BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)

CLASS: M.TECH **SEMESTER : I**
BRANCH: ECE **SESSION : MO/18**

SUBJECT: EC512 STOCHASTIC PROCESSES AND INFORMATION THEORY

TIME: 3 HOURS **FULL MARKS: 50**

INSTRUCTIONS:
1. The question paper contains 5 questions each of 10 marks and total 50 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
***4*. Before attempting the question paper, be sure that you have got the correct question paper.**
5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

Q.1(a) State and derive an expression for power spectral density and its properties. [5]

Q.1(b) Explain wide sense stationary random processes. Sate the condition for two random vectors X and Y are independent and uncorrelated. [5]

Q.2(a) Define entropy for continuous and discrete random variable. A binary memory less system produces two messages with probability p and 1-p. Show that the entropy is maximum when both messages are equiprobable. [5]

Q.2(b) Consider a BSC with $P(x_1)$ = α [5]

(a) Prove that the mutual Information I(X;Y) is given by

$$I(X;Y) = H(Y) + p\log_2(p) + (1-p)log_2(1-p).$$

(b) Compute I(X;Y) for α=0.5 and p=0.1

(c) Repeat (b) for α=0.5 and p=0.5 and Comment on the result.

Q.3(a) Prove that the information capacity of a continuous channel of bandwidth W hertz, perturbed by additive Gaussian noise of power spectral density $N_0/2$ is given by $C = W\log_2\left(1+\frac{P}{N_0W}\right)$ bits/sec. [5]

Q.3(b) State and Explain Source Coding and Channel Coding theorem. [5]

Q.4(a) Explain the importance of rate distortion theory. [5]

Q.4(b) Derive the expression of rate distortion function for Gaussian as well as Binary symmetric source and comments over the sketch of rate distortion function for both sources. [5]

Q.5(a) For the AWGN multiple access channel, prove, using typical sequences, the achievability of any rate pairs ($\mathbf{R_1}$, $\mathbf{R_2}$) satisfying [5]

$$\boldsymbol{R_1 < \frac{1}{2}\log\left(1+\frac{P_1}{N}\right),}$$

$$\boldsymbol{R_2 < \frac{1}{2}\log\left(1+\frac{P_2}{N}\right),}$$

$$\boldsymbol{R_1 + R_2 < \frac{1}{2}\log\left(1+\frac{P_1+P_2}{N}\right).}$$

Q.5(b) Write short notes on Broadcast Channel and Relay Channel. [5]

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