



**UNIVERSITÀ
DEL SALENTO**

CORSO DI LAUREA LM65 -

CdLM Communication Engineering and Electronic Technologies

**SCHEDE INSEGNAMENTI DIDATTICA PROGRAMMATA
a.a. 2020/2021**



SCHEDA INSEGNAMENTO

ELECTRONIC AND PHOTONIC DEVICES

Corso di studio di riferimento	LM65 - CdL Magistrale in Communication Engineering and Electronic Technologies
Dipartimento di riferimento	Dipartimento di Ingegneria dell'Innovazione
Settore Scientifico Disciplinare	ING-INF/01
Docente	Massimo DE VITTORIO
Crediti Formativi Universitari	6
Ore di attività frontale	54
Ore di studio individuale	96
Anno di corso	I anno
Semestre	I
Lingua di erogazione	Inglese
Percorso	PERCORSO COMUNE

Prerequisiti	Background on solid state physics is recommended
Contenuti	<p>The course deals with the working principle of the most important electronic devices (diodes, bipolar junction transistor, CMOS technology ...) and photonic devices (LED, Laser, optical fibers, photovoltaic devices ...).</p> <p>It is organized in the following parts:</p> <ul style="list-style-type: none">- Introduction on the solid state physics, energy bands and current transport mechanisms in semiconductors.- Two terminal and three terminal electronic devices (p-n and Schottky junction diodes, bipolar transistors and MOSFETs- light emitting and detecting photonic devices <p>The course also includes lectures on simulation of devices behavior.</p>
Obiettivi formativi	<p>Knowledge and understanding. Students must have a background in electromagnetic fields and waves and basic background in material science:</p> <ul style="list-style-type: none">- the students must have the basic cognitive tools to understand semiconductor crystals and their electronic properties and apply this to understand how electrons move and distribute in a semiconductor device;- they must have a solid knowledge of the electromagnetic waves and fields;- they must be able to understand electric fields, potentials and voltages and electrostatic properties of materials;- They must have a basic knowledge of electronic circuits, passive and active two- and three-terminals electronic devices.



	<p>Applying knowledge and understanding . After the course the student should be able to:</p> <ul style="list-style-type: none">- understand what are the carrier transport, absorption and recombination mechanisms in semiconductor devices;- understand how an electronic device works and what are the key parameters to design an efficient two terminal or three terminal electronic devices;- design a LED or Laser device for different photonic applications;- understand and design a photodetector. <p>Making judgements. Students are guided to learn critically everything that is explained to them in class, to understand the behavior of the state of the art technologies for electronic and photonic devices and to design new devices.</p> <p>Communication. The students will be stimulated to be able to communicate with a varied and composite audience, not culturally homogeneous, in a clear, logical and effective way, using the methodological tools acquired and their scientific knowledge and, in particular, with and professional and scientific vocabulary.</p> <p>Learning skills. Students must acquire the critical ability to understand the behavior of devices at the nanoscale. They should be able to develop and apply independently the knowledge and methods learnt with a view to possible continuation of studies at higher (doctoral) level or in the broader perspective of cultural and professional self-improvement of lifelong learning.</p>
Metodi didattici	The teaching of the course will make use of both the blackboard and projection of videos and slides. Simulation of devices will be also done by exploiting freely available online tools.
Modalità d'esame	Oral exam. The student is asked theoretical questions on each part of the course. During the discussion the student is asked to elaborate on the purpose of specific technological solutions in the design and fabrication of electronic devices and he/she is also asked to propose a different solution for a device with specific properties.
Programma	<p>Solid State Physics Physics of semiconductor materials, semiconductor technology, metal-semiconductor junction, p-n junction (12 hours).</p> <p>Semiconductor Electronic devices The Bipolar Junction Transistor (BJT), BJT working principle, BJT static and dynamic I-V characteristics, Models for BJT, The MOS Transistors and system, current-voltage characteristics of a MOSFET, MOSFET small and large signal models (22 hours).</p> <p>Photonic devices</p>



