B.E. COMPUTER SCIENCE & ENGINEERING 2nd YEAR 2nd SEMESTER EXAM- 2023
DATA COMMUNICATION

Time: 3 hours **Full Marks: 100**

Group A (Total Marks: 20) [CO1 and CO2]
Answer Question No. 1 (Compulsory) and Question No. 2 OR Question No. 3

1. (a) What are the different types of addresses used in communication? Explain with suitable examples their use and association with different layers of OSI model. 4+3+3

   (b) What are the propagation time and transmission time for an e-mail of 2.5 kbyte message size to reach your friend at 12000 km if the bandwidth of the network is 1Gbps?

   (c) How Fourier transform and Fourier series are used for signal processing? Find the Fourier series expansion of the periodic function $f(x) = x, -\pi \leq x \leq \pi$, $f(x + 2\pi) = f(x)$.

2. (a) A signal has travelled from point 1 to point 2. Suppose, its power is increased 100 times. There can be N cascaded amplifiers between point 1 and point 2, each with a M dB gain. Find the maximum value of N, if the condition N<=M needs to be satisfied. 3+3+4

   (b) We have sampled a low-pass signal with a bandwidth of 400 KHz using 512 levels of quantization. Calculate the bit rate of the digitized signal.

   (c) What is crosstalk? How is it minimized in case of twisted-pair of wire? Distinguish between attenuation distortion and delay distortion.

3. (a) Why two separate frequencies are used for uplink and downlink transmission in case of satellite communication? 3+4+3

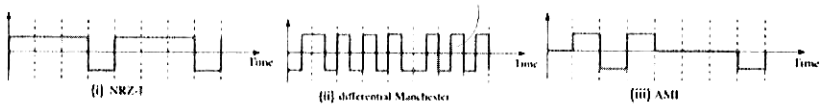
   (b) A 400-milliwatt signal goes through ten devices, each with a noise level of 12.65 microwatts on average. The signal contains frequencies of 1000 Hz, 2000 Hz, 3000 Hz, and 4000 Hz. Calculate the theoretical highest bit rate for the channel. Suppose, the theoretical maximum bit rate becomes 12000 bps if the above-mentioned channel is noiseless. In this case, what is the number bits per signal level used to represent the data?

   (c) Assume that we have a digital signal of bit rate N. Discuss the approximation (rough and better) of this digital signal with an analog signal in a low-pass channel with limited bandwidth. What is the required bandwidth of a low pass channel if we need to send 500 kbps by using baseband transmission?

Group B (Total Marks: 25) [CO3]
Answer Question No. 4 (Compulsory) and Question No. 5 OR Question No. 6

4. (a) Describe (i) Baseline Wandering (ii) DC components (iii) Self-Synchronization. Explain the Manchester and Differential Manchester schemes (with suitable diagram and example) and discuss how they overcome the problems associated with other polar schemes? 6+6+3

(b) Find the 8-bit data stream for each case depicted in the following figures and give explanations of your answer. Explain what price you have to pay for digitization in terms of bandwidth in following cases.



(c) "Average signal rate in the Manchester scheme is greater than that of NRZ-I" - Is this statement true? justify your answer.

5. (a) Discuss any one deficiencies of NRZ-I. Which encoding technique can solve that deficiency and the problem of synchronization. Let us consider a system that needs to send data at Q Mbps. Find the minimum bandwidth requirement of the following combination of coding schemes: 4B/5B and NRZ-I. (3+4)+3

(b) Calculate the number of levels and frequencies, the baud rate, and the bandwidth when the carrier frequency is 10 MHz and you want to send 3 bits at a time at a bit rate of 3Mbps.

6. (a) Why do we need encoding of data before sending over a medium? What is quantization error? How can it be reduced? 4+6

(b) What is the result of scrambling the sequence 11100000000000 using i) B8ZS ii) HDB3 scrambling techniques? Assume that the last non-zero signal level has been positive. Explain in accordance with the rules of each scheme.

Group C (Total Marks: 25) [CO4]
Answer Question No. 7 (Compulsory) and Question No. 8 OR Question No. 9

7. (a) Compare the bandwidth of ASK, binary FSK and binary PSK. If we need to send 6000 bits per second, what is the required bandwidth for the following cases? assume d=1. (i) ASK (ii) BFSK (iii) BPSK 5+5+5

(b) What are the two components of a signal when the signal is represented on a constellation diagram? Explain with a diagram. Show the constellation diagrams for ASK, BPSK and QPSK.

(c) Suppose, we need to modulate a 6-KHz audio signal, find the bandwidth for the following cases. (i) Amplitude modulation (ii) Frequency modulation (set $\beta = 4$) (iii) Phase modulation (set $\beta = 2$).

