UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Ingegneria
ACADEMIC YEAR	2020/2021
BACHELOR'S DEGREE (BSC)	ELECTRONICS ENGINEERING
SUBJECT	ELECTRONICS 2
TYPE OF EDUCATIONAL ACTIVITY	B
AMBIT	50287-Ingegneria elettronica
CODE	02945
SCIENTIFIC SECTOR(S)	ING-INF/01
HEAD PROFESSOR(S)	MACALUSO ROBERTO Professore Associato Univ. di PALERMO
OTHER PROFESSOR(S)	
CREDITS	9
INDIVIDUAL STUDY (Hrs)	153
COURSE ACTIVITY (Hrs)	72
PROPAEDEUTICAL SUBJECTS	
MUTUALIZATION	
YEAR	3
TERM (SEMESTER)	2° semester
ATTENDANCE	Not mandatory
EVALUATION	Out of 30
TEACHER OFFICE HOURS	**MACALUSO ROBERTO** Tuesday 13:00 15:00 DEIM

DOCENTE: Prof. ROBERTO MACALUSO

PREREQUISITES	Logic circuits, Electronic Devices, Electronics 1
LEARNING OUTCOMES	Knowledge and understanding skills The course aims to provide the student a broad basic preparation in the analysis and design of digital electronic systems. The student will be able to analyze, identify and solve problems concerning the design of medium complexity digital systems or mixed analog/digital systems, using integrated circuits of the most common logical families: CMOS and TTL. Ability to apply the acquired knowledge and understanding The student will be able to apply the methodologies for the design of digital circuits together with the necessary analog interfaces. He will also be able to read and use the data sheets provided by the manufacturers of integrated circuits so that he/she can properly choose the components necessary to carry out the proposed projects. He/She will be able to make design choices that take into account the tolerance of the used components, the fan-out of the integrated circuits, the propagation times, the costs. Independent judgment ability The student will acquire his own methodology for analyzing the problem to be solved and the design methodologies to be used to solve problems in the most efficient way possible; through this methodology he/she will be able to choose the most suitable components for writing the executive scheme of a medium complexity digital system project. Communication skills The student will acquire the ability to communicate effectively in a written and oral way on topics and problems inherent to the subject of the course also in an international context: particular attention is in fact paid to technical English terminology. The student will be able to hold conversations on the technologies used for the realization of the majority of digital electronic circuits on the market, to highlight problems related to the speed and power dissipation of these digital systems. Learning skills The student will be able to independently face any problem related to the design of medium complexity digital circuits realized either in TTL or CMOS technology. This mastery will allow him/her to access effortlessly both to medium technical level professional positions in the field of Electronics and to specific courses of the Master degree in Electronics Engineering. Learning assessment The evaluation will be based on a written exam, which will include, in addition to a project, also two questions on the main topics of the course. The written test tends to verify that the student has adequate design skills, is able to propose original solutions to real problems, taking into account also the tolerances of the components used and the costs, is able to correlate the various contents of the course independently, includes the applications or the implications of the various contents dealt with in the discipline, has acquired adequate language properties, especially with reference to technical English terminology. The sufficiency threshold will be reached when the student shows knowledge and understanding of the topics at least in the general lines and minimum application skills in order to solve concrete cases. The student must also possess presentation and argumentative skills that allow the transmission of his/her knowledge to the examiner. Below this threshold, the examination will be insufficient. On the other hand, the more the examinee, with its argumentative and design skills, will be able to solve the proposed problems, and the more detailed his/her knowledge and application skills will be, the more positive the evaluation will be. Each question of the written test will be given a maximum score, indicated on the text of the test itself. The mark of the written exam will be given in thirtieths, for a maximum of 30/30, given by the sum of the scores assigned to each of the questions. The assignment of scores will depend on the number and severity of any errors present, as well as on the lack of topics covered. Bonuses may be added to the overall score which will contribute to the formation of the final mark: 1) "presentation" bonus (max 1 point), given to the works presented in an excellent way from a formal point of view and exhibited with excellent properties of language and fluidity of analytical and technical treatment; 2) "originality" bonus (max 2 points), depending on the originality of the design solutions given. The overall assessment of the exam will be done according to the following scheme: 30-30 cum laude: Excellent evaluation. Excellent knowledge of the topics; excellent analytical ability even in new contexts; excellent ability to provide