	Optical processes in semiconductors, the LED, the LASER, laser waveguide and resonant cavities, material gain, type of semiconductor lasers, optical detectors and photovoltaic devices (20 hours).
Testi di riferimento	[1] lecture notes [2] S.M. Sze, Semiconductor Devices: Physics and Technology, Bell Tel.Labs.Inc. [3] R.S. Muller-T.I. Kamins, Dispositivi Elettronici nei Circuiti Integrati, Boringhieri [4] Ghione G., Dispositivi per la Microelettronica, McGraw Hill.
Altre informazioni utili	



SCHEDA INSEGNAMENTO

MATHEMATICAL METHODS FOR ENGINEERING

Corso di studio di riferimento	LM65 - CdL Magistrale in Communication Engineering and Electronic Technologies
Dipartimento di riferimento	Dipartimento di Ingegneria dell'Innovazione
Settore Scientifico Disciplinare	MAT/05
Docente	Diego P=allara
Crediti Formativi Universitari	9
Ore di attività frontale	81
Ore di studio individuale	144
Anno di corso	I anno
Semestre	I
Lingua di erogazione	Inglese
Percorso	PERCORSO COMUNE

Prerequisiti	Prerequisites: Ordinary differential equations, multiple, line and surface integrals. Complex Analysis, linear algebra, elementary physics.
Contenuti	Measure theory. Theory of distributions. Elements of Functional Analysis. Complements on Ordinary Differential Equations. Equations of Mathematical Physics.
Obiettivi formativi	Aims and Scope: Concepts of advanced mathematical Analysis - Problem solving for ordinary and partial differential equations arising from physics or engineering.
Metodi didattici	Lessons and exercises
Modalità d'esame	Final examination: The final (written) exam consists in solving 2 exercises (8+8 points) and answering 2 theoretical questions (7+7 points) related with the topics of the course.
Programma	<p>Measure theory. (hours: 9) Positive measures. Measurable functions. Integral. Limit theorems in integration theory. Real and vector measures, total variation. Absolute continuity and singularity of measures. Image measure. Lebesgue's Measure in R^n. Product Measures and Fubini's Theorem. Parameters dependent integrals. Functions Gamma and Beta of Euler. Convolution.</p> <p>Functions of bounded variation (BV) and Riemann-Stieltjes Integral. (hours: 9) Pointwise and essential variation. Monotonous functions. Features of bounded variation functions. Absolutely continuous functions. Cantor's function. Definition and existence of the integral of Riemann-Stieltjes. Integral's properties. Hausdorff's measures. Self-similar fractals.</p>



	<p>Theory of distributions. (hours: 8) Definition and examples. Derivative of a distribution. Examples of Differential Equations in D'. Temperate distributions. Support of a Distribution, convolution. Fourier Transform in L^1, L^2, S, S'.</p> <p>Elements of Functional Analysis. (ore: 8) The spaces L^1, L^2. Banach and Hilbert spaces. Scalar products and induced norms, orthonormal bases. Fourier Series in L^2. Linear, continuous, compact Operators. Spectral Theory of Compact Self-adjoint Operators.</p> <p>Complements on Ordinary Differential Equations. (hours: 10) Sturm-Liouville theory for boundary value problems. Connections between boundary value problems and orthogonal developments. Differential Equations with analytical coefficients: regular case; Singular case and Frobenius theorem. Examples of Ordinary Differential Equations Solvable by Series: Equations of Bessel and Legendre.</p> <p>Equations of Mathematical Physics. (hours: 12) Examples of Partial Differential Equations solved by the method of separation of variables, by series developments and Fourier transform. Boundary value problems, initial value problems, and mixed problems. Heat equation in the strip, and in the whole space. Wave equation in one, two and three dimensions. Wave equation in the half-line and in an interval. Eigenvalues of Laplacean in the square, in the disc, in the ball. Hermite polynomials.</p>
Testi di riferimento	<p>References.</p> <p>M. Carriero, L. Anzilli: Introduzione alle Equazioni a Derivate Parziali Lineari, Quaderni di Matematica, 1/2015, ESE - Salento University Publishing. http://siba-ese.unile.it/index.php/quadmat/article/view/15679/13592</p> <p>S.Fornaro, D.Pallara, Appunti del corso di Metodi matematici per l'Ingegneria, web page of prof. Pallara.</p> <p>F. Tomarelli - Mathematical Analysis tools for Engineering, Società Editrice Esculapio, Bologna, 2019.</p> <p>F.Gazzola, F.Tomarelli, M.Zanotti: Analisi Complessa, Trasformate, Equazioni Differenziali, Società Editrice Esculapio, Bologna, III Ed., 2015. Eng. ver.: Analytic functions, Integral transforms, Differential equations, Esculapio, Bologna, II Ed., 2015.</p> <p>E.Kreyszig: Advanced engineering mathematics, John Wiley Sons, New York, 1993.</p> <p>A.N.Tichonov, A.A.Samarskij, Equazioni della fisica matematica, MIR, Mosca, 1981.</p> <p>A.N.Tichonov, A.A.Samarskij, B.M.Budak, Problemi della fisica matematica, MIR, Mosca, 1981.</p>
Altre informazioni utili	



