Seat No.: _____ Enrolment No._____

# GUJARAT TECHNOLOGICAL UNIVERSITY

**M.E Sem-I Examination January 2010**

**Subject code: 710203 Subject Name: Information Theory and Coding**

**Date: 25 / 01 / 2010** **Time: 12.00- 2.30 pm**

**Total Marks: 60**

## Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Symbols and notations have conventional meaning unless stated.**
4. **Figures to the right indicate full marks.**

**Q.1** **(a)** Give the properties of a PDF (probability density function) and show that a normal (Gaussian) PDF satisfies those properties. **06**

**(b)** Explain the characteristic function of a RV (random variable) and its properties. If two RVs X and Y are statistically independent and Z=X+Y then show the relation between the characteristic functions of the given RVs X, Y and Z. **06**

**Q.2** **(a)** Explain mean and variance of an RV. If X is a Poisson's RV then determine the mean and variance of X. **06**

**(b)** If RVs X and Y are statistically independent and have circularly symmetrical joint PDF then show that X and Y are normal RVs with zero mean and equal variance. **06**

**OR**

**(b)** If X is a uniform RV distributed over an interval $(-\pi/2, \pi/2)$ and Y=sin X, then determine the PDF of Y. **06**

**Q.3** **(a)** Explain the spectral representation of a continuous time random process x(t) using the autocorrelation function and Fourier transform. **06**

**(b)** Explain the filtering of a random process showing the relations between the input-output auto-correlation functions, and corresponding spectral densities using the filter impulse response h(t) and its Fourier transform $H(\omega)$. **06**

**OR**

**Q.3** **(a)** If the continuous time processes x(t) and y(t) are correlated then explain how a filter response h(t) can be estimated such that the processes x(t) and y(t) behave as the input and output of the estimated filter. **06**

**(b)** Consider the discrete time processes x[n] and y[n] are such that y[n]=h[n]*x[n], where h[n] is the impulse response of a linear shift invariant filter, and * operator denotes convolution sum. Explain the estimation of inverse of the filter h[n]. Also explain the required conditions in order to have a stable inverse filter. **06**

**Q.4** **(a)** Explain information and entropy in the context of a discrete message source. Also give various units of information and entropy. **06**

**(b)** A source produces a sequence of symbols selected from the letters A, B, C and D with probabilities 0.5, 0.25, 0.125, and 0.125, respectively. Determine the maximum number of the symbols that can be transmitted per minute on a channel with the capacity of 350 K-bits per second. **06**

**OR**

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|---|---|---|---|
| **Q.4** | **(a)** | Explain Kraft's inequality and its significance in coding. | **06** |
| | **(b)** | A source produces a sequence of symbols selected from the letters A, B, C and D with probabilities 0.5, 0.25, 0.125, and 0.125, respectively. Determine Shannon-Fano code for encoding the source effectively using the binary alphabets. | **06** |
| **Q.5** | **(a)** | Explain Hamming distance. Tabulate Hamming distance between binary words 0011, 1001, 1010, and 1100. Identify the pair with the maximum Hamming distance. | **06** |
| | **(b)** | Explain convolution codes with an example. | **06** |

**OR**

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| **Q.5** | | Write short-notes on the following. | |
| | **(a)** | JPEG- an image compression format. | **06** |
| | **(b)** | Cryptography. | **06** |

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