Communication Theory 2 (6 CFU): 5th of April, 2012 [Prof. P. Migliorati, Univ. of Brescia]

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Questions

1. A block code with $N = 7$ is characterized by the generator polynomial: $g(D) = (D + 1)(D^3 + D + 1)$.
   - Determine the value of K, the number of possible codewords and the minimum distance.
   - Is this code a cyclic code ?
   - Consider now a Hamming code with $N = 127$. Determine the error probability in case of both hard (use the more precise estimation) and soft decoding.
2. Consider a convolutional code with $R = 1/3$, and octal generators $(2, 3, 1)$.
   - Determine and draw the state diagram of the coder.
   - The received sequence (hard decision) is equal to: $000, 110, 010, 110, 011, 110, 101, 011, 000$. Determine, applying the Viterbi algorithm, the maximum likelihood transmitted sequence (related to information bits).
   - Determine the bit-error probability (considering at least 3 non zero terms in the union bound), and the minimal bandwidth required in case of an information bit-rate equal to 10 Mbit/sec.
3. Turbo Codes
   - Indicate the detailed block diagram of a turbo decoder, indicating clearly the significance of the used symbols.
   - Describe the curve that represents the performance (P(E) as a function of Eb/No) of a turbo code, indicating the role of the iterations and of the interleaver.
4. OFDM
   - Describe the analytical expression of an OFDM symbol and the block diagram of an OFDM encoder.
   - Indicate the main advantages and disadvantages of the OFDM modulation systems.
5. DSSS-CDMA
   - Describe why and when a DSSS modulation system is robust against multi-path fading.
   - Describe the basic idea of the Rake Receiver, indicating also why this is working properly in the case of DSSS modulation.
6. CPM
   - Demonstrate that the MSK can be interpreted as a binary FSK modulation system.