SCHEDA INSEGNAMENTO

Statistical Signal Processing

Corso di studio di riferimento	LM65 - CdL Magistrale in Communication Engineering and Electronic Technologies
Dipartimento di riferimento	Dipartimento di Ingegneria dell'Innovazione
Settore Scientifico Disciplinare	ING-INF/03
Docente	Giuseppe Ricci
Crediti Formativi Universitari	9
Ore di attività frontale	81
Ore di studio individuale	144
Anno di corso	I anno
Semestre	I
Lingua di erogazione	Inglese
Percorso	PERCORSO COMUNE

Prerequisiti	Prerequisites: sufficiency in calculus, probability theory, and linear algebra.
Contenuti	Overview. This is a course in estimation and detection theory; it is aimed at providing principles and tools to solve problems in signal processing, radar, sonar, and communication. It will also serve as the necessary prerequisite for more advanced courses in communication engineering.
Obiettivi formativi	<p>Learning Outcomes.</p> <p>Knowledge and understanding After the course the student should understand the main aspects of estimation and detection theory and in particular *classical and Bayesian approaches to estimation; strategies to solve binary hypotheses tests (Neyman-Pearson, GLRT). *The Kalman filter and the extended Kalman filter and their use to solve simplified tracking problems.</p> <p>Applying knowledge and understanding After the course the student should be able to *formulate and solve parameter estimation problems and derive corresponding Cramer-Rao lower bounds. *Formulate and solve detection problems resorting to the optimum (i.e., Neyman-Pearson test or UMP test) if possible or to a suboptimum one (GLRT). *Evaluate the performance parameters and discuss complexity issues associated with different solutions.</p> <p>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.</p> <p>Communication</p>



	<p>The ability to communicate on technical topics should be acquired by discussing in a rigorous way not only concepts and tools of detection and estimation theory, but also the adopted solution to a specific problem.</p> <p>Learning skills</p> <p>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.</p>
Metodi didattici	Lectures, exercises, and computer projects. Problem--solving skills are of paramount importance and are gained via assigned homeworks.
Modalità d'esame	<p>Written exam. The exam consists of two cascaded parts (maximum overall duration: two hours and a half):</p> <p>the first part is closed book (suggested duration 50 minutes); the student is asked to illustrate two theoretical topics; it is aimed to verify to what extent the student has gained knowledge and understanding of the selected topics of the course and is able to communicate about his/her understanding (the maximum score for illustrating each topic is typically 5/30);</p> <p>the second part, that starts when the student has completed the first part, is open book and requires solving two (or three) problems; it is aimed to determine to what extent the student has: 1) the ability to identify and use data to formulate responses to well-defined problems, 2) problem solving abilities and the capacity to integrate different concepts and tools (the maximum score for the solution of each problem is typically 10/30 or 6-7/30 if the second part of the exam requires solving three problems).</p>
Programma	<p>Course Content.</p> <p>Introduction: examples of statistical reasoning (7 hours).</p> <p>Review of probability theory and rudiments of multivariate normal theory (7 hours). Solution to assigned problems (3 hours).</p> <p>Estimation Theory: Classical and Bayesian Parameter Estimators (ML, LS, WLS, ILS, MAP, MMSE, and LMMSE estimators). How to measure the performance of an estimator. Cramer-Rao bounds (17 hours). Solution to assigned problems (18 hours). Computer generation of random vectors and moment estimation (3 hours).</p> <p>Direction of arrival estimation: CML and MUSIC algorithm (3 hours). Matlab implementation of the MUSIC algorithm (3 hours).</p> <p>Application of LMMSE estimation to filtering and beamforming. Minimum variance and minimum power distortionless beamformers. Linearly constrained minimum variance and minimum power beamformers.</p> <p>Generalized sidelobe canceler (5 hours).</p> <p>Discrete-Time Kalman Filter. Extended Kalman Filter. Applications of Kalman Filter to tracking (8 hours).</p> <p>Steepest-descent algorithm: derivation and analysis. Least-mean-square algorithm: derivation and analysis (4 hours).</p> <p>Detection Theory: Neyman-Pearson Lemma, Testing of composite binary hypotheses, UMP tests, GLRT, Constant False Alarm Rate property (6 hours).</p> <p>Solution to assigned problems (2 hours).</p>