8. (a) In synchronous TDM, the data rate of the link is n times faster, and the unit duration is n times shorter- justify the statement with a suitable example. Explain the interleaving process used in TDM. (4+2)+4

(b) Assume the number of hopping frequencies is M. Show that each station uses 1/M of the bandwidth in both FDM and FHSS. Explain how FHSS is better than FDM in handling malicious senders.

9. (a) Describe a digital multiplexing technique for combining several low-rate channels into one high-rate one (with suitable diagram). Four 1-kbps connections are multiplexed together. A unit is 1 bit. Find (i) the duration of 1 bit before multiplexing, (ii) the transmission rate of the link, (iii) the duration of a time slot and (iv) the duration of a frame. (3+4)+3

(b) Define DSSS and explain how it achieves bandwidth spreading.

Group D (Total Marks: 15) [CO5]
Answer any one i.e., Question No. 10 OR Question No. 11

10. (a) Summarize the criteria for a good polynomial generator. 3+6+6

(b) Consider the following generators:
(i) $x^8 + x^2 + x + 1$
(ii) $x^{16} + x^{12} + x^5 + 1$
Find the suitability of the above generators in relation to burst errors of different lengths L <= r, L = r+1 and L > r+1, where r is the degree of the polynomial.

(c) The message 11001001 is to be transmitted using the CRC polynomial $x^3 + 1$ to protect it from errors. Find the transmitted message. Assume that one single error occurred in the leftmost bit position of the transmitted message. Can it be detected by the receiver? Justify your answer.

11. (a) Let G(x) be the generator polynomial used for CRC checking. What is the condition that should be satisfied to detect (i) single bit errors, (ii) two isolated single bit errors and (iii) odd number of errors. 6+6+3

(b) Let us consider a sender has some data in hexadecimal as follows: 3BC6 A45C 0EEC E2BE. If it is required to calculate the checksum, then show the checksum calculation in the sender and receiver site (assume no error occurs during data transmission and consider that a 16-bit checksum is used). Now, suppose an error has occurred during transmission, and consequently the 8th and 12th hexadecimal digits from the left are changed to 'E' and 'A' respectively. In this scenario, show the checksum at the receiver site.

(c) A Hamming code can only correct a single error or detect a double error - Explain a procedure to make it detect a burst error.

Group E (Total Marks: 15) [CO6]
Answer any one i.e., Question No. 12 OR Question No. 13

12. (a) The timer of a system using the Stop-and-wait ARQ protocol has a time-out of 6 ms. Draw the flow diagram for four frames if the round trip delay is 4 ms. Assume if the first frame (frame 0) is lost. 5+5+5

(b) Explain the importance of send and receive window size in flow control mechanisms. What should be the right size of send window in Go-back -N ARQ and Selective Repeat ARQ? Justify your answer with suitable examples.

(c) Assume 6 bits are used to represent the sequence number. W_s and W_r denote send and receive window size respectively. Find the values of W_s and W_r for (i) Stop-and-Wait ARQ (ii) Go-Back-N ARQ (iii) Selective Repeat ARQ.

13. (a) Assume that, in a Stop-and-Wait ARQ system, the bandwidth of the line is 1 Mbps, and 1 bit takes K ms (last 2 digits of your exam roll number) to make a round trip. What is the bandwidth-delay product? If the system data frames are 1000 bits in length, what is the utilization percentage of the link? What is your comment on utilization of the link in your case for high bandwidth or long delay? 5+5+5

(b) Let us consider, Stop-and-Wait ARQ Protocol is used by a system. How long does it take to deliver 1 million bits of data if each packet contains 1000 bits of data and the distance between the sender and receiver is 5000 km and the propagation speed is $2\times10^8\ m/sec$? Ignore any delays in transmission, waiting, or processing. We make the assumption that no data or control frames have been lost or corrupted.

Suppose, in the above scenario, it is now decided to use Go-Back-N ARQ Protocol instead of Stop-and-Wait. In this case, how long does it take to deliver 1 million bits of data? Consider the sender window size in Go-back-N is 7 and ignore the overhead due to the header and trailer.

Moreover, if it is decided to use Selective-Repeat ARQ Protocol (window size 4), how much extra time does it take to deliver 1 million bits of data compared to that of the Go-back-N ARQ Protocol.

(c) A node is using the following sequence numbers

0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,0,1,2,3,....

What is the size of the window if Selective Repeat ARQ protocol is used? Assume frame 1 is lost. Show how Selective Repeat ARQ protocol behaves in this case with a suitable flow diagram.