PART C — (1 × 15 = 15 marks)

16. (a) One experiment has four mutually exclusive outcomes, A_i $i = 1, 2, 3, 4$ and a second experiment has a three mutually exclusive outcomes, B_j $j = 1, 2, 3$. The joint probabilities $P(A_i, B_j)$ are;

$P(A_1, B_1) = 0.10$; $P(A_1, B_2) = 0.08$; $P(A_1, B_3) = 0.13$;

$P(A_2, B_1) = 0.05$; $P(A_2, B_2) = 0.03$; $P(A_2, B_3) = 0.09$;

$P(A_3, B_1) = 0.05$; $P(A_3, B_2) = 0.12$; $P(A_3, B_3) = 0.14$;

$P(A_4, B_1) = 0.11$; $P(A_4, B_2) = 0.04$; $P(A_4, B_3) = 0.06$

(i) Determine the probabilities $P(A_i), i = 1, 2, 3, 4$ and $P(B_j), j = 1, 2, 3$.

(ii) Suppose we observe the outcomes $A_i, i = 1, 2, 3, 4$ of experiment, A. Determine the Mutual Information, $I(B_j; A_i)$ for $j = 1, 2, 3$ and $i = 1, 2, 3, 4$ in bits. Also Determine the Average Mutual Information, $I(B : A)$.

Or

(b) Consider a random variable $x \in \{-3, -1, +1, +3\}$ with apriori probabilities $P_x(\pm 3) = 0.1$ and $P_x(\pm 1) = 0.4$. Given an observation of the random variable $y = x + n$; where n is a zero mean Gaussian random variable with variance, σ^2 independent of x. Deduce the decision threshold, y of the MAP detector. Now suppose $\sigma^2 = 0.25$ and $y = 2.1$, what is the decision?

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Reg. No. : [| | | | | | | | | | | |]

Question Paper Code : 20417

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2018.

Fifth Semester

Electronics and Communication Engineering

EC 6501 — DIGITAL COMMUNICATION

(Regulations 2013)

(Common to : PTEC 6501 – Digital Communication for B.E. (Part-Time) – Fourth Semester – Electronics and Communication Engineering – Regulations – 2014)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What is Nyquist rate?

2. A PCM system uses a uniform quantizer followed by a 7-bit binary encoder. The bit rate of the system is equal to 50×10^6 bits/sec. What is the maximum message bandwidth for which the system operates satisfactorily?

3. Write down the expression for Output Signal to Noise Ratio of a DPCM receiver mentioning both Predictive Gain and Prediction error-to-Quantization Noise Ratio.

4. A Delta modulation system is tested with a 10KHz sinusoidal signal with 1 V peak to peak at the input. It is sampled at 10 times the Nyquist rate. What is the corresponding SQNR?

5. Draw the NRZ-M and Biphase-M baseband encoding forms for the data [1 0 1 1 0 0 0 1 1].

6. Write down the decision rule for detecting the original input sequence $\{b_k\}$ from the output binary sequence $\{c_k\}$ of a pre-coded Duo-Binary scheme.

7. Draw the BER curve for ASK, FSK and BPSK digital modulation schemes.

8. Obtain the orthonormal basis function for the signal,

$$s_1(t) = \begin{cases} \sqrt{\frac{2E_b}{T_b}} \cos(2\pi f_c t); & 0 \le t \le T_b \\ 0 & ; 0 \le t \le T_b \end{cases}$$

9. State Noisy Coding theorem.

10. The generator polynomial $G(D)$ for a (7, 4) cyclic code is $G(D) = 1 + D^2 + D^3$. Find the code vector for the data vector, [1 0 1 0].

PART B — (5 × 13 = 65 marks)

11. (a) Derive the signal to Quantization noise ratio in PCM system.

Or

(b) Explain in detail about Delta modulation transmitter and receiver. A sinusoidal signal $X(t) = a_0 \cdot \cos(2\pi f_0 t)$ is applied to a delta modulator that operates with a sampling Period, T_s and step size, $\Delta = 2\delta$.

(i) Find the expression for amplitude, a_0 to avoid slope overload distortion.

(ii) Compute the maximum permissible value of the output signal power.

(iii) Compute the variation of Quantization noise in delta modulation.

(iv) Find the maximum value of output signal to noise ratio.

12. (a) Given the autocorrelation lags $R_{yy}(0) = 128$; $R_{yy}(1) = -64$; $R_{yy}(2) = 80$; $R_{yy}(3) = -88$; $R_{yy}(4) = 89$. Find all the prediction error filters upto order 4. The four reflection coefficients and the corresponding Mean square prediction errors.

Or

(b) Consider the linear prediction of a stationary autoregressive process, $x(n)$ generated from the first-order difference equation $x(n) = 0.9x(n-1) + v(n)$ where $v(n)$ is white noise of zero mean and unit variance. Determine the tap weights of the second order forward prediction error filters.

13. (a) State and prove Nyquist criterion for distortionless baseband data transmission.

Or

(b) (i) The binary data stream 00 11 01 001 is applied to a duobinary system. Construct the duobinary coder output and corresponding receiver output.

(ii) The binary data stream 00 10 11 0 is applied to a duobinary system. Construct the duobinary coder output and corresponding receiver output. Assume that there is Pre-Coder at the input. (5 + 8 = 13)

14. (a) Derive the expression for a Maximum likelihood detector and prove that the ML detector reduces to Minimum distance detector for the special case of a white - Gaussian noise vector channel.

Or

(b) Derive the probability of error for PSK signaling scheme.

15. (a) (i) The generator polynomial if a (7, 4) cyclic code is $G(P) = P^3 + P + 1$. Find the code word for the message bit $X = [1100]$ in systematic form. Also find out the Generator matrix and parity check matrix. (6)

(ii) For a systematic Linear block codes, the three parity check digits P_1, P_2, P_3 are given by $P_{4\times3} = \begin{bmatrix} 1 & 0 & 0 \\ 1 & 1 & 1 \\ 1 & 1 & 0 \\ 0 & 1 & 1 \end{bmatrix}$

(1) Construct Generator matrix

(2) Construct code generated by this matrix.

(3) Determine error correcting capability.

(4) Decode the received code with own example. (7)

Or

(b) A convolutional code is described by $g_1 = [100]$, $g_2 = [101]$, $g_3 = [110]$.

(i) Draw the encoder corresponding to this code.

(ii) Draw the state transition diagram for this code.

(iii) Draw the trellis diagram for this code.

(iv) The input message sequence is [1 1 0 1 0 1 0 0]. The received sequence with error is [100 110 111 101 001 101 001 010], using viterbi algorithm find the transmitted code word sequence.