UNIVERSITAT DE VALÈNCIA - ESTUDI GENERAL

M.Sc. in ELECTRONICS ENGINEERING

2003/04 SYLLABUS

Dpt. Electronics Engineering
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CONTENTS

1.- General Description of the High School of Engineering.

The High School of Engineering of the University of Valencia has been created very recently. In fact it was officially established on the 24th of September of 2003.

This new High School of Engineering of the University of Valencia has its origins at the common needs and desires of three Departments of our University. These Departments are Chemical Engineering, Electronical Engineering and Informatics. All these departments are involved in lecturing in several engineering and technical degrees of our University at its Campus of Burjassot. These degrees are:

- M. Sc. in Electronic Engineering
- M. Sc. in Computer Engineering
- M. Sc. in Chemistry Engineering
- B. Eng. in Telecommunications Engineering specialising in Electronic Systems
- B. Eng. in Telecommunications Engineering specialising in Telematic Systems

The High School of Engineering is in charge of an approximate number of 2800 students from which 700 are enrolled in the M.Sc in Electronics Engineering and B. Eng. in Telecommunications specialising in Electronic Systems in a total of 56000 students from all the University of Valencia.

The Electronics Engineering Department is responsible for teaching M.Sc in Electronics Engineering and B. Eng. in Telecommunications specialising in Electronic Systems. Currently, there are 60 lecturers. The Department research covers the areas of Electronics, Digital Signal Processing and Electronic Technology. There are four research groups, namely, Industrial Electronics and Instrumentation Lab (LEII), Digital Signal Processing Group (GPDS), Communication and Electronic Digital Systems Group (DSDC), and Medical Imaging Acquisition and Processing Group (SATI).

The Computer Engineering Department is responsible for teaching M.Sc in Computer Engineering and B. Eng. in Telecommunications specialising in Telematic

Systems. Currently, there are around 70 lecturers. This Department covers the areas of Architecture and Technology of Computers, Computer Science and Engineering Systems. Research work concerns Image Processing, Robotics and Traffic Technology.

2.- Location of the High School of Engineering

The university centres are located in three campuses:

- Burjassot-Paterna, with the faculties of Biology, Physics, Chemistry, Mathematics, and Pharmacy.
- Blasco Ibáñez, with the centres of the Humanities area as well as the Medicine and Odontology College, the Nursing School, and the Psychology College.
- Tarongers, which encompasses the colleges of Social Sciences, Economics, and Law.

In each campus, there are different services and research institutes. As mentioned above, the Faculty of Physics is located in the Burjassot-Paterna Campus (Science Campus). There are two ways to arrive to the Burjassot-Paterna Campus by public transportation:

- Tramway: Company "FGV (metro-tranvia)" line 4 stopping down in "Campus de Burjassot" and "Vicent Andrés Estellés" stops.
- EMT (red buses from the municipality). The line arriving to the campus is number 63, only during weekday and lective periods.

3.- Professional Skills.

The engineer in Electronics from the University of Valencia is trained to perform correctly in several branches of the electronics industry, i.e.:

- Electronic Instrumentation
- Electronic Systems (analogue and digital) for information processing
- Power Electronics
- Telematics
- Digital Signal Processing

This degree is conceived to respond the professional requirements of industry. Possible environments for our graduates are:

- Project managing in R+D departments.
- Development of products and technologies.
- Technology transfer.

These tasks can be developed in companies in the electronics, communication, computing, automotive, medical sector, and, in general, in any company that uses electronics as a relevant part in its production process. The scientific basis that back our engineers, enable them to carry out research (scientific and technological) in Universities and Public or Private Research Organisations. Anyway, this basis will ease their future re-cycling that should assure a perfect update in their future work in Electronics.

4.- Teaching Contents.

The teaching content of the M. Sc. in Electronics Engineering is organised into units called MODULES. A given number of credits are assigned to each module, so that one credit equals 10 teaching hours. There are four different types of modules:

- Core Modules: these correspond to disciplines determined by national General Guidelines imposed by the Government in order to provide uniformity of criteria along the country.
- Compulsory Modules: these correspond to disciplines determined by the University of Valencia, which are compulsory for each degree.
- Elective Modules: these correspond to disciplines determined by the University of Valencia for the Technical Engineering Degree in Telecommunications (Electronic Systems), the student must choose from a determined number of credits depending on the student's preferences.
- Free Choice Modules: these correspond to modules which are chosen freely by the student from amongst the disciplines of various degrees offered at the University of Valencia and/or other specific degrees, of which a determined number of credits must be studied.

