B.Tech.

SIXTH SEMESTER EXAMINATION, 2004-2005

DIGITAL COMMUNICATION

Time : 3 Hours   *Total Marks : 100*

Note : (i)   Answer **ALL** questions.

(ii)   All questions carry equal marks.

(iii)   In case of numerical problems assume data wherever not provided.

1.   Attempt *any four* parts of the following :   (5x4=20)

(a)   A DMS has an alphabet of 8 letters x_i, $i = 1$, ..., 8 with probabilities 0.25, 0.20, 0.15, 0.12, 0.10, 0.08, 0.05 and 0.05. Determine an optimum binary code for the source using Huffman Coding procedure.

(b)   Let X be output of a DMS with letters a_1, a_2, a_3 in its alphabet with probabilities 0.45, 0.35 and 0.20. X is transformed to Y by following linear operation $Y = aX + b$ where a and b are constants. Determine entropy of Y.

(c)   Prove that for a DMS an optimum code exists in which lower probability letters consistently have higher length codewords.

(d)   Show that $I(x ; y) \leq$ min. $\{H(x), H(y)\}$.

(e) What is Shannon limit ? Determine its value.

(f) Find minimum bandwidth needed for transmission if 6 messages of 20 KHz bandwidth each are multiplexed using FDM followed by SSB modulation.

2. Attempt *any four* parts of the following : (5x4=20)

(a) A sinusoidal signal is input to a mid tread type uniform quantizer. Draw the quantizer output for one cycle of the input.

(b) Show that for a uniform quantizer with a given dynamic range, if the number of quantization levels is doubled then signal-to-quantization noise power increases by 6 dB.

(c) What is the A-law of companding ? Give its expression and draw it.

(d) What is the maximum power of a sinusoidal input to a delta modulator with step size D, if no slope-overload distortion is to take place. The sampling interval is T_s.

(e) What is sigma-delta modulator ? Give its block-schematic diagram ?

(f) What is T3 system ? Describe it briefly.

3. Attempt *any two* parts of the following : (10x2=20)

(a) (i) Let $X_\alpha (f)$ be the raised cosine spectrum with roll-off factor α. Show that

$$\int_{-\infty}^{\infty} X_\alpha (f) \, df = 1 .$$

      (ii)   What is minimum bandwidth solution for pulse shape with zero ISI ? Assume symbol duration is T.

  (b)   Given a bit sequence of 01011001, draw line codes in NRZ-L, NRZI and pseudoternary formats. Compare them on the basis of their bandwidth and clocking capability.

  (c)   Derive the optimum correlation receiver structure for coherent reception in AWGN channel.

**4.**   Attempt *any two* parts of the following :   **(10x2=20)**

  (a)   Derive the probability of bit error for QPSK scheme in AWGN channel.

  (b)   Apply gram-schmidt procedure to following signals to obtain an orthonormal basis set and signal coordinates.
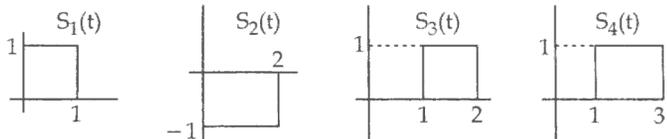
  (c)   Digital information is to be transmitted by carrier modulation through an AWGN channel with a bandwidth of 100KHz and $No = 10^{-10}$ w/Hz. Determine the maximum rate that can be transmitted through the channel for :

    (i)   Four phase PSK

    (ii)   Binary FSK

    (iii) Four-frequency orthogonal FSK with incoherent reception.

5. Attempt *any two* parts of the following : (10x2=20)

(a) Show that a block code with hamming distance of $2t+1$ can detect at most 2t bit errors and correct upto t bits of errors using minimum distance decoding rule.

(b) (i) Show that a cyclic code with $(1+x)$ as factor of its generator polynomial will detect all odd number of bit errors.

(ii) Let $g(x) = x^8 + x^6 + x^4 + x^2 + 1$ be a polynomial over the binary field. Find the lowest rate cyclic code whose generator polynomial is $g(x)$.

(c) Consider a convolutional coder with following structure.
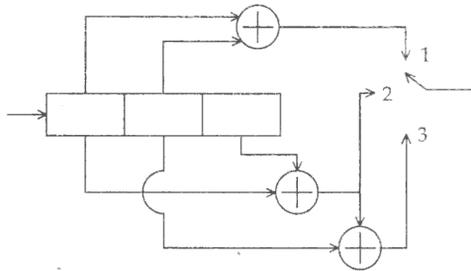
(i) Determine its rate, constraint length and generators.

(ii) Determine its state diagram and transfer function.

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