Testi di riferimento	<p>[1] Handouts (in progress).</p> <p>[2] L. L. Scharf, "Statistical Signal Processing: Detection, Estimation, and Time Series Analysis," Addison-Wesley, 1991.</p> <p>[3] H. L. Van Trees, "Detection, Estimation and Modulation Theory," Part. 1, John Wiley & Sons, 1968.</p> <p>[4] H. L. Van Trees, "Optimum Array Processing. Part. 4 of Detection, Estimation, and Modulation Theory," John Wiley & Sons, 2002.</p> <p>[5] S. M. Kay: "Fundamentals of Statistical Signal Processing: Estimation Theory," Volume I, Prentice-Hall, 1993.</p> <p>[6] S. M. Kay: "Fundamentals of Statistical Signal Processing: Detection Theory," Volume II, Prentice-Hall, 1998.</p> <p>[7] Y. Bar-Shalom, T. E. Fortmann, "Tracking and Data Association, Academic Press", 1988.</p> <p>[8] Y. Bar-Shalom, X., Rong Li, T. Kirubarajan, "Estimation with Applications to Tracking and Navigation. Theory Algorithms and Software," John Wiley & Sons, 2001.</p> <p>[9] S. Haykin, "Adaptive Filter Theory," Prentice-Hall, 1996.</p>
Altre informazioni utili	<p>Per ulteriori informazioni si rimanda all'url: https://www.unisalento.it/scheda-utente/-/people/giuseppe.ricci</p>



SCHEDA INSEGNAMENTO

DIGITAL TRANSMISSION THEORY

Corso di studio di riferimento	LM65 - CdL Magistrale in Communication Engineering and Electronic Technologies
Dipartimento di riferimento	Dipartimento di Ingegneria dell'Innovazione
Settore Scientifico Disciplinare	ING-INF/03
Docente	Francesco BANDIERA
Crediti Formativi Universitari	9
Ore di attività frontale	81
Ore di studio individuale	144
Anno di corso	I anno
Semestre	II
Lingua di erogazione	Inglese
Percorso	PERCORSO COMUNE

Prerequisiti	Sufficiency in Statistical Signal Processing
Contenuti	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.
Obiettivi formativi	<p>Learning Outcomes .</p> <p>Knowledge and understanding</p> <p>After the course the student should understand the following aspects of digital communication systems</p> <ul style="list-style-type: none">* Performances of modulation formats.* Channel capacity and channel coding techniques.* Equalization techniques for band-limited channels.* Countermeasures against Fading channels <p>Applying knowledge and understanding</p> <p>After the course the student should be able to</p> <ul style="list-style-type: none">* Compute the probability of error of a digital modulation scheme.* Design optimum and sub-optimum receivers for digital communications.* Design adaptive equalizers to combat intersymbol interference and fading. <p>Making judgements</p> <p>Students should acquire the ability to compare pros and cons of different approaches to the solution of a specific problem through examples and problems.</p> <p>Communication</p> <p>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.</p> <p>Learning skills</p>