As regards the number of credits, the teaching content of the ITT-SE is distributed in the following way:

Core Modules	Compulsory Modules	Elective Modules	Free Choice
81 credits	18 credits	13.5 credits	14.5 credits

The total teaching content of Electronics Engineering is 142 credits, 127 of which correspond to tutorial or laboratory sessions and 15 correspond to the “End of Degree Project” or “Final Project”. There are no incompatibilities between different modules but there are some hints for the better following of the modules.

The year is divided into two semesters. The first semester begins the last week of September and finishes in mid February. The second semesters starts in mid February and finishes at the end of June. The last three weeks of each semester are nor dedicated to lecturing but only to examinations. There are modules with annual and one-semester duration. There are three holiday periods during the academic year: the Christmas break, from 21st December to 8th January, the Fallas break, from 16th March to 20th March, and the Easter break, which covers one week in the end of March or beginning of April.

5.- Admission to the Studies

Students have direct access to this degree, without the need for complementary studies, if they have passed the first cycle (first 3 years) of Telecommunication Engineering or have a Technical Engineering degree in Industrial Electronics (B.Eng. or similar) such as Telecommunication Engineering specialising in Electronic Systems or Technical Engineering in Telecommunication Systems.

In addition, students have access to Electronic Engineering if they have passed the first cycle of the Physics Degree, the first cycle of Industrial Engineering, or have the Technical Industrial Engineering degree in Electricity, Technical Engineering in Telematics, Technical Engineering in Sound and Image, or finally if they have passed Technical Computing Engineering or the first cycle of Computing engineering. For all these cases, it is necessary to complete the complementary studies which have been established by the University of Valencia, and which are incorporated into the

Electronic Engineering syllabus as compulsory subjects for all students who have not already passed them.

The students are admitted depending on their results until all the vacants are filled. For the 2003-04 academic year, there were 50 positions available.

6.- Subjects Map.

COMPLEMENTARY MODULES

Code	Term	MODULE'S NAME	Type[1]	Cred.	Theo.	Lab.
13095	both	Analysis of Linear Circuits and Systems	CP	9	7.5	1.5
13116	1st	Microelectronics	CP	6	3	3
13097	both	Digital Electronic Devices and Circuits	CP	10.5	6	4.5
13100	both	Analog Electronics I	CP	12	7.5	4.5

M. Sc. Elect. Eng.(IE) FOURTH YEAR

Code	Term	MODULE'S NAME	Type	Cred.	Theo.	Lab.
13080	both	Electronic Instrumentation	CO	12	6	6
13094	both	Processing and Transmission of Signals	CO	9	6	3
13074	both	Electronic Circuits and Systems Design	CO	12	7.5	4.5
13073	1st	Electronics & Photonic Devices	CO	7.5	6	1.5
13093	2nd	Electronics & Photonic Device Technology	CO	4.5	3	1.5
13082	1st	Digital Signal Processing	CP	4.5	3	1.5
		Elective	EL	9		
		Free Choice	FC	10		
		TOTAL		**69**		

[1] Legend: CO: Core subject
CP: Compulsory subject
EL: Elective subject
FC: Free Choice

M. Sc. Elect. Eng.(IE) FIFTH YEAR

Code	Term	MODULE'S NAME	Type [2]	Cred.	Theo.	Lab.
13077	Both	Electronic Equipment	CO	9	6	3
13089	Both	Electronic Systems for Information Proc.	CO	12	7.5	4.5
13091	both	Telematic systems	CO	9	6	3
13084	2nd	Projects	CO	6	4.5	1.5
13085	1st	Automatic Regulation	CP	4.5	3	1.5
13072	1st	Electromagnetic Compatibility	CP	4.5	3	1.5
13088	2nd	Advanced Digital Systems	CP	4.5	3	1.5
13083	2nd	Final Degree Project	CP	15		
		Elective	EL	4.5		
		Free Choice	FC	4.5		
		TOTAL		**73.5**		

ELECTIVE SUBJECTS (can also be chosen as free choice subjects)

Code	Term	Year	MODULE'S NAME	Cred.	Theo.	Lab.
13075	1st	4th	Power Systems Design	6	3	3
12739	1st	4th	Electromagnetic waves	6	6	0
13078	2nd	4th	Digital Filtering	6	3	3
13092	1st	5th	Advanced Techniques for Information Proc.	4.5	3	1.5
13079	1st	5th	Biomedical Engineering	6	4.5	1.5
13076	2nd	5th	High Speed Digital Design	7.5	4.5	3
13087	2nd	5th	Instrumentation Systems	4.5	1.5	3
13051	2nd	5th	Robotics	6	4.5	1.5

