UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Ingegneria
ACADEMIC YEAR	2021/2022
MASTER'S DEGREE (MSC)	ELECTRONICS AND TELECOMMUNICATIONS ENGINEERING
SUBJECT	ELECTRONIC PROGRAMMABLE SYSTEMS
TYPE OF EDUCATIONAL ACTIVITY	B
AMBIT	50364-Ingegneria elettronica
CODE	20513
SCIENTIFIC SECTOR(S)	ING-INF/01
HEAD PROFESSOR(S)	GIACONIA GIUSEPPE COSTANTINO Professore Associato Univ. di PALERMO
OTHER PROFESSOR(S)	
CREDITS	9
INDIVIDUAL STUDY (Hrs)	162
COURSE ACTIVITY (Hrs)	63
PROPAEDEUTICAL SUBJECTS	
MUTUALIZATION	
YEAR	1
TERM (SEMESTER)	2° semester
ATTENDANCE	Not mandatory
EVALUATION	Out of 30
TEACHER OFFICE HOURS	**GIACONIA GIUSEPPE COSTANTINO** Tuesday 12:00 13:30 Dipartimento di Ingegneria Edif. 9 stanza U011 - Enginering Dept. Builg. 9 room U011 Wednesday 12:00 13:30 Dipartimento di Ingegneria Edif. 9 stanza U011 - Enginering Dept. Builg. 9 room U011

DOCENTE: Prof. GIUSEPPE COSTANTINO GIACONIA

PREREQUISITES	Good understanding of the topics covered in the former first level Degree on Electronic Engineering and in particular strong knowledge of the contents of the courses "Embedded Electronic Systems".
LEARNING OUTCOMES	Knowledge and ability 'to understand The course tends to focus the study of the design methods for programmable electronic systems. Design methods and tools suitable for the development of complete applications, including a digital system as the central part of the solution are analyzed. Capacity 'to apply knowledge and understanding The student will mature a deep knowledge of the design criteria that lead to the design of a medium complexity digital system. He will also be able to interface this system with a scenario generally constituted by sensors, actuators, and logic interface connections with the chosen microprocessor and/or microcontroller. Making judgments The student will be able to independently design a medium complexity digital system, with deep insight into the functionalities starting from board layout containing the system and the firmware description loaded in the program memory of the designed system. Communication skills The student will acquire competences to discuss on the programmable electronic systems of the most modern electronics used in high technical and scientific contexts, strong practical knowledge of the circuit techniques and firmware solutions for the above systems. Learning ability All the knowledge gained during the course are primarily aimed at providing students with the essential tools to autonomously work and understand complex issues, normally carried out within a PhD program or that may be met in daily work.
ASSESSMENT METHODS	Lab assessment and oral examination, grading from 18 to 30 (out of 30). The student must primarily pass a laboratory assessment where in a predefined time interval (usually from 90 up to 150 minutes) he must use methods learned during the course and correctly solve a proposed design. This assessment must reach a minimum of 18 (out of 30) in order to get access to the oral examination, otherwise the student must repeat the lab assessment at later date. During the oral examination the student is asked to answer at least 2 questions chosen among the topics of the course syllabus. The exam is designed to test the acquired knowledge, the planning and solving ability, the presentation skills and the use of appropriate technical language of the student. The assessment is based on the following grades: a) excellent (30-30 cum laude): excellent knowledge of the topics, excellent use of technical language, good analytical ability, the student is able to apply knowledge to solve the proposed problems; b) very good (26-29): good knowledge of the topics, good use of technical language, the student is able to apply knowledge to solve the proposed problems; c) good (24- 25): basic knowledge of the main topics, discrete use of technical language, limited ability to independently apply the knowledge to the solution of the proposed problems; d) satisfactory (21-23): the student knows the main topics but has not a full grasp of them, satisfactory use of technical language, poor ability to independently apply the acquired knowledge; e) sufficient (18-20): minimal knowledge of the main topics and basic use of technical language, very little or no ability to independently apply the acquired knowledge; f) insufficient: the student does not have a minimum acceptable knowledge of the contents of the topics covered in the course.
EDUCATIONAL OBJECTIVES	The course is focused on the study of design methods for programmable electronic systems. Design methods and tools for complete development of application having a digital system as a central part are mainly analyzed. It is organized in 6 modules, each one including a set of pre-recorded video lectures and a set of e-tivity: More into details, the list of modules is the following one: 1) Introduction to programmable digital systems design. Analisys of sytems requirements. (4 hours of video lectures); 2) Digital Systems: Standard Logic, ASIC and Microprocessors.

