Question Paper

Exam Date & Time: 07-May-2024 (02:30 PM - 05:30 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

IV Semester B.Tech End Semester Examination, April/May 2024

DIGITAL TRANSMISSION [ICE 2226]

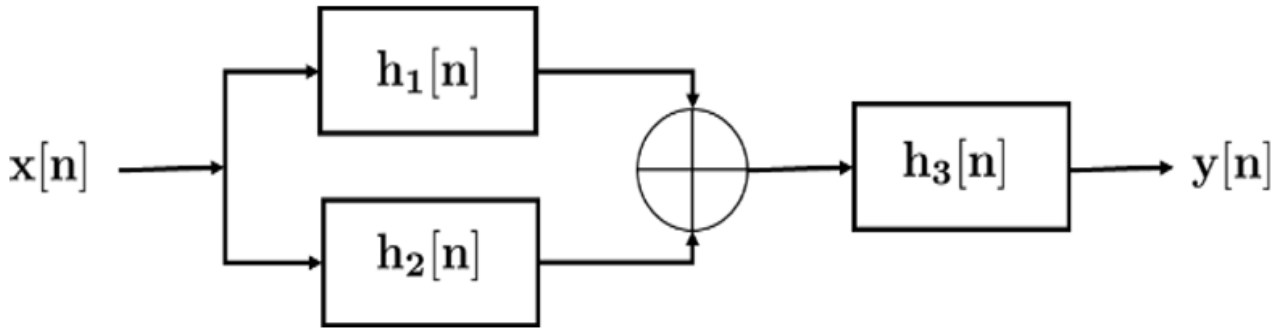
Marks: 50 **Duration: 180 mins.**

PART-A

Answer all the questions.

1) A system is characterized by an input signal x(n) = [2, 1, 3] and three impulse responses: $h_1(n)$ = [1, 1, 1], $h_2(n)$ = [2, 2, 2], and $h_3(n)$ = [1, 2, 1]. Find output y(n) of the system given below. [CO1, PO1,2,3,6,8,12 BL3] (5)

A)



B) Define what it means for a system to be Bounded-Input Bounded-Output (BIBO) stable? (3)

Analyse the following systems for BIBO stability. Briefly explain your reasoning for each system:

a. y(t) = 2x(t) + 5 (where x(t) and y(t) are the input and output signals, respectively)

b. y(t) = sin(x(t))

[CO1, PO1,2,3,6,8,12, BL4]

C) Define the invertibility property of a system. Provide a real-life example of an invertible system. Briefly explain why it satisfies the invertibility property. (2)

[CO1, PO1,2,3,6,8,12, BL3]

2) Why are LTI systems important in engineering? Explain their significance in analysing and designing various systems. Determine given system are LTI system or not. (4)

A)

a. $y(t) = e^{(x(t))}$

b. y(t)= 3 x(t)+ 2

[CO1, PO1,2,3,6,8,12, BL3]

B) Explain the significance of an eye diagram in a digital communication system. How does it help assess the quality of a transmitted signal? In an eye diagram, what property of the signalling is suggested by the width and opening of the "eye"? Briefly justify your answer. (3)

[CO2, PO1,2,3,6,8,12, BL3]

C) Why are square pulses not ideal for transmitting data in line coding schemes. Explain how Nyquist's first criterion helps reduce Inter-Symbol Interference (ISI) in digital communication systems. [CO2, PO1,2,3,6,8,12, BL3] (3)

3) Draw a basic block diagram illustrating the data communication format for USART transmission. Label the key components involved (e.g., Start bit, Data bits, Stop bits). Consider a data sequence of 10101011 to be transmitted using USART with a configuration of 8 data bits, start bit, stop bit, and parity bit. Sketch the resulting waveform, indicating the voltage levels for logic 0 and logic 1. [CO2, PO1,2,3,6,8,12, BL3] (4)

A)

B) In terrestrial communication, when there is no line-of-sight path between the transmitter and receiver, which fading model is most likely to be dominant? Briefly explain your reasoning. Does fading exist in deep space communication? Justify your answer. [CO3, PO1,2,3,4,6,8,12, BL3] (3)

C) Using a block diagram, explain the basic working principle of a Phase-Locked Loop (PLL). Briefly describe the function of each block. (3)

Indicate how the output frequency of the VCO is adjusted in a PLL to achieve lock with the reference signal. [CO3, PO1,2,3,4,6,8,12, BL3] .

4) A) Design a digital phase detector using D flip-flops and an AND gate. Draw a clear circuit diagram with labelled inputs and outputs. Consider two input signals with slightly different phase and explain how the phase difference between these signals affects the output of the phase detector. [CO3, PO1,2,3,4,6,8,12, BL4]. (4)

B) A continuous channel experiences white Gaussian noise. The signal-to-noise power ratio (SNR) is given as 8 dB, and the channel bandwidth (W) is 12 MHz. Using the Shannon-Hartley theorem, estimate the information capacity (C) of the channel in bits/second. [CO4, PO1,2,3,4,6,8,12, BL3] . (3)

C) Explain one advantage of using Differential Phase Shift Keying (DPSK) compared to conventional Phase Shift Keying (PSK). Calculate the bandwidth of a Quaternary Phase Shift Keying (QPSK) modulated signal if the data bit rate is 160 kbps. [CO4, PO1,2,3,4,6,8,12, BL3] (3)

5) A) Consider a data sequence "1011010" to be transmitted using MSK. Sketch the corresponding MSK signal. Label the axes (time and frequency) and indicate the transitions between symbols. [CO4, PO1,2,3,4,6,8,12, BL3] (4)

B) Hamming distance (d_{min}) plays a critical role in error-correcting codes. Discuss the trade-offs between increasing and decreasing d_{min}. (3)

a. Explain the relationship between d_{min} and the ability to detect and correct errors.

b. How does d_{min} affect the size of the codeword and consequently, the transmission efficiency?

c. When would you prioritize a higher d_{min} versus a lower d_{min}? Provide specific examples. [CO5, PO1,2,3,6,8,12, BL4]

C) A sender wants to transmit 4 frames of data, where each frame consists of 4 bits. To detect errors during transmission, the sender decides to calculate a checksum. What will be the checksum value for these 4 frames? (3)

Frame 1: 0100, **Frame 2:** 1111, **Frame 3:** 1001, **Frame 4:** 0010 [CO5, PO1,2,3,6,8,12, BL3]

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