[2] Legend: CO: Core subject
CP: Compulsory subject
EL: Elective subject
FC: Free Choice

7.- Degree Modules

The purpose of the M.Sc in Electronics Engineering is to prepare students for a variety of careers; specifically, this degree will prepare the student to

- Apply knowledge of digital number systems, logic gates, combination and sequential logic circuits.
- Describe the internal structure of a microprocessor and electrical signals.
- Interface external devices to a microprocessor system and write appropriate software to obtain desired interface performance.
- Apply working knowledge of AC and DC circuits and understand the physical principles of passive circuit devices.
- Demonstrate knowledge of the physical principles, theory and operation of solid state devices.
- Perform accurate and valid parameter measurements with industry standard test equipment while observing standard safety practices.
- Construct and troubleshoot electronic circuits from schematic diagrams.
- Demonstrate a cooperative and responsible attitude in the workplace.
- Demonstrate fundamental principles of physical phenomena.
- Design and construct analogue signal processing circuits and perform software verification through simulation.
- Solve mathematical problems relating to circuit analysis of linear and digital circuits.
- Design and construct digital electronic circuits employing microprocessors, including reduced instruction set processor and interrupt-driven systems.
- Design and construct prototype electronic circuits using schematic capture, circuit board layout software and printed circuit fabrication systems.
- Apply automated methods of signal sampling and testing, including real-time data acquisition and computer recording.
- Understand and apply methods to quantize and encode an analogue signal into a digital signal.
- Use the z-transform to specify the parameters of digital signals.
- Synthesize digital signal processing systems to perform specified tasks.

- Design, program and commission automation systems and networked industrial plants.
- Research, plan and prepare a comprehensive capstone project.
- Research, plan and prepare professional technical documents similar to comprehensive manuals.

COMPLEMENTARY STUDIES

Analysis of Circuits and Linear Systems (code 13095) (9 Credits). Annual.

Fundamental concepts. Basic network elements. Network matrices. Kirchoff laws. Network theorems. Alternating current. Network frequency response. Bode charts. Laplace transformation in the network theory. Network stability.

Analog Electronics I (code 13100) (12 Credits). Annual.

Theory (7,5 cred.):

Electronics and analogue signals. Passive components: resistance, capacitors and reels. Active components: tension and current sources. Semiconductor substances. Solid devices: the diode and transistor. Other types of solid devices. Signal amplifiers with transistors: polarisation, calculating input and output gains and impedance in different configurations. Frequency response of amplifiers with bipolar transistors. Designing amplifiers. Amplifiers with field effect transistors. Analysis and design. Power amplifiers: A and B type circuits. Designing power amplifiers. Integrated power amplifiers. Feedback in amplifiers. Effects of feedback. Application of power amplifiers. Oscillators. Feedback applications in oscillator design. Types of oscillators. Power sources. Rectification. Filtering. Designing unregulated supplies. Regulators for power supplies. Types. Designing regulated power supplies. Using integrated regulators. Differential amplifiers. Differential gain. Common mode gain. Common mode rejection factor. Measuring parameters of differential amplifiers. Operational amplifiers: structure, types, characteristics. Applications. Designing signal and power amplifiers, power supplies, oscillators. Radio frequency circuits. Tuned amplifiers. Mixers. Modulator circuits. Frequency, phase and amplitude modulation. Detector circuits.

Lab Sessions (4.5 cred):

Basic laboratory equipment and general work procedures in the laboratory. Determining frequency response in passive networks. Designing and building circuits with diodes. Designing an amplifier with a bipolar transistor in common emitter. Determining its frequency response and its input and output impedance. Multi-phase amplifiers with bipolar transistors. Signal amplifiers with a field effect transistor. Designing a power stage without feedback for audio frequency. Using negative feedback in audio power amplifiers. Using positive feedback for creating oscillators. Designing and assembling an unregulated power supply. Designing a power supply regulator. Design and assemble of a differential amplifier with bipolar transistors. Designing a power amplifier for audio use with operational amplifiers. Design and experimental study of radio frequency circuits.

Digital Electronic Devices and Circuits (code 13097). (10.5 Credits). Annual.

