

SRN

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|



**PES University, Bengaluru**  
(Established under Karnataka Act No. 16 of 2013)

UE17EC352

**DECEMBER 2020: END SEMESTER ASSESSMENT (ESA) B TECH 6<sup>th</sup> SEMESTER**

**UE17EC352 – Digital Communication**

|             |                      |                |
|-------------|----------------------|----------------|
| Time: 3 Hrs | Answer All Questions | Max Marks: 100 |
|-------------|----------------------|----------------|

|   |     |   |   |
|---|-----|---|---|
| 1 | a)  | A discrete sinusoid is uniformly quantized, with $N$ bits/sample. Assuming $N$ to be large, find the expression for the SNR in dB   | 6 |
|   | b)  | With the help of suitable diagrams, explain the following about DPCM: i) the DPCM operation, ii) signal recovery at the receiver, and ii) improvement in SNR over PCM   | 8 |
|   | c)  | Derive the expression for the power spectrum of the bipolar NRZ signal  | 6 |
| 2 | a)  | Briefly explain i) Inter Symbol Interference and ii) Nyquist criterion  | 6 |
|   | b)  | A quaternary communication system ( $M=4$ ) uses raised cosine pulse shaping with $\alpha = 0.75$ . If the first zero crossings of the raised cosine pulse $p(t)$ occur at $\pm 100\mu s$ , find i) the symbol rate, ii) the bit rate, and iii) the bandwidth.                | 6 |
|   | c)  | For the AWGN channel, draw the block diagram of the i) detector and ii) vector receiver. Derive the minimum distance decision rule, starting from the MAP decision rule.  | 8 |
| 3 | a)  | Prove that the matched filter maximizes the output SNR  | 5 |
|   | b)  | With the help of block diagrams, explain the generation and detection of DPSK symbols   | 8 |
|   | c)  | A digital modulation system uses a bandwidth of 3 MHz. The additive white Gaussian noise has $N_0 = 10^{-19}$ . Find the average carrier power required to achieve $P_e = 10^{-4}$ , for the following cases: i) BFSK and ii) DPSK. Note that $\text{erfc}(2.75) = 10^{-4}$ . | 7 |
| 4 | a)  | For a discrete memoryless source with an $M$ -symbol alphabet, show that the maximum entropy is $\log_2(M)$ .   | 6 |
|   | b)  | For any source, prove that the average length of any prefix code is greater than or equal to its entropy.   | 6 |
|   | c)  | Find the Huffman code for the source with symbol probabilities $\{0.3, 0.18, 0.15, 0.12, 0.11, 0.1, 0.04\}$ . Also find the code efficiency.  | 8 |
| 5 | a)  | Derive the expression for the capacity of a binary erasure channel  | 7 |
|   | b)  | Find the differential entropy of a Gaussian random variable with zero mean and a variance of $\sigma^2$ .   | 6 |
|   | c)  | An analog signal bandlimited to 6 kHz is sampled at twice the Nyquist rate, resulting in a sequence of independent samples. The samples are uniformly quantized into 256 equally likely levels.   | 7 |
|   | i)  | Find the average information rate of this source.   |   |
|   | ii) | If this data is to be transmitted without errors over a channel with a bandwidth of 100 kHz, what is the minimum transmit power required? The additive Gaussian noise has $N_0 = 10^{-10}$  |   |