	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.
Metodi didattici	Classroom lectures given by the instructor using the board.
Modalità d'esame	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.
Programma	<p>Course Contents</p> <p>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).</p> <p>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)</p> <p>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)</p>
Testi di riferimento	<p>[1] J. G. Proakis, Digital Communications, McGraw Hill, 4th Ed., 2004.</p> <p>[2] J. M. Wozencraft, I. M. Jacobs, Principles of Communication Engineering, Waveland Press (reprint 1990).</p> <p>Other useful references</p> <ul style="list-style-type: none">- J. G. Proakis M. Salehi, Digital Communications, McGraw Hill, 5th Ed., 2008.- T. M. Cover, J. A. Thomas, Elements of Information Theory, Wiley, 1991.



	<ul style="list-style-type: none">- 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.
Altre informazioni utili	Office Hours: By appointment; contact the instructor by E-Mail (< a href="mailto:francesco.bandiera@unisalento.it">francesco.bandiera@unisalento.it), Telegram (@francescobandiera) or at the end of class meetings.



SCHEDA INSEGNAMENTO

Microwaves

Corso di studio di riferimento	LM65 - CdL Magistrale in Communication Engineering and Electronic Technologies
Dipartimento di riferimento	Dipartimento di Ingegneria dell'Innovazione
Settore Scientifico Disciplinare	Ing-Inf/02
Docente	Luca Catarinucci
Crediti Formativi Universitari	9
Ore di attività frontale	81
Ore di studio individuale	144
Anno di corso	I anno
Semestre	II
Lingua di erogazione	Inglese
Percorso	PERCORSO COMUNE

Prerequisiti	Electromagnetic Fields
Contenuti	Microwave course is aimed at providing both theoretical and practical knowledge on the main aspects of microwave engineering. It also serves as the necessary prerequisite for more advanced courses in communication engineering.
Obiettivi formativi	after the course, the student should be able to <ul style="list-style-type: none">- Apply microwave analysis methods to determine the main properties of high-frequency circuits.- Apply knowledge on transmission lines and waveguides particularly for their use as elements in impedance matching and filter circuits.- Design an impedance matching network with either distributed or lumped elements through the Smith Chart.- Evaluate both analytically and experimentally the scattering parameters of N-Port microwave devices- Illustrate the main aspects of N-Port networks, microwave filters, and resonant cavities.
Metodi didattici	Frontal lessons, practical exercises, laboratory activities.
Modalità d'esame	Oral exam. The oral exam is aimed at verifying the knowledge and understanding of the course topics acquired by the student (maximum overall duration: 45 minutes).
Programma	(81 hours, of which 61 as frontal lessons, 12 as practical exercises, and 8 as laboratory activities) Introduction: the main differences between low-frequency and high-frequency circuits (2 hours frontal lesson). Transmission lines and waveguides: transmission lines theory. Smith chart. Line-Load matching through single and double stub techniques using the



	<p>Smith chart. Quarter-wave matching. Properties of the most PERCORSO COMUNE transmission lines: coaxial cable, microstrip line, coplanar stripline. Properties of the most PERCORSO COMUNE waveguides: rectangular, circular, and "ridge" (24 hours frontal lesson).</p> <p>Solutions of assigned exercises and practical examples of use of the Smith Chart. (12 hours practical exercitations).</p> <p>Microwave junctions. N-port junctions. Scattering matrix. 2-port, 3-port and 4-port cases. (8 hours frontal lesson)</p> <p>Microwave devices: functional description of the main passive components used in microwave circuits. Attenuators. Circulators. Dividers and combiners (Resistive, T-junction, Wilkinson). Directional couplers theory. Two-hole couplers. Branch-Line. Rat-Race. Magic-T. (12 hours frontal lesson)</p> <p>Resonant cavities: brief overview on resonant cavities. Rectangular and circular resonant cavities. Application as filters and frequency meters. (4 hours frontal lesson)</p> <p>Microwave filters: general information on Microwave filters. Main design techniques for a microwave filter. (6 hours frontal lesson)</p> <p>Passive RFID technology : overview on passive RFID technology. The conjugate matching techniques in the design of RFID tags. (5 hours frontal lesson)</p> <p>Microwave circuits analysis (Laboratory Activity): Introduction to microwave CAD programs; analysis of microwave circuits. Examples of design of simple microwave circuits. (5 hours laboratory activity)</p> <p>S-Parameter evaluation (Laboratory Activity): Vector Network Analyzer description. Laboratory measurement of the scattering parameters of various microwave devices (rat race, Wilkinson divider, etc.). (3 laboratory activity)</p>
Testi di riferimento	<p>[1] David M. Pozar, Microwave Engineering, John Wiley & Sons Inc</p> <p>[2] Sorrentino Roberto, Bianchi Giovanni, Microwave and RF Engineering, Wiley</p> <p>[3] E. Collin, Foundation of microwave engineering, McGraw Hill, New York</p>
Altre informazioni utili	



