**SEMESTER: WINTER SESSION: 2014-15**

**Examination: M.Tech (CSE-IS) Time: 03 Hours Max Marks: 100**

**Subject: Information Theory & Coding (CSC52103)**

**Instructions:** Answer any **FIVE** questions. Answer all parts of any Question at one place.

Assume suitable data wherever not provided.

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| **1.** | **a.** | Define Hamming distance and Hamming weight with examples. State the Hamming distance decoding rule. | **2+2** |
| **b.** | Consider the following (3,2) channel code:   |  |  | | --- | --- | | **Message** | **Codeword** | | 00 | 000 | | 01 | 001 | | 10 | 011 | | 11 | 111 |   Suppose the erroneous received words are 010, 100, 101 and 110 respectively. Determine which received word(s) is/are possible to correct according to the Hamming distance decoding rule. | **4** |
| **c.** | Show that the entropy of a Gaussian distribution with mean **and variance **isnats. | **5** |
| **d.** | Suppose *X* is a random variable that takes on values from *M*-letter alphabet with finite entropy. Show that. | **7** |
| **2.** | **a.** | Encode the following sequence using the LZ77 algorithm: ***cabracadabrar***  Assume you have a window size of ***13*** with a look-ahead buffer of size ***6***. Also decode the encoded message to make sure that you have obtained the correct sequence. Write down the merits and demerits of LZ77 algorithm over LZ78 algorithm. | **5+3+3** |
| **b.** | Which features causes video compression quite different from still image compression? Describe the Three-Step Search (3SS) fast motion estimation algorithm with a suitable example. Also explain in what extent it reduces the overall processing cost compares to the full search mechanism. | **2+5+2** |
| **3.** | **a.** | Suppose a binary channel correctly transmits a 0 (as a 0) twice as many times as transmitting it incorrectly (as a 1) and correctly transmits a 1 (as a 1) three times more often than transmitting it incorrectly (as a 0). The input to the channel can be assumed equiprobable.  Find the following:   1. What is the channel matrix? Sketch the channel. 2. Calculate the output probabilities. | **2+1+3** |
| **b.** | Define channel capacity. Determine the channel capacity of the channel as shown below where each input symbol is equiprobable. | **1+5** |
| **c.** | Explain the importance of Shannon limit. For a continuous channel show that the channel capacity is when bandwidth approaches infinity, where *P* is average signal power and *N0* is power density spectral of noise. | **2+6** |
| **4.** | **a.** | Show that a block code corrects upto *t* errors iff its minimum distance is greater than *2t*. | **5** |
| **b.** | State the properties for a linear block code.  Given the (7,3) linear code with generator matrix    Find the following:   1. Determine a systematic form of G. 2. Find the parity-check matrix. 3. Show the relation between the generator matrix and the parity-check matrix. 4. Verify using the parity-check matrix whether the received word 1101101 is either valid codeword or not. 5. Find all codewords of the code. | **3+3+2+2+2+3** |
| **5.** | **a.** | Define the generator polynomial of a cyclic code? Prove that the nonzero code polynomial of minimum degree in a cyclic code, *C* is unique. | **2+5** |
| **b.** | Given the *(7,4)* cyclic code with  determine systematic codeword polynomial for the information polynomial  Also determine the parity check polynomial. | **3+2** |
| **c.** | Describe LFSR based cyclic code encoding process with a suitable example. | **8** |
| **6.** | **a.** | Determine whether the polynomials    over GF(2) are (i) irreducible and (ii) primitive. Justify your answer. | **6** |
| **b.** | Given the polynomial  over GF(2), construct the field GF(23) and therefore find the roots of . | **6** |
| **c.** | Describe the construction process of BCH codes. Given that the minimal polynomials of and  over GF(24) are respectively. Construct a binary BCH code over GF(24) for (i) single error correcting and (ii) double error correcting. Also determine the code’s information length of each code. | **3+2+3** |