	SPLD, CPLDs and FPGAs. Introduction to HDL Languages: (10 hours of video lectures); 3) Common interfaces and DMA management. (2 hours of video lectures) 4) Microprocessor based real time systems. (4 hours of video lectures) 5) Main 32 bit RISC Architecture processors (8 hours of video lectures 6) DSP enabled processors: instructions and data parallelism (4 hours of video lectures). We propose a set of virtual laboratorial experiences as additional learning activities, also devised to facilitate the self-assessment of the learning outcomes. We expect that each student will dedicate about 32 hours for these activities. About one half of the activities are proposed as activities to be carried out autonomously by the students, while another half will be supervised or led by the course tutor. More into details, all the planned interactive activities are focused on to the capability to develop skills toward the design of VHDL entities implementing simple to medium complexity Finite State Machine capable to fulfil physical contraints.
TEACHING METHODS	Pre-recorded video lessons, virtual laboratory exercises The activities are distributed in order to obtain the expected learning outcomes. In particular, the contents of the course are delivered in the form of pre-recorded video lessons and targeted exercises to be carried out in remote autonomous or interactive form using a personal computer and open source design software. This enrichment allows the student to gradually apply the theoretical knowledge learned in class to cases of practical exercises, thereby stimulating the development of learning skills. Ultimately all the activities contribute to the development of a learning curve based also on the revision of the knowledge gradually acquired. The course consists of a series of pre-recorded video lessons that describe the main digital processors and systems found in modern electronic equipment. The basic methods for the analysis of embedded systems and their sizing during the design phase are studied. During the course, practical examples of designing systems subject to design constraints are mentioned, thus preparing the way for a possible practical design case.
SUGGESTED BIBLIOGRAPHY	Main references: • Notes, handouts and other useful articles or web link given by the instructor through the student portal • A.Clements: Principle of Computer Hardware Third Ed. - Oxford University Press. - ISBN 9780198564539 • D. S. Dawoud and R. Peplow: Digital System Design - Use of Microcontroller, River Publishers Series - ISBN: 9788792329400 (freely available at https://www.riverpublishers.com/book_details.php?book_id=54) Other suggested references: • K.C. Wang: Embedded and Real-Time Operating Systems - Springer ebook ISBN 978-3-319-51517-5 (e-book disponibile presso UniPa Discovery Service - https://link.springer.com/book/10.1007/978-3-319-51517-5)

SYLLABUS

Hrs	Frontal teaching
4	Introduction to programmable digital systems design. Analisys of sytems requirements and preliminary design.
10	Digital Systems at a glance: Standard Logic, ASIC and Microprocessors. SPLD with recorded outputs and their expansion to CPLDs. Introduction to FPGAs and study of re-configurable elementary cells. Internal common logic and I/O block of a Xilinx FPGA. Introduction to Hardware Descriptions Language: VHDL and Verilog. Definition of Entities and Structural VHDL Description. VHDL structural descriptions by using a schematic approach. Top Level Concept and Hierarchical Design. VHDL Scheduling Event Simulation Model: Concurrent Programming. Synchronous and Asynchronous Sequential Logic in VHDL. Definition and VHDL encoding of Moore and Mealy type machines. Behavioral and physical synthesis. Analysis of critical paths in synthesizable structures.
2	Common interfaces and management of internal registers on parallel, serial programmable timer and DMA interfaces
4	Microprocessor based real time systems. Real time clock dimension criteria. Process scheduling and related algorithms. Periodic and aperiodic processes. Priority levels issues and possible solutions
8	Microprocessor systems with 16 and 32 bit class: general characteristic of RISC architecture soft IP core (ARM7TDMI). Programming models, interrupts managements, instructions set and related address modes.
4	DSP enabled processors: instructions and data parallelism; implementation of complex instructions and digital filtering

Hrs	Practice
32	Lab practice Exercises, carried out with personal computer and free design software, focussed on programmable systems, based on FPGA. It is based on full learning of digital design methodologies using the VDHL hardware description language.