**UNIVERSITÀ
DEL SALENTO**

OBIETTIVI FORMATIVI E PROGRAMMI DI MASSIMA DEGLI INSEGNAMENTI DI II E III ANNO

**LM65 - CdL Magistrale in Communication Engineering and Electronic Technologies - II anno
APPLIED ELECTROMAGNETICS**

Obiettivi formativi

Il corso intende formare nello studente una spiccata capacità di applicare le conoscenze teoriche dell'Elettromagnetismo e delle Microonde a casi reali

Programma di massima

Il corso propone alcuni esempi di applicazioni scientifiche e industriali dell'Elettromagnetismo, con particolare riferimento al BioElettromagnetismo, alle applicazioni biomediche e ai sistemi wireless intelligenti



**UNIVERSITÀ
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OBIETTIVI FORMATIVI E PROGRAMMI DI MASSIMA DEGLI INSEGNAMENTI DI II E III ANNO

**LM65 - CdL Magistrale in Communication Engineering and Electronic Technologies - II anno
CAD AND LABORATORY OF HIGH FREQUENCY CIRCUITS AND ANTENNAS**

Obiettivi formativi

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Programma di massima

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OBIETTIVI FORMATIVI E PROGRAMMI DI MASSIMA DEGLI INSEGNAMENTI DI II E III ANNO

**LM65 - CdL Magistrale in Communication Engineering and Electronic Technologies - II anno
Electromagnetic Solutions for Hi-Tech**

Obiettivi formativi

At the end of the course the student should be able to:

- Apply the basic concepts of electromagnetism.
- Set up high frequency device designs based on requirements.
- Master (among others) the concepts of impedance matching, radiation diagram, gain, polarization, image theorem, filiform antennas, aperture antennas.
- Enrich the knowledge (from the point of view of Electromagnetics) of consolidated (e.g. Wi-Fi and GSM), emerging (RFID UHF and HF, NFC, Bluetooth Low Energy), and approaching technologies (mm-Wave Wi-Fi , 5G).

Programma di massima

The course aims at introducing and deeply investigating some of the applicative aspects of Electromagnetics which are more appealing to the student and more relevant from the point of view of their use in the labour market.

Starting from general projects focused on RF aspects of new wireless technologies, the basic concepts functional to their development will be deepened, the final projects will be executed and skills useful for the practical realization and tests of the designed devices will be developed.

"Electromagnetic Solutions for Hi-Tech" focuses on various topics in common with other courses belonging to the same scientific sector, but it remains a self-consistent course not bound by any prerequisites. Strategically, in "Electromagnetic Solutions for Hi Tech" qualitative and applicative aspects are highlighted and stressed, even though the approach keeps on being extremely rigorous.



OBIETTIVI FORMATIVI E PROGRAMMI DI MASSIMA DEGLI INSEGNAMENTI DI II E III ANNO

**LM65 - CdL Magistrale in Communication Engineering and Electronic Technologies - II anno
MEASUREMENTS FOR TELECOMMUNICATIONS**

Obiettivi formativi

1) Knowledge and understanding

The course describes methods and models in the field of measurement systems and apparatus with a specific focus on TLC. Students must have basic knowledge related to electronics, electronic components, signal theory. They should know the main electronic architectures and signal acquisition systems operating both in time and frequency domains. They should be able to deal efficiently with practical applications and measurement issues with a specific skill to cope with the intrinsic limitation between theoretical models and practical cases.

