BENGAL ENGINEERING AND SCIENCE UNIVERSITY, SHIBPUR
M.E. 1st SEMESTER (CST) FINAL EXAMINATIONS, 2011

Information and Coding Theory (CS 907)

Full Marks: 70 **Time: 3 hrs**

Answer any five questions, taking at least two from each group. All questions carry equal marks.

Part - A (Information theory)

1. State and prove Kraft inequality. What do you understand by optimality of source coding? Argue whether Shannon-Fano code is an optimal source coding scheme. Explain analytically how the optimality of source coding affected by distortions over the channel.
   3+3+3+5

2. Show analytically how the probability of error is related to the channel capacity. Justify in lines of Shannon whether it is possible to achieve reliable transmission through an unreliable channel without compromising the rate of message transmission.
   6+8

3. How is an information channel characterized? Obtain the channel matrix for a binary symmetric channel and its extensions. Find the probability of an undetected error in the Hamming code whose parity check matrix is given in Q-5 when the channel distortion probability is 10^{-2}.
   4+4+6

4. Write short notes on the following: (a) Entropy of Markov source (b) Mutual information (c) Instantaneous and uniquely decodable codes.
   5+4+5

Part - B (Coding theory)

5. Explain the concept of dual code C_d for a n, k linear code C. Given the parity check matrix $H = \begin{bmatrix} 1 & 0 & 0 & 1 & 0 & 1 & 1 \\ 0 & 1 & 0 & 1 & 1 & 1 & 0 \\ 0 & 0 & 1 & 0 & 1 & 1 & 1 \end{bmatrix}$ draw the syndrome computation circuit. Show how the minimum distance of linear block code can be examined from the parity check matrix and hence explain how BCH codes are able to correct multiple errors.

   4+4+6

6. State and prove the main properties of the generator polynomial of a cyclic code. Explain with proper proof how the cyclic code can be generated in systematic form. For a (7,4) cyclic code obtain the codeword corresponding to the message $u(X) = 1 + X^2 + X^3$ in both ordinary and systematic forms.

   5+5+4

7. Obtain the generator polynomial of 2 error correcting code in GF(2^4) with primitive element α. Suppose you received the word $r(X) = 1 + X^3 + X^4 + X^8 + X^9 + X^{11}$ for this code with possibly two random errors. Obtain the syndrome. Verify which of the following is the valid error pattern: (a) $X^5 + X^9$, (b) $X^6 + X^{10}$, (c) $X^7 + X^{10}$. Now complete the decoding by obtaining the valid codeword.

   4+5+3+2

8. Explain mathematically the following:

   - (a) Burst error correction in cyclic codes
   - (b) Syndrome based decoding of BCH codes
   - (c) Standard array based decoding scheme

   5+5+4