Communication Theory 2 (6 CFU): 11th of September, 2012 [Prof. P. Migliorati, Univ. of Brescia]

Surname, Name, Matr.: ..... Signature: .....

Questions

1. Design a (6, 2) cyclic code by choosing the shortest possible generator polynomial[1].
   - Determine the generator matrix G (in the systematic form) for this code and find all the possible codewords.
   - How many errors can be corrected by this code ?
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.
   - Describe the channel equalization procedure performed in 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.
   - Describe the major strategies used to simplify the CPM receivers.

[1] Hint: $D^6 + 1 = (D + 1)^3 \cdot (D + 1)^3 = (D + 1) \cdot (D + 1) \cdot (D^2 + D + 1) \cdot (D^2 + D + 1)$.