2) Applying knowledge and understanding

At the end of the course, the student should be able to apply rigorously the basic and most important concepts related to metrology for a generic measurement process. Specifically, the student should be able to correctly use measurement instrumentations adopted in testing, diagnostics and characterization of components, devices and telecommunication systems.

3) Making judgements

Students will possess the ability to identify the operating modalities for correlating a theoretical concept or model with the most appropriate practical context. The course promotes the development of independent judgment suitable to appropriately choose the measurement technique as well as the critical ability to interpret the goodness of the results of the models/methods applied to the datasets under examination.

4) Communication

Through the methodologic tools provided in the course and, in particular, those addressed during the laboratory sessions, students will be able to communicate with an appropriate technical terminology so as to proficiently deal with all the issues related to measurements, data acquisition and processing, testing activity and results.

Additionally, thanks to the laboratory sessions, the students will have the opportunity to draft autonomously a technical report describing the practical and theoretical issues related to the discussed topics.

5) Learning skills

Students must acquire the critical ability to relate, with originality and autonomy, to the typical problems of measuring a quantity, characterizing a TLC signal and testing electronic devices and components. They will also be able to use instrumentation and measurement methods largely adopted in the field of TLC applications and they should be able to apply autonomously the knowledge and methods learned in view both of a possible PhD courses as well as of a professional career.

Programma di massima

The course provides the basic concepts for a correct use of measurement instrumentation adopted in testing, diagnostics and metrological characterization of components, devices and telecommunication systems.

Instrumentation and measurement methods mainly adopted in the field of TLC applications will be presented, analysed and used.

The course also includes several practical laboratory sessions.



OBIETTIVI FORMATIVI E PROGRAMMI DI MASSIMA DEGLI INSEGNAMENTI DI II E III ANNO

**LM65 - CdL Magistrale in Communication Engineering and Electronic Technologies - II anno
Microelectronic design c.i.**

Obiettivi formativi

After the course the student should be able to:

- 1) Describe the basic analog circuits (bandgap reference, current mirrors, differential couple, Miller opamp, class A and class AB output stages, etc).
- 2) Evaluate the performance parameters and discuss complexity issues associated with different basic analog circuits.
- 3) Demonstrate circuit analysis capability of not standard circuits.
- 4) Understand the technology limits in circuit design.
- 5) Use the simulator to analyse performance of analog circuits.
- 6) Express properly the results of the analysis and the design of analog circuits.

Programma di massima

The course is aimed at providing principles and tools to analyze and design analog circuits in CMOS integrated technology.



OBIETTIVI FORMATIVI E PROGRAMMI DI MASSIMA DEGLI INSEGNAMENTI DI II E III ANNO

**LM65 - CdL Magistrale in Communication Engineering and Electronic Technologies - II anno
RF MICROELECTRONICS C.I.**

Obiettivi formativi

After the course the student should be able to:

- 1) Describe the basic RF analog circuits (LNA, Mixer, etc...) and wireless transceiver architectures.
- 2) Evaluate the performance parameters and discuss complexity issues associated with different basic RF analog circuits and wireless transceiver architecture.
- 3) Demonstrate circuit analysis capability of not standard circuits.
- 4) Understand the technology limits in circuit design.
- 5) Use the simulator to analyse performance of RF analog circuits.
- 6) Correctly expose a RF circuit study or a wireless transceiver architecture description.

Programma di massima

This is a course in RF Microelectronics: it is aimed at providing principles and tools to analyze and design RF analog circuits in CMOS integrated technology.



