7 **CO2**

1. Which of the three multiplexing techniques is (are) used to combine analog signals? Which of the three multiplexing techniques is (are) used to combine digital signals?
2. Distinguish between multilevel TDM, multiple slot TDM, and pulse-stuffed TDM.
3. Distinguish between synchronous and statistical TDM.
4. Distinguish between a link and a channel in multiplexing.
5. Assume that a voice channel occupies a bandwidth of 4 kHz. We need to multiplex 10 voice channels with guard bands of 500 Hz using FDM. Calculate the required bandwidth
6. There are 4 stations A, B, C and D that transmits 1, 0, 1 and 1 respectively. Assume user D is listening to user B and user A is listening to user C. By taking appropriate parameters show the process of reception of data for both stations D and A.
7. Define FHSS and DSSS. explain how it achieves bandwidth spreading.
8. We need to use synchronous TDM and combine 20 digital sources, each of 100 Kbps. Each output slot carries 1 bit from each digital source, but one extra bit is added to each frame for synchronization. Answer the following questions:
   a. What is the size of an output frame in bits?
   b. What is the output frame rate?
   c. What is the duration of an output frame?
   d. What is the output data rate?
   e. What is the efficiency of the system (ratio of useful bits to the total bits)?
9. Repeat Problem 8, if each output slot carries 2 bits from each source.

Tutorial 8 **CO1,3**

1. Give an example to show how hamming distance can be used to deduce the correct code (i.e. original code from the sender) for a received, damaged code.

2. What is the Hamming distance for each of the following codewords:

a. d(10000, 00000)
b. d(10101, 10000)
c. d(11111,11111)
d. d(000,000)

3. Given the dataword 1010011110 and the divisor 10111,

a. Show the generation of the codeword at the sender site (using binary division).
b. Show the checking of the codeword at the receiver site (assume no error).

4. In Table 1, the sender sends dataword 10. A 3-bit burst error corrupts the codeword. Can the receiver detect the error? Define your answer.

Datawords	*Codewords*
00	000
01	011
10	101
11	110

Table 1

5. Prove that the code represented by Table 2 is not linear code. You need to find only one case that violates the linearity.

Dataword	Codeword
00	00000
01	01011
10	10111
11	11111

Table 2

6. This problem shows a special case in checksum handling. A sender has two data items to send: 0x4567 and 0xBA98. What is the value of the checksum?

Tutorial 9 **CO1,3**

1. Find the suitability of the following generators in relation to burst errors of different lengths.

a. $(x^6 + 1)$
b. $(x^{18} + x^7 + x + 1)$
c. $(x^{32} + x^{23} + x^7 + 1)$

2. Can the value of a checksum be all 0s (in binary) ? Defend your answer. Can the value be all 1s (in binary) ? Defend your answer.
3. We need a dataword of at least 11 bits. Find the values of k and n in the Hamming code C(n,k) with $d_{min} = 3$.
4. Apply the following operations on the corresponding polynomials:

a. $(x^3 + x^2 + x + 1) + (x^3 + x^2 + x + 1)$
b. $(x^3 + x^2 + x + 1) - (x^3 + x^2 + x + 1)$
c. $(x^3 + x^2) * (x^4 + x^2 + x + 1)$
d. $(x^3 + x^2 + x + 1) / (x^2 + 1)$

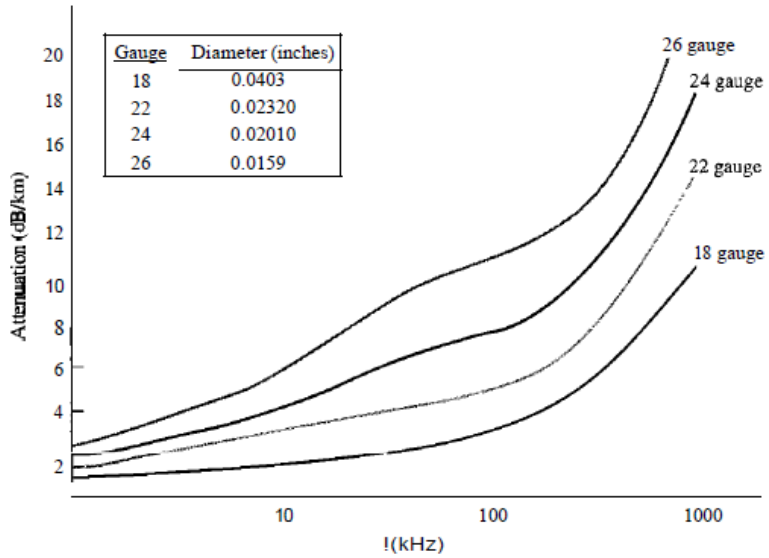
5. What kind of arithmetic is used to add data items in checksum calculation? What kind of error is undetectable by the checksum?
6. Assuming even parity, find the parity bit for each of the following data units.

