

Code:1821

Roll No.: 4152

**M.Sc.(INFORMATICS) II Sem-2018**  
**Paper IT-21- Voice and Data Communication**

Max.Marks:75

Time: 3hrs

*Write your Roll No. on the top immediately on receipt  
of this question paper*

**Attempt five questions in all**  
**Question No.1 is compulsory**

(5)

**Q.1(a)** Let  $e$  be the function from  $B^3$  to  $B^4$  given by

$$e(b_1 b_2 b_3) = b_1 b_2 b_3 b_4,$$

where  $b_4 = b_1 + b_3$ .

(i) Is  $e$  one-to-one? If not, determine two different vectors  $b$  and  $c$  in  $B^3$  such that  $e(b) = e(c)$ .

(ii) Determine the matrix  $A$  so that  $e$  can be written as a matrix transformation in the form

$$e(b_1 b_2 b_3) = A \begin{bmatrix} b_1 \\ b_2 \\ b_3 \end{bmatrix} = \begin{bmatrix} b_1 \\ b_2 \\ b_3 \\ b_4 \end{bmatrix}.$$

(b) A parity (5, 6) check code is used and the following words are received. Determine whether an error will be detected. (3)

(i) 001101, (ii) 101110, (iii) 110000, (iv) 111010

(c) Let  $e$  be the function from  $B^2$  to  $B^4$  given by the following matrix transformation: (7)

$$e(b_1 b_2) = \begin{bmatrix} 1 & 0 \\ 0 & 1 \\ 1 & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} b_1 \\ b_2 \end{bmatrix}$$

(i) Determine all the code words.

- (ii) Is this a linear code?  
 (iii) Since all the code words have the same parity, if we used a parity check on a received word would this check detect all possible errors? Explain your answer. (4)

Q.2(a) Find the weight of each of the following words in  $B^6$ .

(i)  $x = 011000$ , (ii)  $x = 000001$ , (iii)  $x = 000000$ , (iv)  $x = 101010$  (4)

(b) The code matrix of the parity (3, 4) code is

$$C = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \\ 1 & 1 & 1 \end{bmatrix}$$

Find the code words that are linear combinations of the columns of  $C$ . What is the dimension of the subspace formed by these code words.

(c) Find the code matrix  $C$  for the Hamming matrix  $H(5)$ . (7)

Q.3(a) What are the important features of cyclic codes? In CRC division using polynomial, if the augmented data word is  $x^3 + x^2$  and divisor is  $x^3 + x + 1$ , then find the codeword. (5)

(b) A sine wave is offset  $\frac{1}{6}$  cycle with respect to time 0. What is its phase in degrees and radians? (3)

(c) If a periodic signal is decomposed into five waves with frequencies of 100, 300, 500, 700 and 900 Hz, what is its bandwidth? Draw the spectrum, assuming all components have a maximum amplitude of 5V. (5)

(d) A digitized voice channel is made by digitizing a 4-kHz bandwidth analog voice signal. We need to sample the signal at twice the highest frequency. We assume that each sample requires 8 bits. What is the required bit rate? (2)

Q.4(a) The loss on a cable is usually defined in decibels per kilometer (dB/km). If the signal at the beginning of a cable with  $-0.3\text{dB/km}$  has a power of  $2\text{mW}$ , what is the power of the signal at  $5\text{km}$ ? (4)

(b) We need to send  $265\text{kbps}$  over a noiseless channel with a bandwidth of  $20\text{kHz}$ . How many signal levels do we need? (2)

(c) A telephone line normally has a bandwidth of  $3000\text{Hz}$  (300 to  $3300\text{Hz}$ ) assigned for data communications. The signal to noise ratio is usually 3162. Calculate the capacity of the line? (3)

- (d) In a digital transmission, the receiver clock is 0.1% faster than the sender clock. How many extra bits per second does the receiver receive if the data rate is 1kbps? How many if the data rate is 1Mbps? (3)
- (e) Five channels, each with a 100kHz bandwidth, are to be multiplexed together. What is the minimum bandwidth of the link if there is a need for a guard band of 10kHz between the channels to prevent interference? (3)
- Q.5(a)** What do you understand by Time division multiplexing? distinguish between multilevel TDM, multiple slot TDM and pulse-stuffed TDM. (5)
- (b) A multiplexer combines four 100kbps channels using a time slot of 2 bits. Show the output with four arbitrary inputs. What is the frame rate? What is the frame duration? What is the bit rate? What is the bit duration? (4)
- (c)(i) What are the different satellite orbits? Using Kepler law, find the rotation period of Moon around the Earth. (3)
- (ii) Which type of orbit does a GEO satellite have? Explain your answer. (3)
- Q.6(a)** Show that the angle of acceptance in a fiber is given by (5)

$$\theta_a \leq \sin^{-1} \left[ \frac{1}{n_0} (n_1^2 - n_2^2)^{1/2} \right]$$

where symbols have their usual meanings.

- (b) Discuss the principle of fiber-optic communication by using the ray approach. What is the purpose of cladding in a fiber? (5)
- (c) Determine the core radius for a step-index fiber having the following parameters:  $n_1 = 1.450$ ,  $n_2 = 1.447$  and operating wavelength  $\lambda = 1.3\mu m$ . Also determine the NA and maximum acceptance angle. (5)