# INFORMATION & CODING THEORY

# 2019

1. Describe the discrete memoryless source model (sampling, optimal Lloyd Max quantization …etc.).
2. Derive the Nyquist criterion for ISI free communication over band limited channels.
3. Describe the memoryless channel model (AWGN channel and BSC), derive the bit error probability as a function of the signal-to-noise ratio.
4. Define and describe the properties of entropy, joint entropy, conditional entropy and mutual information.
5. Define the typical set of an IT source (AEP) and derive its properties.
6. Define the properties of uniquely decodable codes, and discuss the source coding theorem.
7. Describe the Shannon-Fano, Huffman, and arithmetic coding and discuss there performance.
8. Describe the LZ based compression algorithm.
9. Describe the channel coding theorem, and define the channel capacity and elaborate on its calculation for symmetric channels.
10. Define and explain the relationship between the following properties and parameters of error correcting codes
    - minimum code distance;
    - code-length and message-length versus performance (Singleton and Hamming bounds);
    - general algorithmic complexity of coding with tables
11. Introduce the concept of linear block coding and explain the meaning of
    - systematic codes
    - generator matrix and parity check matrix (and their relationship)
    - algorithmic complexity of linear block coding (including detection).
12. Give the construction of *bin*ary Hamming codes (define the corresponding matrices and the error correcting capability)
13. Describe the Reed Solomon codes (generator matrix, parity check matrix, performance)

14. Describe the steps of the Error Trapping Algorithm for error detection in the case of cyclic codes

15. Describe the cyclic RS codes (generator polynom, parity check polynom, implementation)

16. Describe the CDMA/FH system and the CDMA/DS system with Walsh-Hadamard codes and with random codes

17. Describe the OTP method and RSA algorithm for cryptography