Theory Sessions (6 cred):

Numerical systems. Commutation algebra. Logic circuits. Simplifying logic functions. Bipolar logic families. MOS logic families. Combinatory MSI circuits. Logic gate bistables. Registers and counters. Analysis and design of sequential circuits. Sequential digital circuits. D/A converters. A/D converters.

Lab Sessions (4.5 cred):

Simplifying logic functions. Study of TTL and CMOS logic gates. Simulating TTL and CMOS logic gates. Design and analysis of combinatory MSI circuits. Studying bistables, registers and counters. Design and analysis of sequential circuits. Design and analysis of temporary digital circuits. D/A and A/D converters.

Microelectronics (code 13116). (6 Credits). 1st semester.

Theory Sessions (3 cred):

Semiconductor models and devices. Statistics and transporting charge in semiconductors. Physics of the PN union. Physics of bipolar components: the transistor and thyristor. Physics of unipolar or field effect devices. Crystalline and epitaxial growth. Oxidation and deposition of layers. Diffusion and implantation of ions. Lithography techniques. Integration of passive components. Bipolar integration technology. MOSFET manufacturing technology.

Lab Sessions (3 cred):

Study of various semiconductor elements. Operating the ? -Electronics program, integrated circuit design. Logic circuit design.

CORE MODULES

Electronic and Photonic Devices (code 13073).(7.5 Credits). 1st semester.

Theory Sessions (6 cred):

Characterising and modelling electronic components in static regime. Characterising and modelling electronic components in small and large signal regime. Characterising and modelling electronic components in commutation regime. Characterising and modelling photonic components.

Lab Sessions (1.5 cred):

The union diode model. The PN union diode. The Schottky diode. Effect of temperature and area on the diode model. The bipolar transistor model (BJT). The Ebers-Moll model. The Gummel-Poon model. Effect of temperature and area on the BJT model. Power transistors. The field effect transistor model (FET). The JFET model. Effects of temperature and area on the JFET model. The MOSFET model. Effect of temperature on the MOSFET model.

Electronic Circuits and Systems Design (code 13074). (12 Credits). Annual.

Theory Sessions (7.5 cred):

Integrated circuits with MOS transistors. Basic CMOS gates at transistor level. Integrated circuits for specific applications (ASIC). Design stages of the ASIC. Testing the ASIC. VHDL language. Programmable logic CPLD and FPGA devices. Design tools for PLDS and FPGAS.

Lab Sessions (4.5 cred):

Synthesis of basic CMOS gates at transistor level: layout. Designing integrated circuits for specific applications: simulating faults for ASIC. Descriptive language. VHDL hardware: analysis and synthesis of logic circuits. Designing and implanting logic circuits through programmable logic.

Electronic and Photonic Devices Technology. (code 13093) (4.5 Credits). 2nd semester.

Resistance, parameters and specifications. Special resistance: ntcs, ptcs, powermetres, varistors. Manufacturing technology. Capacitors: parameters and specifications. Variable capacitors. Varactors. Manufacturing technology. Inductors: parameters and specifications. Ferrites. Diodes: types and characteristics. Manufacturing technology. Bipolar transistors. Signal, power and radio frequency transistors. Manufacturing technology. Field effect transistors. JFET, MOSFET and power MOSFETs. Manufacturing technology. IGBTs: manufacturing technology. Negative resistance elements. Manufacturing technology. Thyristors, GTOs. Manufacturing technology. Light emission devices. The LED and laser diode. Manufacturing technology.

Processing and Transmission of Signals. (code 13094) (9 Credits). Annual.

Theory Sessions (6 cred):

Basic concepts of communication: general considerations of communication. Elements of a communication system. Signals. Examples of communication systems. Problems associated with transmitting signals. Need for signal modulation. The electromagnetic spectrum. Representation of signals in frequency. Fourier analysis. Theory and basic concepts of modulation. Basis of linear modulation. Sending signals through transmission lines. Electronic techniques in communications: concepts of electronic noise and non-linear distortion. Selective networks and networks of impedance adjustment. Small signal amplifiers at high frequencies. High-frequency oscillators. Electronic circuits and subsystems in emitters and receivers.

Lab Sessions (3 cred):

Representation of signals in the field of frequencies. Analysing signals and communication systems. Transmission lines. Signal generating circuits. Sinusoidal oscillators, VCO and applications in modulation circuits. Wide-band amplifiers. Circuits for the linear modulation of signals. Circuits for the angular modulation of signals.

