COMMUNICATION ENGINEERING AND ELECTRONIC TECHNOLOGIES

(Lecce - Università degli Studi)

Teaching DIGITAL TRANSMISSION THEORY

GenCod A003094

Owner professor Francesco BANDIERA

Teaching in italian DIGITAL TRANSMISSION THEORY

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SSD code ING-INF/03

Reference course COMMUNICATION ENGINEERING AND ELECTRONIC

Course type Laurea Magistrale

Credits 9.0

Teaching hours Ore-Attivita-frontale: 81.0

For enrolled in 2019/2020

Taught in 2019/2020

Course year 1

Language INGLESE

Curriculum PERCORSO COMUNE

Location Lecce

Semester Secondo-Semestre

Exam type Orale

Assessment Voto-Finale

Course timetable https://easyroom.unisalento.it/Orario

BRIEF COURSE DESCRIPTION

The course aims to provide students with the necessary knowledge about the systems for transmission and reception of information in digital form and over a real communication channel.

REQUIREMENTS

Sufficiency in Statistical Signal Processing

COURSE AIMS	**Learning Outcomes**. ***Knowledge and understanding*** After the course the student should understand the following aspects of digital communication systems * Performances of modulation formats. * Channel capacity and channel coding techniques. * Equalization techniques for band-limited channels. * Countermeasures against Fading channels ***Applying knowledge and understanding*** After the course the student should be able to * Compute the probability of error of a digital modulation scheme. * Design optimum and sub-otimum receivers for digital communications. * Design adaptive equalizers to combat intersymbol interference and fading. ***Making judgements*** Students should acquire the ability to compare pros and cons of different approaches to the solution of a specific problem through examples and problems. ***Communication*** The ability to communicate on technical topics should be acquired by discussing in a rigorous way not only concepts and tools of digital communications, but also the adopted solution to a specific problem. ***Learning skills*** Selected problems will be proposed that require elaborating on introduced concepts and methods, also with the help of selected readings suggested by the instructor (from the list of references). Identifying solutions to non trivial problems will be important to be ready for autonomous lifelong learning.
TEACHING METHODOLOGY	Classroom lectures given by the instructor using the board.
ASSESSMENT TYPE	Oral. The student must answer to 3 questions about the entire course syllabus; each question is worth 10/30 for a total of 30/30. Examination time is between 30 and 60 minutes.
OTHER USEFUL INFORMATION	**Office Hours:** By appointment; contact the instructor by E-Mail (*francesco.bandiera@unisalento.it*), Telegram (*@francescobandiera*) or at the end of class meetings.

FULL SYLLABUS	**Course Contents** Part I – Introduction. Summary about digital modulation schemes. Linear modulations (PAM, PSK, QAM) and orthogonal modulations (FSK, PPM). Bandwidth efficiency, power efficiency, comparisons. Probability of error of M-PAM and M-FSK. Union bound on the probability of error. Non coherent FSK: optimum receiver design and bandwidth requirements. Qualitative performance assessment. (11 hours). Part I - Channel Capacity and Channel Coding. Channel models and capacity. Channel coding theorem. Linear block codes. Hamming codes. Cyclic codes. Performance analysis of coded systems. Hard and soft decoding. Interleaving. Convolutional Codes. Block-diagram of the encoder. Representations: tree, trellis, state-diagram, transfer function. Decoding: maximum likelihood sequence detector and Viterbi algorithm. Performance analysis with soft and hard decisions decoding. (30 hours) Part III - Digital Transmission over real channels. Design of communication systems for the bandlimited channel. Channel models. Inter Symbols Interference (ISI). Nyquist criterion and eye diagram. Equalization. The optimum receiver for channels with ISI: maximum likelihood sequence detector and Viterbi algorithm revisited. Performance analysis. Linear equalization methods: zero forcing (ZF) and minimum mean squared error (MMSE). Performance analysis. Non linear equalizers (decision-feedback). Adaptive Equalization. Adaptive linear equalizers: ZF, least mean squares (LMS), recursive least squares (RLS). Convergence properties and performance analysis. Blind equalization: maximum likelihood, per survivor processing, multiple signals classification (MUSIC). Digital Transmission over Multipath Fading Channels. Channel Models and classification. Channel selectivity in time and/or frequency. Transmission of digitally-modulated signals over the flat/flat channel: diversity reception techniques and performance analysis. Digital transmission over the frequency-selective fading channel: RAKE receiver and its performance. Adaptive implementations. (40 hours)
REFERENCE TEXT BOOKS	[1] J. G. Proakis, "Digital Communications", McGraw Hill, 4th Ed., 2004. [2] J. M. Wozencraft, I. M. Jacobs, "Principles of Communication Engineering," Waveland Press (reprint 1990). Other useful references - J. G. Proakis M. Salehi, "Digital Communications," McGraw Hill, 5th Ed., 2008. - T. M. Cover, J. A. Thomas, "Elements of Information Theory," Wiley, 1991. - A. H. Sayed, "Fundamentals of Adaptive Filtering," John Wiley and Sons, 2003. - V. Pless, "Introduction to the Theory of Error-Correcting Codes," Wiley, 1998. - Scientific papers highlighted by the instructor.