	original solutions for solving real problems; excellent language and learning properties; excellent ability to link together the various topics covered during the course. 28-29: Very good evaluation. Very good command of the topics covered during the course, full ownership of language; the student is able to apply knowledge fluently to solve the proposed problems and to comfortably move from one topic to another. 26-27: Good evaluation. Good basic knowledge of the main topics and good processing skills. The student is able to apply the knowledge to solve the proposed problems, although with some uncertainty. 24-25: Fair evaluation. Fair basic knowledge of the main topics covered during the course; fair language property with limited ability to independently apply knowledge to the solution of the proposed problems and to connect the various topics covered during the course. 21-23: Satisfactory. Partial mastery of the course topics, satisfactory property of language with modest ability to independently apply the acquired knowledge and solve the assigned problems. 18-20: Sufficient. Minimum ability to independently apply the knowledge acquired and to solve the proposed problems; minimal knowledge of the course topics and technical language. Insufficient: the examinee does not have an acceptable knowledge of the contents of the topics covered during the course and cannot provide any reasonable solution to the assigned problems. The student did not deliberately study certain topics on the subject.
ASSESSMENT METHODS	Written exam
EDUCATIONAL OBJECTIVES	The course represents the first teaching of Digital Electronics proposed by the Bachelor Degree program in Electronics Engineering and aims to provide students with a broad basic preparation in the field of analysis and design of digital electronic systems. Together with the study of the main logical families, with particular attention to the CMOS family, the related microfabrication technologies that are at the basis for the realization of integrated circuits are also presented. The latter will be deepened and extended towards nanotechnologies in the Master degree program in Electronics Engineering. Together with theoretical lessons, a series of digital electronic systems design exercises which make use of data sheets of commercial integrated circuits (both in bipolar and CMOS technology) will be proposed. This will allow students to master the methodologies for the design of digital electronic systems.
TEACHING METHODS	Classes, exercises.
SUGGESTED BIBLIOGRAPHY	• A. Sedra, K. Smith: Circuiti per la Microelettronica – IV Edizione, Ingegneria 2000. • Jan M. Rabaey, A. Chandrakasan, B. Nikolic': Circuiti integrati digitali – II Edizione, Pearson, 2020. • Note ed appunti del docente da scaricare dal portale studenti previa iscrizione al corso.

SYLLABUS

Hrs	Frontal teaching
1	Introduction to digital electronics and comparison with analog electronics.
1	Monolithic integration: hints on the evolution of microelectronics. Hybrid circuits.
4	Switching operation of the active semiconductor components: bipolar transistor (BJT), MOSFET and CMOS. Applications.
3	Propagation time and power dissipation (static and dynamic) of a CMOS inverter. Switching and short circuit power. Delay-power product. Output separator stages (buffer). Fan out and fan in.
8	Historical evolution of logical families: DL, RTL, DTL. Logical families TTL, STTL and CMOS: static and dynamic characteristics. Study of the fundamental logic gates. Open collector, open drain, three state gates and applications. BiCMOS family. Hints on the ECL family. Compatibility and comparison between logic families. Fan out, fan in and interconnection issues. Speed and power dissipation.
4	Synthesis methods of logical functions implemented in CMOS logic with pull-up and pulldown networks. Examples. Dependence of the delay on the configuration of the inputs.
2	Circuits for sequential networks in CMOS technology: bistable integrated circuits SR, JK, D and T. Shift registers. Description of technical data sheets of integrated circuits available on the market.
2	Counting circuits: binary, asynchronous and synchronous, decade counters, in BCD code, updown. Description of data sheets of commercial ICs.
3	Encoders-decoders, multiplexers-demultiplexers in TTL and CMOS technology.
3	Multivibrator circuits: Schmitt trigger, astable, monostable made with CMOS logic gates. Description of commercial integrated circuits.
3	Analog / digital conversion. Quantization error. Sample and hold circuit.
3	Main analog-to-digital and digital-to-analog converters.
5	Methodologies for the design of digital electronic systems.

SYLLABUS

Hrs	Frontal teaching
5	MOSFET and CMOS manufacturing process flow and related technologies.

Hrs	Practice
25	- Design of a circuit for driving an LED. - Design of a circuit for driving a low power relay. - Power dissipation and propagation delay in circuits with CMOS logic gates. - Synthesis of logical functions in CMOS technology through pull-up and pull-down networks. - Design of digital or mixed (analog/digital) electronic circuits using commercial integrated circuits: logic gates, encoders/decoders, various types of counters, flip-flops, registers, analog switches, multiplexers/ demultiplexers, AD and DA converters, Operational amplifiers.