Electronic Instrumentation. (code 13080) (12 Credits). Annual.

Theory Sessions (6 cred):

Basic principles of measuring systems. Statistic processing of measurements. Voltage and current measurement. Resistance, capacitance and inductance measurement. Frequency and time measurement. Measurement of non-electrical magnitude. Primary sensors. Variable resistance sensors: conditioners. Variable reactance and electromagnetic sensors: conditioners. Sensors, generators and conditioners. Filtering. Communication systems for sensors. Basic concepts of obtaining signals. Analog switches and multiplexers. Sampling and holding amplifiers. A/D and D/A conversion. Causes for error and calibration in obtaining signals. Signal distribution. Internal interference of the measuring system. External interference of the measuring system.

Lab Sessions (6 cred):

Study of the dynamic response of a first-rate temperature sensor system. Temperature/voltage converters based on thermistors. Piezoelectric transducers and switches through the detection of tension thresholds. Instrumentation amplifiers. Electronic scalar through charge cell and instrumentation amplifier. I/f current and transductance transducer. Measurement of angular displacements. Study of transmitting analog signals in current. Studying the characteristics of a DAC. Studying the characteristics of an ADC.

Electronic Equipment. (code 13077) (9 Credits). Annual.

Theory Sessions (6 cred):

Introduction. Multimeters. Impedance measures. Power sources. Signal generators. Dynamic charges. Oscilloscopes. Test points. Registry equipment. Spectrum analysers. Logical analysers. Frequency meters and period meters. Energy measurement. Generators of network transients. Dielectric meters. Automatic measuring systems.

Lab Sessions (3 cred):

Digital multimeter. Function generator. Analog oscilloscope. Digital frequency meters. Digital oscilloscope. Spectrum analyser. Impedance analyser. IEEE - 488 protocol.

Electronic Systems for Processing Information. (code 13089) (12 Credits). Annual.

Theory Sessions (7.5 cred):

Basic functional blocks. Interconnection structures. Characteristics of memory systems. Memory types. Input/output modules. Input/output techniques. Controlling an acquisition card. Operation and structure of the CPU. Operation of the control unit. Operating systems requirements. Multiprogramming. Memory control. Advanced microprocessors. Advanced architecture. Multiprocessing. RISC computers. Arithmetic of finite length word. Basic elements of architecture. Fixed point processors: DSP TMS320C25. Floating point processors: DSP TMS320C30. Programming. Addressing modes. Command groups. Programming examples. Development tools. Applications. Examples.

Lab Sessions (4.5 cred):

Introduction to C language. Basic programming and library functions. Files: generating waves. Binary and ASCII formats. Graphical functions: displaying data files in binary and ASCII formats. Controlling a data acquisition system: channel selection, gain, sampling frequency. Introduction to Assembler TMS 320. Managing software tools: compiler, linker, simulator. Programming a FIR filter in Assembler TMS 320C25. Programming a generator of square, triangular and sinusoidal waves in Assembler C25. PWM modulation and demodulation in Assembler C25.

Telematic Systems. (code 13091) (9 Credits). Annual.

Theory Sessions (6 cred):

Network types. ISO-OSI model. Telematics services. Data transmission. Hardware. Data and signals. Digital transmission types. Introduction to the telephone system. Commutation. Codification in non-reliable channels. Detecting and correcting errors. Redundant code types. Block codes. Linkage protocols. Introduction to the theory of queues. Communication networks. LAN. WAN.

Lab Sessions (3 cred):

Use of data transmission network. CRC coding. Delta coding. RS -232 transmission.

Projects. (code 13084) (6 Credits). 2nd semester.

Theory Sessions (4.5 cred) + Lab Sessions (1.5 cred):

Project selection. Project planning concepts. Project planning techniques. Programming techniques and project control. Legislation for electronic projects. Insurance of quality.

COMPULSORY MODULES

Automatic Regulation (code 13085) (4.5 Credits). 1st semester.

Theory Sessions (3 cred):

Systems, systems theory and control theory. Classical control theory. Variables of state and description of dynamic systems in the space of states. Analysis of linear state equations in continuous and discrete systems in time. Stability. Controlling and observing linear systems invariable in time. Controlling and observing invariable linear systems in time. The relationship between state variables and transfer functions in the description of systems. Design of linear control systems with feedback. Optimum control theory. Non-linear control systems.