a. 1001011
b. 0001100
c. 1000000
d. 1110111

Tutorial 10 **CO1**

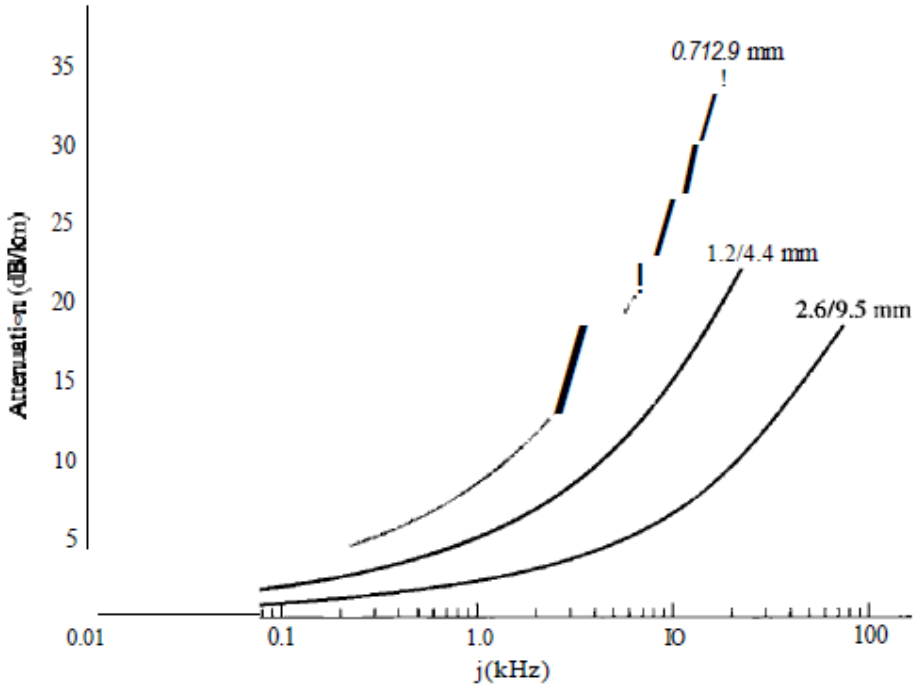
1. Using Figure tabulate the attenuation (in dB) of a 18-gauge UTP for the indicated frequencies and distances.

Distance	dB at 1 KHz	dRat 10KHz	dB at 100 KHz
1 Km			
1OKm			
15 Km			
20Km			



2. How does sky propagation differ from line-of-sight propagation?
3. If the power at the beginning of a 1 Km 18-gauge UTP is 200 mw, what is the power at the end for frequencies 1 KHz, 10 KHz, and 100 KHz? Use the result of Exercise 1.
4. Using table given below tabulate the attenuation (in dB) of a 2.6/9.5 mm coaxial cable for the indicated frequencies and distances.

Distance	*dB at 1 KHz*	*dB at 10 KHz*	*dB at 100KHz*
1 Km			
1OKrn			
15Km			
20Km			



5. If the power at the beginning of a 1 Km 2.6/9.5 mm coaxial cable is 200 mw, what is the power at the end for frequencies 1 KHz, 10 KHz, and 100 KHz? Use the result of Exercise 4

6. Calculate the bandwidth of the light for the following wavelength ranges (assume a propagation speed of 2 x 10^8 m): a. 1000 to 1200 nm b. 1000 to 1400 nm 7. A beam of light moves from one medium to another medium with less density. The critical angle is 60°. Do we have refraction or reflection for each of the following incident angles? Show the bending of the light ray in each case. a. 40° b. 60° c. 80°	

Component wise Continuous Evaluation

Component	Continuous Evaluation		
	Assignments (2) 30%	CT 1 35%	CT 2 35%

Lesson Plan:

Sr. No	Topics	Hour(s)	CLO Mapping	Applications
1	**Unit I** Introduction to Data Communication: • Introduction to Course and Policy, Need and effectiveness of communication Components of network, its type • Topology, protocols and Need of layered architecture • OSI reference model • TCP/IP protocol suite, • Applications and Data Communications and Networking for Today's Enterprise • Doubt Solving Session	[7] 1 1 2 1 1 1	CO 1	Network design,Network programming
2	**Unit II** Data and Signal: • Types of Analog and digital signals and its characteristics • Transmission of digital signal, data rate limits, signals in time and frequency domain • Transmission impairment, performance measurement of network	[4] 1 2 1	CO1, CO3	Network Design and troubleshooting, Noise Removal
3	**Unit III** Digital Transmission: • Digital Transmission: Digital to digital and Analog to digital conversion, Transmission modes • Analog transmission: Digital to analog and analog to analog conversion	[6] 3 3	CO2	Digital Data Transmission, Radio and TV Broadcasting
4	**Unit IV** Multiplexing and Spread Spectrum Techniques:	[5]	CO2	Privacy of data, Anti-jamming

	• Pseudo-Noise Sequence & DS Spread Spectrum • FH Spread Spectrum • Multiple Access Techniques: TDMA, FDAM, CDMA • Switching Techniques, types of switching, structure of switch, types of switches	1 1 2 1		
5	**Unit V** Error Detection and Correction: • Detection versus correction, coding, block coding • Cyclic codes, checksum, forward error correction.	[4] 2 2	CO1,3	Error Detection & Correction in Transmission
6	**Unit VI** Transmission Media: • Guided media • Unguided media	[4] 2 2	CO1	Home and College Network

Course Assessment Schemes

Continuous Evaluation: Assignments, Quizzes, Sessional Exam
Semester End Evaluation: Semester End Examination (SEE)

Teaching-learning methodology:

- Use of Black board, PPT, Discussion, and Videos etc.

Active learning techniques

- Short Quiz after completion of Chapter (s)
- One Minute Paper

Course Material:

Following material available on course website:
Moodle: https://lms.nirmauni.ac.in/course/view.php?id=1028

- Course Policy
- PPTs, Notes, other Material
- Assignments, Tutorials
- Question bank
- Web-links, Moodle link, Video Lectures, Journals
- Animations /Simulations, Software's
- Advanced topics
- Industries/Organizations

Course Outcome Attainment:

- Use of formal evaluation components of continuous evaluation, semester end examination
- Informal feedback during course conduction