OBIETTIVI FORMATIVI E PROGRAMMI DI MASSIMA DEGLI INSEGNAMENTI DI II E III ANNO

**LM65 - CdL Magistrale in Communication Engineering and Electronic Technologies - II anno
SIGNALS ACQUISITION AND ELECTRONIC DESIGN**

Obiettivi formativi

Learning Outcomes

After the course the student should be able to:

- * Understand the principles of operation of commonly used sensors, transducers, and instruments.
- * Define technical specifications and to select sensors and transducers for a given application.
- * Understand terminologies associated with instrumentation systems (e.g., range, sensitivity, dynamic response, calibration, hysteresis, error, accuracy, precision, data uncertainty, mean and standard deviation).
- * Use data acquisition software and hardware to collect and analyze data from a physical system.
- * Analyze and understand the operation of computerized instrumentation systems for industrial processes using multiple sensors, electronic interfaces, data acquisition boards based on microcontrollers.
- * Use commercial software for the design and simulation of electronic boards managed by a microcontroller
- * Gain experience in developing computerized instrumentation systems for industrial processes using multiple sensors, interface electronics, data acquisition smart boards.
- * Acquire an experience in designing an electronic acquisition system of physical quantities.

Programma di massima

Overview

This course embraces themes of sensing and transduction, signal acquisition, design of analog/digital circuit blocks, analysis of embedded systems and an overview on rapid prototyping solutions for advanced electronic design. These are vital subjects for any system which extracts signals from the real world and processes the information digitally. The course comprises information on signals, sensor and transducer principles, related applications, embedded electronic design for signal acquisition and finally design and testing, by using a specific software, of an electronic acquisition board managed by a microcontroller.



OBIETTIVI FORMATIVI E PROGRAMMI DI MASSIMA DEGLI INSEGNAMENTI DI II E III ANNO

LM65 - CdL Magistrale in Communication Engineering and Electronic Technologies - II anno

Telecommunication Systems

Obiettivi formativi

Knowledge and understanding. Students must have a solid background with a broad spectrum of basic knowledge of digital communications and systems:

- Describe the characteristics of advanced digital communication techniques and discuss the principles of modern system design;
- Understand the different types of diversity that can be exploited to improve the performance of a communication system;
- Illustrate data-aided and non-data-aided synchronization techniques for timing recovery in baseband and passband;
- Describe how surveillance and (geo)localization can be performed via radio signals, and illustrate satellite-based navigation system.

Applying knowledge and understanding. After the course the student should be able to:

- Work with analytical models and solve optimization, detection, and estimation problems related to the course topics;
- Describe the peculiar aspects and main challenges of (mobile) multiuser systems, and how advanced digital communication techniques can be adopted to efficiently cope with them;
- Discuss the evolution of cellular networks from a system perspective, state-of-the-art technologies and security, and the ongoing trends;
- Understand the differences among several techniques addressing the same problem and recognize the main trade-offs.
- Recognize and understand the tendencies and innovations in the ICT field, with awareness of related privacy, security, and ethical issues.

Making judgements. Students are guided to learn critically what is taught during classes, comparing different approaches to address modern telecommunication needs, and to have a clear view of the big picture.

Communication. It is essential that students are able to communicate with a varied and composite audience, not culturally homogeneous, in a clear, logical and effective way, using the methodological tools acquired, their scientific knowledge, and the specialty vocabulary. The course promotes the development of the following skills: ability to highlight and expose in precise terms the characteristics or a variety of telecommunication systems, identifying their salient features without getting lost into protocol/standard details; ability to describe and analyze the different options available for a given application scenario or use case, and illustrate the main trade-offs.

Learning skills. Students must acquire the critical ability to discuss, with originality and autonomy, the most important aspects in the design of telecommunication systems and, in general, cultural issues linked to related areas within the ICT domain. They should be able to develop and apply the knowledge learned in the continuation of their studies and in the broader perspective of cultural and professional self-improvement of lifelong learning. Therefore, students are explicitly asked to refer to and compare different sources and textbooks, also by autonomously selecting authoritative materials from the vast amount of information available (libraries, online repositories, and the Web at large), summarizing them for an effective study.

Programma di massima



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The course provides an overview of modern communication principles and techniques, and how they are composed into "systems". The focus is on multiuser wireless systems, in particular mobile cellular networks from 2G (GSM) to 4G (LTE) and next-generation (5G), and (geo)localization systems.