Lab Sessions (1.5 cred):

Reviewing the classical control theory. Study of classical control systems with MATLAB. Study of second-order systems. Study of higher order systems. Study of non-minimal phase systems. Compensation of systems with delay-advance networks. Study of the immunity to disturbances of systems with feedback. Study of PI and PID controllers. Analysis of systems in the state space. Introduction to Simulink. Design and implantation of a temperature regulator for a Peltier refrigerator. Design and implantation of a speed regulator for a DC motor.

Digital Signal Processing. (code 13082) (4.5 Credits). 1st semester.

Theory Sessions (3 cred):

Introduction. Discrete signals. Discrete systems. Generalised sampling theorem. Z transformation. Frequency analysis of signals. Making discrete time systems. Digital filtering. Modifying sampling frequency. Properties of and calculating the DFT. Introduction to adaptive processing. Applications of digital processing of signals: image processing and digital audio.

Lab Sessions (1.5 cred):

Introduction to the MATLAB program. Programming with MATLAB. Analysing the randomness of time-series. Frequency response of the L.T.I.S. Effects of group delay. Analysis of FIR and IIR digital filters. Modifying sampling frequency: Decimation and interpolation. Implantation of a spectrum analyser: spectral zoom. Spectral analysis of signals with the DFT. Introduction to adaptive processing.

Advanced Digital Systems (code 13088) (4.5 Credits) 2nd semester.

Theory Sessions (3 cred):

Importance of automatisms. Technological alternatives. Definition and characteristics of the embedded systems. Implication for the designer. Historic introduction to microprocessor systems. Basic architecture. CPU. Memory. I/O.

Interruptions. DMA. Programming. Advanced architecture. Parallel processing. Scalar and superscalar processors. DSPs. Commercial products: advanced microprocessor for embedded applications. Other alternatives: multiprocessors nets, embedded PC, SOC, etc. Microcontrollers: general concepts. Commercial panorama in 8 bits micros: MCS51, 68HC11, PIC16FXX. Architecture, memory management, description of integrated peripherals, addressing mode, and instruction set. Concepts of design and examples of application. On board interfaces: SCI, SPI, Microwire. IIC. Others. Backplanes: ISA, PCI, VME , etc. Interfaces Centronics, RS232C, RS422 y RS485. Communications in specific applications: industrial control, instrumentation, domotics. Design of communication protocols. I/O digital control. Sensors and actuators. A/D and D/A conversion. Examples of peripheral modules: screens, keyboards, readers, motors, and others. Methodology in the applications programming. Development tools. Classic design of applications: states machine, Petri nets. New trends in embedded applications design: hard-soft co-design. Operative systems: process management and planning, memory and I/O management, SOTR, examples of OS.

Lab Sessions (1.5 cred):

Study of the application and possible alternatives of embedded systems design. Hardware and software design. Verification and construction. Exposition and documentation.

Electromagnetic Compatibility. (code 13072) (4.5 Credits). 1st semester.

Theory Sessions (3 cred):

Introduction to EMI and EMC. EMI generation sources. Feedback mechanisms and protection measures. EMI analysis. Modelling EMI systems and EMI prediction. EMC design and methodology. Noise reduction techniques in electronic systems. Interconnections and wiring for EMI control. Designing grounds and power supplies for EMI control. Filtering for reducing noise in common and differential mode. Electromagnetic screening. Theory of electromagnetic screening. Screening methods for EMI protection. Practical applications of EMI control. Intrinsic noise sources. Noise generated by active components. Noise in digital circuits and layout. Radiation in digital circuits. EMC design of PCBs and ground planes. Techniques for preventing feedback in the design of PCBs. Techniques for preventing feedback in electronic systems. EMI design in power systems. EMC engineering strategies for advanced products. EMI measurements. Measuring transmitted noise. Measuring radiated noise. Electrical field, magnetic field, types of antennae. Electromagnetic susceptibility measurements. Measurements for EMI noise reducing systems. EMC legislation. The European 89/336/EEC guidelines on electromagnetic compatibility. EMC IN - 55011 guidelines for industrial, scientific and medical appliances. EMC guidelines for other applications.

Lab Sessions (1.5 cred):

EMI generation sources. Feedback mechanisms and protection measures. EMC design and methodology. Noise reduction techniques in electronic systems. Filtering and oscillating for reducing noise in common and differential mode. Screening methods for EMI protection. Noise in digital circuits and layout. Radiation in digital circuits. EMC design of PCBs and ground planes. Techniques for preventing feedback in the design of PCBs. Techniques for preventing feedback in electronic systems. EMI measurements. Electromagnetic susceptibility measurements. Measurements for EMI noise reducing systems.

