MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent unit of MAHE, Manipal)

FIFTH SEMESTER BTECH. (E & C) DEGREE END SEMESTER EXAMINATION
NOVEMBER 2022
SUBJECT: ANALOG AND DIGITAL COMMUNICATION (ECE - 3151)

TIME: 3 HOURS **MAX. MARKS: 50**

Instructions to candidates
- Answer **ALL** questions.
- Missing data may be suitably assumed.

Q. No.	Questions	M*	C*	A*	B*
1A.	Let x(t) be a periodic signal with period T. The signal is defined over the interval [-T/2, T/2] as follows $x(t)=\begin{cases}0, & \frac{-T}{2}\le t\le -\alpha T\\ -1, & -\alpha T\le t\le 0\\ 1, & 0\le t\le \alpha T\\ 0, & \alpha T\le t\le \frac{T}{2}\end{cases}$. Evaluate the fourier series coefficients a_0, a_n, b_n.	5	1	1,2	4
1B.	Determine the Hilbert transform of the energy signal $x(t)=\begin{cases}1, & \lvert t\rvert<\frac{T}{4}\\ 0, & otherwise\end{cases}$	3	1	1,2	3
1C.	State Dirichlet condition to be satisfied for the representation of periodic signal in Fourier series.	2	1	1,2	2
2A.	Consider the set of signals $s_i(t)=\begin{cases}\sqrt{\frac{2E}{T}}\cos(2\pi f_c t+i\frac{\pi}{4}), & 0\le t\le T\\ 0, & \text{elsewhere}\end{cases}$ where i=1,2,3,4 and fc=nc/T. i)What is the dimensionality, N,of the space spanned by this set of signals.	5	3	1,2	4

	ii)Find a set of orthonormal basis functions to represent this set of signals iii)Using the expansion $s_i(t) = \sum_{j=1}^{N} s_{ij}\emptyset_j(t)$ Find the coefficients s_{ij}. iv)Plot the locations of $s_i(t)$, I=1,2,3,4 in the signal space using the results of parts (ii) and (iii)				
2B.	Given Signal $S(t) = \begin{cases} \frac{a}{2}, & 0 \le t \le T/2 \\ -\frac{a}{2}, & T/2 \le t \le T \end{cases}$. Find (i) Plot the impulse response of a filter matched to S(t) (ii) Plot the matched filter output as a function of time	3	3	1,2	3
2C.	The signals $S_1(t)$,$S_2(t)$ and $S_3(t)$ are represented with to two basis functions ϕ_1 and ϕ_2 .The coordinates of these signals are S_1=(3,0);S_2=(-2,3);S_3=(-3.-3), Draw the constellation diagram and express the signals as a linear combination of the basis functions.	2	3	1,2	2
3A.	With neat and labelled diagram, explain the duobinary signaling scheme. Also, explain the error propagation problem in duobinary signaling and how it is resolved by using a precoded duobinary scheme (provide the necessary diagrams and equations).	5	2	1,2	2
3B.	In a binary PCM system, the output signal-to-quantization noise ratio is to be held to a minimum of 25 dB. Find (i) the number of required levels for a midtread uniform quantizer, (ii) the corresponding output signal-to-quantization noise ratio (in dB) and (iii) the corresponding bit rate, if sampling rate is 6.4 kHz Show all the intermediate steps.	3	2	1,2	4

3C.	With neat and labelled diagram, explain the types of quantization error in delta modulation.	2	2	1,2	2
4A.	Starting from fundamentals derive that the variance of non-uniform quantization error is $\sigma_Q{}^2 \cong \frac{x_{max}{}^2}{3L^2}\int_{-x_{max}}^{x_{max}} f_x(x)\left[\frac{dc(x)}{dx}\right]^{-2} dx$ mentioning all intermediate steps.	5	2	1,2	3
4B.	With neat and labelled block diagrams, explain the generation and demodulation of QPSK.	3	4	1,2	2
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 initial reference bit as 1.	2	4	1,2	3
5A.	Construct minimum variance Huffman code for the given source probabilities p_k=[0.1, 0.2, 0.3,0.4]. Also determine the entropy, average code length and variance from the given source coding techniques.	5	5	1,2	4
5B.	Prove the following property of mutual information: $I(X;Y) = H(X) + H(Y) - H(X,Y)$	3	5	1,2	3
5C.	State the channel coding theorem (provide the relevant mathematical expressions).	2	5	1,2	2