III B.Tech. I Semester Regular Examinations, November -2005
COMMUNICATION THEORY
(Information Technology)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. Draw the transfer characteristics of an idealized low pass filter and an idealized band pass filter with pass band from f_1 to f_2. Explain why these filters cannot be realized physically. [16]

2. (a) Write the relation between probability density function and cumulative distribution function of a random variable (8)
   (b) Consider a probability density f (x)=a $e^{-b\,|x\,|}$ where x is a random Variable whose allowable values range from x= -∞ to x= +∞ Find
      i. The relationship between a and b.
      ii. the cumulative distribution function F (x).
      iii. The probability that the random variable x lies between 1 and 2.
   (c) Explain the concept of stationary and bring out the requirements for a process to be termed as weakly stationary. [2+8+6]

3. (a) Describe principle of VSB transmission. What are its advantages over SSB.
   (b) Explain the working of phase-shift method of suppressing the unwanted side band. [8+8]

4. (a) Explain with a diagram the operation of limiter circuit for FM demodulation.
   (b) Explain analytically how do the AM and narrow-band FM differ from each other. Show that the average power of FM is constant. [8+8]

5. (a) Define the terms: time division multiplexing and demultiflexing, synchronization and explain their importance in digital signalling.
   (b) What are the limitation of delta modulation and how they can be rectified in ADM. [8+8]

6. (a) What is sampling? Explain the need for sampling and hence discuss various types of sampling.
   (b) Explain clearly the process of sampling for low pass signals and derive conditions for optimum reconstruction of signal. [8+8]

7. (a) A discrete memoryless source outputs 3 symbols x1, x2, x3 at a rate of 20 symbols/sec., with probabilities of $^1/_4$, $^1/_4$, $^1/_2$ respectively. Find the entropy and information rate. Derive the required relation.

(b) Show that the channel capacity of an ideal additive white Gaussian noise channel with infinite bandwidth is given by C = 1.44 S/ η, where S is the average signal power, and $\eta/2$ is the noise power spectral density. [8+8]

8. Consider a (7,4) hamming code with the generator matrix G as given below.

$$G = \begin{vmatrix} 1 & 1 & 0 & 1 & 0 & 0 & 0 \\ 0 & 1 & 1 & 0 & 1 & 0 & 0 \\ 1 & 1 & 1 & 0 & 0 & 1 & 0 \\ 1 & 0 & 1 & 0 & 0 & 0 & 1 \end{vmatrix}$$

(a) Construct the parity check matrix H and syndrome matrix, s

(b) Generate all possible code words.

(c) Generate the decoding table. [4+8+4]

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1. (a) What is meant by the strength of an impulse? Discuss its importance in communications.
   (b) Evaluate the following u(t) × u(t): [10+6]
2. (a) What is meant by autocorrelation. Explain with example.
   (b) Prove that the power spectral density and the correlation function of a periodic waveform are a Fourier transform pair. [8+8]
3. (a) Explain the working of balanced modulator with the help of circuit diagram.
   (b) An AM produces 10kw when the modulation percentage is 75. How much of this is carrier power? What would be the percentage power saving if the carrier and one of the sidebands were suppressed. [8+8]
4. (a) Explain the working of Foster-Seely discriminator for FM demodulation.
   (b) Explain with the help of block diagram, the working of Armstrong method for FM generation. [8+8]
5. (a) Define the terms: time division multiplexing and demultiflexing, synchronization and explain their importance in digital signalling.
   (b) What are the limitation of delta modulation and how they can be rectified in ADM. [8+8]
6. (a) State and prove sampling theorem in case of how pass signals.
   (b) If a signal is naturally sampled with a sample width z and with frequency w_s rad/sec. Obtain the expression for Bandwidth. [8+8]
7. (a) The voice frequency-modulating signal of a PCM system is quantized in 16 levels with the following probabilities,
   $P_1 = P_2 = P_3 = P_4 = 0.1$
   $P_5 = P_6 = P_7 = P_8 = 0.05$
   $P_9 = P_{10} = P_{11} = P_{12} = 0.075$
   $P_{13} = P_{14} = P_{15} = P_{16} = 0.025$
   Find the information rate taking the band limiting frequency of the modulating signal at 3 KHz.
   (b) Derive the capacity for binary symmetric channel. [8+8]
8. The generator polynomial of a (15,11) hamming code is defined by g(X) = 1+X+X^4. Develop the encoder and syndrome calculator for this code, using a systematic form for the code. Find all code vectors. [16]

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1. (a) Find the Fourier transform of sin ω_ot and Compare with the transform of cos ω_ot. Plot and compare the power spectral densities of cos ω_ot and sin ω_ot.
   (b) State and prove the conditions required for existence of Fourier transform of a non-periodic signal. [8+8]

