Paper ID : 250559

Roll No: | | | | | | | | | | | | | |

BTECH
(SEM VI) THEORY EXAMINATION 2024-25
DIGITAL COMMUNICATION

TIME: 3 HRS **M.MARKS: 100**

Note: Attempt all Sections. In case of any missing data, choose suitably.

SECTION A

1. Attempt *all* questions in brief. **2 x 10 = 20**

Q No.	Question	CO	Level
a.	Let X be a continuous random variable with probability density function (PDF): $f_X(x) = 2x\,, 0 < x < 1$. Find the mean E[X].	1	K3
b.	Define the Power Spectral Density (PSD) of a random process.	1	K2
c.	Which line coding scheme has zero power at DC (0 Hz) in its Power Spectral Density (PSD)?	2	K2
d.	What is an Eye Diagram?	2	K2
e.	Compare the bandwidth requirements of FSK and PSK modulation schemes.	3	K2
f.	What is a constellation diagram in digital modulation schemes?	3	K2
g.	Differentiate between PN sequence and a random variable?	4	K2
h.	In a BASK system, binary 1 is transmitted with an amplitude of 5 V and binary 0 with 0 V. If the receiver uses a threshold of 2.5 V, determine the decision when the received signal is 4.2 V (assuming no noise).	4	K2
i.	What is mutual information in information theory?	5	K2
j.	calculation generator matrix for linear block code (7,4). If the parity check matrix. H= $\begin{bmatrix} 1 & 0 & 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 & 1 & 0 \\ 0 & 1 & 1 & 0 & 0 & 1 \end{bmatrix}$	5	K3

SECTION B

2. Attempt any *three* of the following: **10 x 3 = 30**

Q No.	Question	CO	Level
a.	Consider a random variable x with PDF, $\rho_X(x) = ae^{-b\|x\|}$. (i) Relationship between a & b (ii) Probability p{1<x<2}	1	K3
b.	Define the block diagram of a digital communication system. Explain the functions of each block in brief.	2	K2
c.	Explain the concept of M-ary digital modulation schemes in communication systems. Discuss the advantages and disadvantages of M-ary signaling compared to binary signaling.	3	K2
d.	Explain the working principle of Frequency Hopping Spread Spectrum (FHSS) and differentiate between slow and fast frequency hopping with examples.	4	K2
e.	Find the code word length, code efficiency, and Redundancy by using Shannon-Fano for the probability $\{\frac{1}{4},\frac{1}{4},\frac{1}{8},\frac{1}{8},\frac{1}{16},\frac{1}{16},\frac{1}{16},\frac{1}{16}\}$ for symbols $s_1, s_2, s_3, s_4, s_5, s_6, s_7, s_8$	5	K3

SECTION C

3. Attempt any *one* part of the following: **10 x 1 = 10**

Q No.	Question	CO	Level
a.	Explain the relationship between the autocorrelation function and the power spectral density (PSD) of a wide-sense stationary (WSS) random process. A wide-sense stationary (WSS) random process X(t) has an autocorrelation function given by $R_x(\tau) = 10e^{-\|\tau\|}$. Find the Power Spectral Density (PSD) $S_X(f)$ of the	1	K3

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	process.		
b.	Describe the following terms in the context of communication systems: (i) Random Processes (ii) Gaussian Random Process	1	K2

4. Attempt any *one* part of the following: 10 x 1 = 10

Q No.	Question	CO	Level
a.	Explain the concept of the Matched Filter in digital communication systems., Also, derive the expression for the matched filter impulse response for maximizing the signal-to-noise ratio (SNR) at the sampling instant.	2	K2
b.	Explain the Gram-Schmidt Orthogonalization procedure. How is it used to obtain an orthonormal basis from a set of linearly independent vectors in communication systems? Illustrate the process with an example.	2	K2

5. Attempt any *one* part of the following: 10 x 1 = 10

Q No.	Question	CO	Level
a.	Explain the working principle of QPSK modulation and demodulation. Also, for a QPSK system with energy per bit $E_b = 10^{-6}$ J and noise power spectral density $N_0 = 10^{-7}$W/Hz, calculate the BER. Draw the constellation diagram of QPSK. (Use approximation $Q(x) = \frac{1}{2}e^{-x^2}$)	3	K3
b.	Explain the modulation and demodulation process with neat diagrams and sketch the constellation diagram of BPSK. Also, discuss the advantage of BPSK over other digital modulation schemes in terms of noise immunity.	3	K2

6. Attempt any *one* part of the following: 10 x 1 = 10

Q No.	Question	CO	Level
a.	Discuss the Bit Error Rate (BER) expressions for BASK, BFSK, and BPSK modulation schemes in an Additive White Gaussian Noise (AWGN) channel. Also, compare their performance in terms of energy efficiency and reliability.	4	K2
b.	(i). A Direct Sequence Spread Spectrum (DSSS) system uses a data rate of 10 kbps and a pseudo-noise (PN) code rate of 1 Mbps**.** Calculate the processing gain (PG) of the system. (2) (ii) Explain in detail the working principle of DSSS. Also, discuss it advantages**,** disadvantages**,** and applications in communication systems. (8)	4	K3

7. Attempt any *one* part of the following: 10 x 1 = 10

Q No.	Question	CO	Level
a.	For the (7,4) cyclic code using a generator polynomial g(x) = $x^3 + x^2 + 1$. Calculate: (i) Draw the block diagram of a Cyclic encoder with m =0110 (ii) Draw the block diagram of the Syndrome calculator with R=1001011.	5	K3
b.	For a (6,3) systematic linear block code, the three parity-check bits c_4, c_5 *and* c_6 are formed from the following equations: $c_4 = u_1 + u_3$, $c_5 = u_1 + u_2 + u_3$, $c_6 = u_1 + u_2$; (i). Write down the generator matrix G. (ii). Suppose that the received word is 010111. Decode this received word by finding the location of the error and the transmitted data bits.	5	K3