End of Degree Project. (code 13083) (15 Credits)

This is a project supervised by a lecturer from the Degree course, which is defended before a board of examiners consisting of three lecturers. The work can be developed in a company. The pupil can enrol for the project during either of the two semesters.

ELECTIVE MODULES

Digital filtering. (code 13078) (6 Credits). 2nd semester.

Theory Sessions (3 cred):

Introduction. Designing FIR filters. Designing IIR filters from analog prototypes. Designing IIR filters using direct methods. Digital filter structures.

Effects of finite precision. Adaptive filtering. Applications: digital communications.

Lab Sessions (3 cred):

Designing FIR and IIR filters: comparing different design methods. Programming digital filter structures. Experimental study of the effects of finite precision. Study of the LMS. Noise removal through adaptive filtering: comparing LMS and RLS.

Biomedical Engineering. (code 13079) (6 Credits). 1st semester.

Theory Sessions (4.5 cred):

Introduction. Biosignals. Origin of biopotentials. Bioelectric processes. Characteristics of biosignals. Characterising signals and noise in the analog processing of biopotentials. Biosignal acquisition systems. Interference models and noise elimination techniques. Measurements in the cardiovascular system. Measurements in the respiratory system. Measurements in the nervous and muscular system. Surgery equipment, therapy and artificial parts. Biotelemmetry systems. Safety considerations. Random signals. Time and frequency domain techniques. Coherent averaging. QRS detection. Processing time-series. Data compression. Introduction to automatic interpretation systems. Classification and recognition. Examples of systems. Obtaining and processing images. X Rays. Nuclear magnetic resonance. Ultrasound. Computerised axial scanner.

Lab Sessions (1.5 cred):

QRS detector. Study of the structure. Assessing the characteristics of the detector. Biotelemetry system. Study of the structure. Assessing the characteristics of the emitter and receiver. Digital processing of biosignals: Digital filtering of the ECG. Spectral analysis. Coherent averaging. Correlation. QRS detection. Project.

Robotics (code 13051) (6 Credits). 2nd semester

Theory Sessions (4.5 cred):

Origins and robot concept. Types. Magnetic components. Robot kinematics. Direct and inverse cinematic of manipulator. Generation of trajectories in the

Euclidean space and articulation space. Internal and external sensorial systems. Technology of actuators (hydraulic, pneumatics and electric). Robots control. Oriented programming languages. Mobile robots. Navigation. Construction technologies. Robot intelligence. A.I. and Robotics.

Lab Sessions (1.5 cred):

Kinematics modelling of an educational robot; programming of an educational robot; programming of a regulator for a DC motor; programming of a mobile robot.

Electromagnetic Waves (code 12739) (6 Credits). 1st semester.

General characteristics of microwaves. Guiding electromagnetic waves. Transmission lines theory. Microwave circuits theory. Components and passive devices for microwaves. Adjustment. Electromagnetic resonators. Noise in microwave circuits. Active microwave devices: Generating and detecting. Integrated microwave circuits (MIC). Microwave applications.

Instrumentation Systems (code 13087) (4.5 Credits). 2nd semester.

Theory Sessions (1.5 credits):

Architecture of an instrumentation system. Virtual instruments. Interconnection systems. Control languages. Software for industrial automation. Remote data acquisition. Input/output digital applications. Acquisition boards. Interpretation of the specifications. Interconnection systems. Equipment control via serial and IEEE488 interfaces. The IEEE488.1 standard. The IEEE488.2 standard. The SCPI standard. Adaptation circuits for the IEEE488 bus. Boards for interfacing bus IEEE488. VXI/PXI interfaces. VXI bus: structure, architecture, protocols and control. The PXI bus: mechanical and electrical characteristics. System configuration. Structured programming in LabView. Iterative structures, conditionals and nodals. Local variables, global and attribute nodes. Data types. Arrays, clusters, chains and input/output files. Analysis and data visualising, graphics. Instrument drivers. Fundamentals. Design techniques.

Lab Sessions (3 credits):

Introduction to LabView. Equipment control via serial interface. Equipment control via IEEE488 interface. Data acquisition. Realisation of an instrumentation system. Introduction to the VXI virtual instrumentation system.

