B.E. COMPUTER SCIENCE & ENGINEERING 2nd YEAR 2nd SEMESTER EXAM- 2022
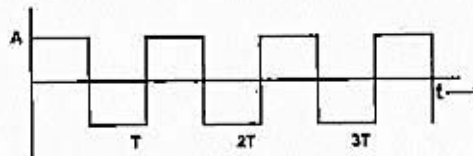
DATA COMMUNICATION

Time: 3 hours

Full Marks: 100

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

1. What is the significance of the OSI model? What are the responsibilities of   2+4+4
   Physical Layer and Data link layer in Internet model? Discuss the
   advantages and disadvantages of combining the session, presentation and
   application layer in the OSI model into one single application layer in the
   Internet model.

2. Explain important criterions for an effective and efficient network? Assume   2+4+4
   hypothetically that we have two links of the same delay, say 2 sec. The
   bandwidth of these links are 5bps and 25bps respectively. Discuss the
   performance of these two links. Consider a square wave form as shown
   below. Decompose it into its harmonics and show the frequency domain
   representation.

3. Why two separate frequencies are used for uplink and downlink   2+6+2
   transmission in case of satellite communication? 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: 10) [CO2]
Answer any one i.e., Question No. 4 OR Question No. 5

4. What are the factors responsible for attenuation in case of terrestrial   2+2+3+3
   microwave communication? What is intermodulation noise?

   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?

5. What is crosstalk? How is it minimized in case of twisted-pair of wire? 2+2+2+4
   Distinguish between attenuation distortion and delay distortion.

   Let us consider a scenario where a signal travels through four points namely P_1, P_2, P_3, and P_4. The signal passes the points in the following order: P_2, P_1, P_4, and P_3. From P_2 to P_3 there is a 1 dB gain of power. Suppose, both from P_2 to P_1 and P_4 to P_3 the signal's power is reduced to one half. The voltages at P_4 and P_2 are denoted as V_4 and V_2 respectively and it is given that the value of $V_2 = 50\ volt$. Find the value of V_4.

Group C (Total Marks: 30) [CO3]
Answer Question No. 6 (Compulsory) and Question No. 7 OR Question No. 8

6. Describe (i) Baseline Wandering (ii) DC components (iii) 6+6+3
   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? Explain what price you have to pay for digitization in terms of bandwidth.

7. Show that the bandwidth with d=0 in multilevel FSK is B=L X S. Assume 5+4+6
   that the available bandwidth is 100 kHz, which spans from 200 to 300 kHz. What should be the carrier frequency and the bit rate if data is modulated using FSK with d = 1?

   "In synchronous TDM, the data rate of the link is n times faster, and the unit duration is n times shorter."- Explain it. Assume that there are four sources, each creating 250 characters per second. If the interleaved unit is a character and 1 synchronizing bit is added to each frame, find (i) the data rate of each source, (ii) the duration of each character in each source, (iii) the frame rate, (iv) the duration of each frame, (v) the number of bits in each frame, and (vi) the data rate of the link.

8. Why do we need encoding of data before sending over a medium? What is 2+3+5+5
   quantization error? How can it be reduced? What is the result of scrambling the sequence 11100000000000 using a) B8ZS b) HDB3 scrambling techniques? Assume that the last non-zero signal level has been positive. Explain in accordance with the rules of each scheme.

Group D (Total Marks: 10) [CO4]
Answer any one i.e., Question No. 9 OR Question No. 10

9. Which digital conversion technique is more susceptible to noise? Defend 2+2+2+4
   your answer. Define carrier signal and its role in analog transmission. 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 (a) the duration of 1 bit before multiplexing, (b) the transmission rate of the link, (c) the duration of a time slot and (d) the duration of a frame.

10. Compare the bandwidth requirement of the three digital-to-analog modulation techniques. Define DSSS and explain how it achieves bandwidth spreading. 6+4

Group E (Total Marks: 10) [CO5]
Answer any one i.e., Question No. 11 OR Question No. 12

11. Discuss the concept of redundancy in error detection and correction. Differentiate linear block code and cyclic code. 2+2+6

Let us consider a CRC generator polynomial is given below:

$$x^{32} + x^{26} + x^{23} + x^{22} + x^{16} + x^{12} + x^{11} + x^{10} + x^8 + x^7 + x^5 + x^4 + x$$

Answer the following questions.

(a) How many single-bit errors can be detected by this generator polynomial? Please justify your answer.

(b) How many out of 10^{12} burst errors of size 33 are left undetected. Provide the calculation.

(c) How many out of 10^{12} burst errors of size 56 are left undetected. Provide the calculation.

(d) Is it capable of detecting a burst error of size 17? Justify your response.

12. What are the conditions to guarantee i) the detection of at least k errors and ii) the correction of at least m errors in a block code? 4+6

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.

13. To improve the efficiency of transmission, multiple frames must be in   5+5
transition while waiting for acknowledgement. Discuss the design (with
suitable diagram, flowchart/algorithm) of a protocol to achieve this goal in
noisy channels.

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 $2 \times 10^8\ m$? 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.

14. What is piggybacking? Explain its advantages? There is no pipelining in   2+2+6
Stop-and-Wait ARQ protocol. Discuss the design of a protocol which
improves the efficiency of transmission by using pipelining.

15. Consider the use of 10 K-bit size frames on a 10 Mbps satellite channel   4+6
with 270 ms delay. What is the link utilization for stop-and-wait ARQ
technique assuming $P = 10^{-3}$? Go-back-N ARQ is very inefficient for a
noisy link. Discuss the design of a protocol to address this issue.