FACULDADE DE CIÊNCIAS E TECNOLOGIA
UNIVERSIDADE NOVA DE LISBOA
Departamento de Engenharia Eletrotécnica
Telecommunications Section

Preparation Exercises for the 2nd Test, for the class of May 16, 2018

1. You have a channel with a bandwidth of 2MHz. What is the maximum data rate that is possible to achieve using symbols with 4 discrete levels? Is it possible to get this maximum rate using a Manchester code (used in classic Ethernet)? Justify your answer.

2. Consider that in a CDMA (Code Division Multiple Access) network nodes A, B, C and D use the codes C_A = -1-1-1+1+1-1+1+1 C_B = -1-1+1-1+1+1+1-1 C_C = -1+1-1+1+1+1-1-1 C_D = -1+1-1-1-1+1-1.
   a) Show the sequence of chips that is effectively transmitted in the channel when node A wants to transmit bit 0 and node D wants to transmit bit 1. Nodes B and C do not intend to transmit. Display all the calculations you made.
   b) What is the maximum binary transmission rate (in bps) achievable by each node with a chip duration of 1/8 X 10^{-9} s?

3. Imagine that you want to implement a new digital voice transmission system using TDM (Time Division Multiple Access). As in conventional systems, each voice channel uses a bandwidth of 4 kHz, and 16 bits are used to encode each voice sample. Two hierarchical levels of multiplexing will be used to carry voice over trunks:
   - The first hierarchical level consists of 10 voice channels plus 10 signalling bits per frame;
   - The second hierarchical level consists of 10 first hierarchical level circuits plus 200 signalling bits per frame.

   What is the binary data rate that is necessary to allocate in the network to carry the signals of the first hierarchical level and second hierarchical level circuits described above?

4. You are using a code with the following set of four words:
   W_1= 00000000 W_2= 00001111 W_3= 11111111 W_4= 11110000
   How many errors can this code correct? And how many can it detect?

5. A data link layer uses Hamming codes for error correction. Assuming that the transmitter wants to send the message "10011", determine which bits are actually sent. Admit even parity and present all calculations performed.

6. We want to transmit a frame that is eight bit long (could be bigger but you would be answering this question during the entire test duration). We want to use the generator polynomial **G(x)=x4+x3+1**. We also want to use "**flag bits with bit stuffing**". Write the bit sequence that is transmitted.
   `Frame = 1 0 0 1 1 0 1 1`

7. The third-generation cellular system (3G) has two very serious problems that had to have solutions: lack of synchronism of the mobile devices, and the power level that they emit. Explain why these two problems are in fact so severe in the 3G systems, and how they were solved.