Power Systems Design (code 13075) (6 credits). 1st semester

Theory Sessions (3 credits):

Magnetic components characterisation. Properties. Loses. Magnetic circuits: Magnetic reluctance. Characteristic diagrams. Simple model of magnetic circuits. Dimensioning of magnetic components. Magnetic nuclei characterisation. Inductor design. Product-area calculation. Methods. Crash design. Power transformers design. Real transformer: magnetising inductance, scattering inductance, frequency response, area-product and apparent power of transformers. Static design of DC/DC PWM basic converters without galvanic isolation. BUCK converters. DC/DC PWM converters with galvanic isolation. Forward and Flyback converters design. Symmetrical converters: Push-Pull, halfbridge and complete bridge. Power factor correction. Soft factor converter. Resonant converters. Input section design in Off-Line converters. EMC design. Applications: Power supply for telephony, power supply for space applications.

Lab Sessions (3 credits):

Magnetic materials characterisation. Transformer design. Simulation and analysis of the dynamic converter. Experimental verification of dynamic behaviour of Buck converters. Static and dynamic analysis of BOOST converters for power factor correction. Behaviour of a converter circuit with galvanic isolation and soft commutation (complete bridge ZVT) for DC/DC applications of high power and performance.

Advanced Technics for Information Processing (code 13092) (4.5 credits). 1st semester

Theory Sessions (3 credits):

Random signals. Distribution functions. Moments. Statistical independence, correlation and orthogonality. Central limit theorem. Introduction to Adaptive Processing. Learning algorithms. Application of Adaptive Processing. Wiener filters. Examples. Wiener filters problems. LMS algorithm. Variants of LMS algorithm. RLS algorithm. Hebb's rule. Artificial neurone. Multilayer perceptron structure. Backpropagation. Function characteristics. Other learning algorithms. Comparation between artificial neurones and Adaptive systems. Fuzzy logic. Implementation of a fuzzy system. Control and modelling applications of fuzzy logic.

Lab Sessions (1.5 credits):

Wiener filter. Adaptive systems. Variants of LMS algorithm. Active noise cancelling. Multilayer perceptron. Multilayer Perceptron applications. Implementation of a fuzzy system.

High Speed Digital Design (code 13076) (7.5 Credits). 2nd semester.

Theory Sessions (4.5 credits):

Review of digital design concepts. Integrated systems for digital process. Design method: flux and tools CAD diagram. Description languages. Costs and automation. Alternatives to integrated circuits. Digital design trends. High Speed design fundaments. Distributed and localised parameters. Reactances. Logic doors at high speed. Transmission lines. Characteristic impedance and propagation time. Impedance adaptation. Line types. Signal propagation in lines. Smith card. Stubs. Hierarchy, parasitic effects and interconnections modelling. Simplified calculus of electric parameters. Packaging. Thermal modelling. Connecting at PCB level: Terminations. Crosstalk in terminations. Connectors and Cables. Backplane. High Speed design techniques in electronic modules. Return current. Diaphony. Board design. Power supply distribution. Uniform tension and clock. Stable reference generation. Distribution techniques. Adjust of delays and crosstalk control. Course project.

Lab Sessions (3 credits):

The High Speed Digital Design laboratory is structured in two parts. In the first one the exercises are devoted to the study of transmission lines aspects, mutual inductance and capacitance and measurement techniques. In the second part, students have to implement a proposed high speed digital design from schematics to PCB routing, assembly and test. In this design they will use high-speed digital families components. They have to produce a short memo with all the work done, problems, results on signal integrity, etc. which will be presented in the final laboratory session.

8.- Qualification System

The results are expressed as numerical marks from 0 to 10. The students are graded according to the following scale: 0-5 SUSPENSO (fail), 5-7 APROBADO (pass), 7- 8.5 NOTABLE (second class), over 8.5 SOBRESALIENTE (first class). Amongst the students with a first class grade, a MATRÍCULA DE HONOR (first class grade with distinction) is awarded, at a rate of one first class grade with distinction for each group of 20 pupils.

Despite this, final marks of the Degree are computed with a different numerical value, i.e.: APROBADO=1, NOTABLE=2, SOBRESALIENTE=3, MATRÍCULA DE HONOR=4.

9.- Evaluation Methods

These can change for each subject from one academic year to another. Nevertheless, the most usual form of assessment for tutorial credits is a final examination. The laboratory credits are assessed according to the criteria of laboratory attendance, dissertations presented after the lab. sessions and, optionally, course work, continual assessment, or a final examination.

10.- ECTS-ERASMUS Coordinators

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