X/K/TY

Reg. No: 23BML0045

VIT
Vellore Institute of Technology

Final Assessment Test – November 2025

Course: BECE306L - Digital Communication Systems

Class NBR(s): 0313 / 0316 / 0317 / 6833 Slot: C2+TC2

Time: Three Hours Max. Marks: 100

- KEEPING MOBILE PHONE/ANY ELECTRONIC GADGETS, EVEN IN 'OFF' POSITION IS TREATED AS EXAM MALPRACTICE
- DON'T WRITE ANYTHING ON THE QUESTION PAPER

General Instruction : Error Function Table is permitted

COs	CO Statements
CO1	Comprehend the sampling and quantization process to recover the original signal
CO2	Analyse the performance of various waveform and Line coding techniques
CO3	Design the various baseband pulses for ISI free transmission over finite bandwidth Channels
CO4	Examine the BER and bandwidth efficiency of the Bandpass modulation techniques
CO5	Analyse the digital communication system with spread spectrum modulation
CO6	Infer the elements of information theory

BL – Blooms Taxonomy Level (1 – Remember, 2 – Understand, 3 – Apply, 4 – Analyse, 5 – Evaluate, 6 – Create)

Answer ALL Questions

(10 X 10 = 100 Marks)

1. a) Find the Nyquist rate and Nyquist interval for the given signal [3] CO1 BL3

$$x(t) = 8\sin(50\pi t)\cos(60\pi t)$$

b) A sinusoidal signal $x(t) = \cos(2\pi \times 10^3 t) + \cos(\pi \times 10^3 t)$ is sampled at a rate of 1500 samples per second. The sampled signal is passed through an ideal low pass filter (LPF) with cut off frequency at 750 Hz. Sketch the spectrum and determine the LPF output frequency/frequencies. [7]

2. The signal $x(t) = 4\sin(2\pi \times 2 \times 10^4 t)$ is sampled at four times the Nyquist rate. Assume the quantization levels are eight. CO2 BL3

i) Encode the signal $x(t)$ using pulse code modulation (PCM) and, draw the sampled signal diagram with proper specification/scaling.

ii) Represent the encoded data in return to zero (RZ) unipolar format.

3. i) When an analog signal is sampled at a rate higher than the Nyquist rate, the successive samples exhibit higher correlation. [6] CO2 BL2

a) Identify a suitable technique to reduce redundancy in the transmitted pulse code modulation (PCM) signal.

(b) Explain the functional block diagram and the corresponding mathematical model for both the transmitter and receiver.

ii) Let the message signal $x(t)$ be the input to delta modulator (DM). The message signal $x(t)$ as follows. [4]

$$x(t) = 10\sin(4\pi \times 10^3 t) + 8\sin(6\pi \times 10^3 t)$$

Find the minimum sampling rate that will prevent slope overload distortion. Assume the step size is 0.65 V.

4.(a) In a binary digital communication system, binary '0' is represented by a waveform with a voltage level of 0 volts, while alternating binary '1's' are represented by voltage levels of +a volts and –a volts for the interval $0 < t < T_b$. Derive the power spectral density (PSD) of the transmitted waveform. CO2 BL2

OR

4.(b) In a binary digital communication system, the symbol '0' and '1' is represented by $S_1(t) and\ S_2(t)$ respectively. The symbol $S_1(t)$ is 0 volt for the entire bit duration T_b. The symbol $S_2(t)$ representation as follows: CO2 BL2

$$S_2(t) = \begin{cases} a & 0 < t < \frac{T_b}{2} \\ 0 & \frac{T_b}{2} < t < T_b \end{cases}$$

Derive the power spectral density of the transmitted wave.

5. Describe the fundamental components and operation of a baseband binary PAM system. Derive the condition under which Inter-Symbol Interference (ISI) is eliminated in a baseband communication system. CO3 BL2

6. Consider the four signals given below and apply Gram Schmidt orthogonalization procedure. CO4 BL3

$$S_1(t) = 1 \qquad (0 \le t \le 2)$$

$$S_2(t) = \begin{cases} 1 & (0 \le t \le 1) \\ -1 & (1 \le t \le 2) \end{cases}$$

$$S_3(t) = \begin{cases} 1 & (0 \le t \le 2) \\ -1 & (2 \le t \le 3) \end{cases}$$

$$S_4(t) = -1 \qquad (0 \le t \le 3)$$

a) Determine the orthonormal basis functions.

b) Represent all the signals by using basis functions.

7. (a) A pair of signals $s_1(t)$ and $s_2(t)$ are used to represent binary symbols 1 and 0, respectively CO4 BL2

$$S_1(t) = \sqrt{\frac{2E_b}{T_b}}\cos(2\pi f_c t) \quad 0 \le t \le T_b \quad \text{and} \quad S_2(t) = 0$$

Sketch the transmitter block diagram and describe the procedure for detecting the message signals.

(b) Derive an expression for the conditional probability that the receiver decides in favour of symbol '0', given that symbol '1' was transmitted.

8. Digital data is to be transmitted through a channel with $N_0 = 10^{-7} W/Hz$. The channel bandwidth of 1 MHz is considered for antipodal signalling scheme and binary frequency signalling scheme. CO4 BL3

a) What is the data rate that can be supported by the channel?

b) Determine the required received signal power to achieve a bit error probability of $P_e = 10^{-5}$ at the data rate obtained in part (a).

9.(a) Generate the pseudo noise (PN) sequence for the feedback shift register of [4, 1] with initial state of the register is 1110. Verify all properties of the PN sequence. CO5 BL2

OR

9.(b) (I) Illustrate with an example, a technique used to generate orthogonal codes of length 8 in a code division multiple access (CDMA) system. [4] CO5 BL2

II) A pseudo-noise (PN) sequence is generated using a feedback shift register length m= 8. The chip rate is 10^6 chips per second. Find the following [6]

i) PN sequence length.

ii) Chip duration of the PN sequence.

10. A transmitter transmits 5 symbols $\{a_1, a_2, a_3, a_4 \text{ and } a_5\}$ and the receiver received 4 symbols $\{b_1, b_2, b_3 \text{ and } b_4\}$. The joint probabilities of the system are given below: CO6 BL3

$$P(A,B) = \begin{pmatrix} 0.25 & 0 & 0 & 0 \\ 0.10 & 0.30 & 0 & 0 \\ 0 & 0.05 & 0.10 & 0 \\ 0 & 0 & 0.05 & 0.10 \\ 0 & 0 & 0.05 & 0 \end{pmatrix}$$

Determine H(A), H(B), H(A, B), H(A/B), H(B/A).

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