2. (a) If A $\in$ B then prove P (A) $\leq$ P (B) in probability theory
   (b) Find the mean and variance of a random variable having the following Pdf: P (x) = 3 $e^{-6\ |x\ |}$, $-\infty < X < \infty$
   (c) Calculate the power spectral density of a stationary random process For which autocorrelation is R_{xx} (t) = σ^2 $e^{-\alpha\ |t\ |}$ [2+6+8]

3. (a) What is the need for modulation? Derive the relation between the ouput power of an AM transmitter and depth of modulation. Give output power in case of critical modulation.
   (b) The ouput RMS current of 60% modulated AM generator is 1.5 A. To what values will this current rise if the generator is modulated additionally, by another audio wave whose modulation index is 0.7? What will be the percentage power saving if the carrier and one of the side bands are now suppressed?[8+8]

4. (a) What are the advantages and disadvantages of FM over AM.
   (b) Explain the working of Fooster-seely discriminator for FM demodulation.[8+8]

5. (a) Explain the concept of quantization of sampled signal and hence discuss the merits and demerits of it.
   (b) Give the block diagram for PCM generation and reception and discuss the features of each block. [6+10]

6. (a) What is sampling? Explain the need for sampling and hence discuss various types of sampling.
   (b) Explain clearly the process of sampling for low pass signals and derive conditions for optimum reconstruction of signal. [8+8]

7. Establish the following:
   (a) H (Y, Z/X) = H(Y/X) + H(Z/X) with equality iff P(y_j Z_k / X_I) = P(y_j / x_I) $\times$ P(Z_k / X_I) for all i,j,k.
   (b) H (Y, Z/X) = H(Y/X) + H(Z/X,Y)

(c) H (Z/X,Y) $\leq$ H(Z/X). [8+4+4]

8. (a) With reference to coding techniques, define and explain the following terms:
   i. systematic code
   ii. parity check matrix
   iii. syndrome .

   (b) Classify the different types of error control coding techniques, and distinguish between them. [8+8]

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Code No: RR311202 **Set No.4**

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1. The waveform v(t)=$e^{-t/\tau}$ u(t) is passed through a high-pass RC circuit having a time constant equal to τ.
   (a) Find the energy spectral density at the output of the circuit.
   (b) Show that the total output energy is one half the input energy. [8+8]

2. (a) A random variable X has the Probability function given by:
   x: -2 -1 0 1 2 3
   y: 0.1 k 0.2 2k 0.3 3k
   Evaluate P (X < 2) the mean of X and variance of X
   (b) Show that if a Gaussian Process is Stationary than it is strictly stationary [8+8]

3. (a) Compare various methods of SSB.
   (b) A 400-W carrier is modulated on a depth of 75%. Calculate the total power in the modulated wave in [8+8]
      i. AM
      ii. DSB-SC
      iii. SSB-SC.

4. (a) Explain the indirect method of FM generation with relevant diagrams.
   (b) A 500Hz modulating voltage fed to a PM generator produces a frequency deviation of 2.25KHz. What is the modulation index, if the amplitude of the modulating voltage is kept constant but its frequency is raised to 6KHz? Determine the modified frequency deviation. [8+8]

5. (a) Explain the concept of quantization of sampled signal and hence discuss the merits and demerits of it.
   (b) Give the block diagram for PCM generation and reception and discuss the features of each block. [6+10]

6. (a) Explain the principle of pulse time modulation and obtain relation between the magnitude of low pass signal and the pulse repetition time T and pulse width τ of pube carries.
   (b) Give the block diagram to generate pube position modulation and explain its working. [8+8]

7. (a) Obtain the channel capacity of the binary symmetric channel shown in Figure 1. Take P (x_1) = α, and P (x_2) = 1 - α. What happens, if p = 0 or 1 or 1/2

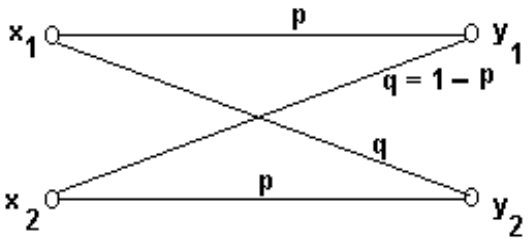

Figure 1:

(b) For a lossless channel with m inputs of x, and m outputs of y, show that the conditional entropy H (X/Y) = 0. [10+6]

8. Write short notes on:

(a) Cyclic redundancy codes

(b) BCH codes

(c) Reed Solomon codes. [6+5+5]

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