Exam Date & Time: 01-Dec-2023 (02:30 PM - 05:30 PM)

# MANIPAL ACADEMY OF HIGHER EDUCATION

**FIFTH SEMESTER B.TECH. EXAMINATIONS - NOVEMBER / DECEMBER 2023**
**SUBJECT: ECE 3151-ANALOG AND DIGITAL COMMUNICATION**

**ANALOG AND DIGITAL COMMUNICATION [ECE 3151]**

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

**a**

**Answer all the questions.**

**Missing data may be suitably assumed.**

1A) With neat diagram, describe the balanced modulator based double sideband suppressed carrier (DSB-SC) generation supported with the relevant expressions. Also explain the quadrature null effect in coherent detection of DSBSC modulated signal with neat block diagram and relevant expression. (5)

1B) Given $c(t) = 20\cos 2\pi \times 10^6 t$ and $m(t) = 5\cos 4\pi \times 10^3 t$.

i) C(t) and m(t) are used to generate an amplitude modulated (AM) signal with $\mu = 0.707$. Find bandwidth (BW) and power.
ii) C(t) and m(t) are used to generate a frequency modulated (FM) signal such that the maximum frequency deviation is 4 times amplitude modulated signal bandwidth. Find the coefficient of the term $\cos 2\pi(512\times 10^3)t$ in the resultant FM expression. (3)

1C) Obtain Fourier transform of signal $e^{-t}u(t)$. Show the calculation steps. (2)

2A) Consider two signals s1(t) and s2(t) defined over the interval 0≤t≤T. Determine the orthonormal basis functions and express the signals in terms of basis functions.

$$s_1(t) = \begin{cases} 2, & for\ 0 \le t \le T \\ 0, & Otherwise \end{cases}$$

$$s_2(t) = \begin{cases} -4, & for\ 0 \le t \le T/2 \\ 0, & Otherwise \end{cases}$$

(5)

2B) Derive the impulse response of a matched filter that gives the maximum value of output SNR. (3)

2C) Assume that three signals $s_1(t)$, $s_2(t)$ and $s_3(t)$ can be represented using two orthonormal basis functions $\Phi_1(t)$ and $\Phi_2(t)$. The coordinates of these signals are $s_1 = (3, 1)$, $s_2 = (-2, -3)$ and $s_3 = (-1, -3)$. Draw the constellation diagram and express the three signals $s_1(t)$, $s_2(t)$ and $s_3(t)$ as a linear combination of the given basis functions. (2)

3A) Consider the binary data sequence 1 0 0 0 1 1 1 which is applied to the input of a duo binary system.
i) Determine the output of the duo-binary coder and the corresponding receiver output, without a precoder.
ii) Determine the output of the duo-binary coder and the corresponding receiver output, with a precoder. (5)

**Assume reference bit to be 1.**

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| 3B) | Describe granular noise and slope overload distortions in delta modulation. How can we reduce their effect? | (3) |
| 3C) | For the given sequence "11100111", plot the resulting waveform, assuming that following PAM format is used.<br>i) NRZ unipolar<br>ii) NRZ bipolar | (2) |
| 4A) | With relevant mathematical expressions, discuss the ideal solution for minimizing the ISI effect. What are the limitations of this ideal solution? How can these limitations be addressed using a practical solution? Give the relevant mathematical expressions. | (5) |
| 4B) | Derive the expression for the average probability of symbol error for coherent binary PSK detection with all intermediate steps. Assume AWGN channel. | (3) |
| 4C) | The binary data sequence **1 0 0 1 0 0 1 1** is applied to the input of a DPSK transmitter. Determine the differentially encoded sequence and transmitted phase. **Assume the initial reference bit as 1.** | (2) |
| 5A) | Construct minimum variance Huffman code for the given source probabilities **pk=[0.1, 0.2, 0.3,0.4]**. Also, determine the average code length of this Huffman code. | (5) |
| 5B) | Determine the entropy, efficiency, and redundancy of the Huffman code as given in Q5A. | (3) |
| 5C) | Determine the minimum variance of this Huffman code as given source coding techniques in Q5A. | (2) |

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