# B.E. Part III (ETC), 5th Semester Final Examination, 2012

## Digital Communication (ET 501)

**Full Marks: 70** **Time: 3 hours**

*Attempt question no. 1 and any two from the rest*
*Answer should be brief and to the point*
*Unnecessary lengthy answers may result in loss of marks*

1. (a) Find out the Nyquist sampling rate for the signal $g(t) = 10.\cos(50\pi t).cos^2(150\pi t)$, where 't' is in seconds.
(b) In a PCM, the amplitude levels are transmitted in a 7 unit code. The sampling is done at the rate of 10 KHz. Calculate the bandwidth required.
(c) A TDM link has 20 signal channels and each channel is sampled 8000 times/second. Each sample is represented by seven binary bits and contains an additional bit for synchronization. What is the total bit rate for the TDM link?
(d) Describe and explain Nyquist minimum bandwidth theorem.
(e) How can you interpret an eye diagram?
(f) What do you mean by power efficiency of digital modulation scheme?
(g) A communication channel with additive white Gaussian noise has a bandwidth of 4 KHz and an SNR of 15. Find out the channel capacity.
(h) An image uses 512 x 512 picture elements. Each of the picture elements can take any of the 8 distinguishable intensity levels. Calculate the maximum entropy in the above image.
(i) Mention some of the advantages of Walsh code.
(j) Briefly discuss about the importance of error correcting code in digital communication with proper examples.

3x10

2. (a) Find out the PSD of granular noise generated by a DM system with a sinusoidal signal of amplitude A and frequency $f_m$ as the test signal. The DM system is designed to handle analog message signals limited to bandwidth W. Hence show that the average quantization noise power is given by $N = \frac{4\pi^2 A^2 W f_m^2}{3 f_s^3}$; where it has been assumed that the step-size $\Delta$ has been chosen so as to avoid slope overload distortion and $f_s$ is the sampling rate.
(b) In a binary PCM system, symbols 0 and 1 have a priory probabilities $p_0$ and $p_1$, respectively. The conditional probability density function of the random variable Y (with sample value y) obtained by sampling the matched filter output, given that symbol 0 and 1 were transmitted, are denoted by $f_Y(y|0)$ and $f_Y(y|1)$ respectively. Show that the optimum threshold $\lambda_{opt}$ for which the average probability of error is minimum, is given by the solution of

$$\frac{f_Y(\lambda_{opt}|1)}{f_Y(\lambda_{opt}|0)} = \frac{p_0}{p_1}$$

(c) Describe the impact of roll-off factor in reducing ISI.

8+8+4

3. (a) The signal component of a coherent PSK system is defined by

$$s(t) = A_c.k.\sin(2\pi f_c t) \pm A_c.\sqrt{1-k^2}.\cos(2\pi f_c t)\,; 0 \le t \le T_b$$

Draw a signal-space diagram for the scheme described. Show that, in presence of additive white Gaussian noise of zero mean and power spectral density $\frac{N_0}{2}$; the average probability of error is

$$P_e = \frac{1}{2}.erfc\left(\sqrt{\frac{E_b}{N_0}(1-k^2)}\right)\text{ ; where } E_b = \frac{1}{2}.A_c^2.T_b.$$

(b) Derive and plot the PSD of QPSK-modulated wave for a carrier frequency $f_c$ and incoming bit rate $R_b$. Hence find out the bandwidth efficiency of QPSK.
(c) Draw the constellation diagram for $\pi/4 - shifted\ QPSK$ modulation and also indicate the possible phase transitions.

10+6+4

4. (a) Let p denote the probability of some event. Plot the amount of information gained by the occurrence of this event for $0 \le p \le 1$.
(b) Show that the entropy of a discrete memory-less source is bounded as

$$0 \le H(\mathcal{S}) \le \log_2 K$$

; where K is the radix of the alphabet $\mathcal{S}$ of the source.
(c) Find out the capacity of an AWGN channel of infinite bandwidth.
(d) Consider the binary sequence 1 1 1 0 1 0 0 1 1 0 0 0 1 0 1 1 0 1 0 0 . . .
Use the Lempel-Ziv algorithm to encode this sequence. Assume that the binary symbols 0 and 1 are already in the codebook.

4+6+4+6

5. (a) Generate one PN sequence of length 15 and demonstrate its properties.
(b) How is Gold code constructed from PN sequence? Explain with example.
(c) What do you understand by spread spectrum modulation?
(d) Consider the 0.5 rate convolution encoder in Fig. 1. Find the encoder output produced by the message sequence 1 0 1 1 1 0. . .

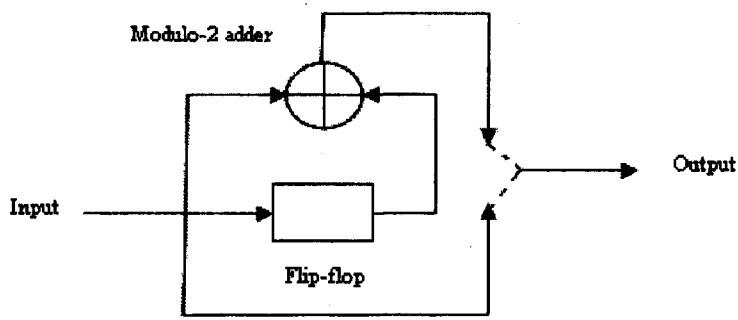


Fig. 1

8+4+2+6

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