UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Ingegneria		
ACADEMIC YEAR	2023/2024		
MASTER'S DEGREE (MSC)	ELECTRONICS ENGINEERING		
INTEGRATED COURSE	APPLIED AND INDUSTRIAL ELECTRONICS - INTEGRATED COURSE		
CODE	20516		
MODULES	Yes		
NUMBER OF MODULES	2		
SCIENTIFIC SECTOR(S)	ING-INF/01		
HEAD PROFESSOR(S)	LULLO GIUSEPPE	Professore Associato	Univ. di PALERMO
OTHER PROFESSOR(S)	VITALE GIANPAOLO	Professore incaricato esterno	Univ. di PALERMO
	LULLO GIUSEPPE	Professore Associato	Univ. di PALERMO
CREDITS	15		
PROPAEDEUTICAL SUBJECTS			
MUTUALIZATION			
YEAR	1		
TERM (SEMESTER)	1° semester		
ATTENDANCE	Not mandatory		
EVALUATION	Out of 30		
TEACHER OFFICE HOURS	**LULLO GIUSEPPE** Monday 11:00 12:00 Studio del docente (DEIM, II piano), previa conferma dell'appuntamento. **VITALE GIANPAOLO** Monday 09:00 10:00 Aule 321 Ed. 9 - Universita di Palermo Wednesday 09:00 10:00 Aule 321 Ed. 9 - Universita di Palermo		

DOCENTE: Prof. GIUSEPPE LULLO

PREREQUISITES	Good knowledge of the topics covered in the first cycle degree course in Electronic Engineering, with particular attention to the analysis of linear circuits during transient and in sinusoidal regime, to electronic devices, to control systems and to analogue and digital Electronics.
LEARNING OUTCOMES	Knowledge and understanding At the end of the integrated course the student will gain advanced knowledge in the field of Electronics and its applications in complex systems. The purpose of the course is to provide theoretical and practical methods for the analysis, the design and the fabrication of the commonest circuits and subsystems that are used in modern electronic systems. A special emphasis will be given to the design of circuits with a "mixed signal" approach, as it is almost impossible to make a clear distinction between purely analogue or digital circuits, and considering also the ubiquity of wireless technologies in modern electronic systems. Moreover many study cases will be faced relating to high performance and high efficiency Power Electronic Systems for static conversion of electrical energy, systems that have gained a central role for industrial applications, in the automotive sector and in the use of renewable energy. Applying knowledge and understanding The student will be able to use adequate software tools to simulate the operation of the main electronic circuits that make up a modern electronic apparatus, for applications at low frequencies, at high frequencies and in Power Electronics. He will also be able to undertake the design of the various circuits, critically evaluating the possible solutions, with a trade-off among performances, costs and overall system size. At this stage he will be able to independently deepen his knowledge of the characteristics of the discrete and integrated devices and subsystems to be used in the project. Making judgements The student will be able to understand the operation of the main electronic circuits, to assess the problems in the interaction among the various parts of a system and the performance limits of the parts, to collect the data needed to evaluate the characteristics of the electronic components or of the subsystems in order to make choices about their optimal use. These capabilities will allow the student to design electronic systems of varying complexity. Communication The student will acquire the ability to communicate and express matters concerning the subjects of the course. It will be able to sustain conversations or to create technical reports on topics related to the operating principle, the characteristics and the performance limits of the main electronic systems that employ either an analogue or a digital processing of signals, as well as related to power electronic systems. He will also be able to face discussions on the main electronic technologies currently available on the market, on the identification of the best solution, with regards to design specifications and to the requirements of minimization of cost and volume for the final device, and on the optimization of the system performances. Lifelong learning skills The student will learn the interactions among the various parts of an electronic system and the performance limits of the same parts. This will allow him to autonomously address the problem of the project, the analysis, the choice of the components in complex electronics systems and to continue his engineering studies in the field of the applications of Electronics, even beyond graduation, with greater autonomy and understanding.
ASSESSMENT METHODS	At the end of the course the final exam consists of an oral interview. The student is usually asked three questions, related to the theoretical subjects dealt with during the course, to circuit simulation and to the experiments carried out in the laboratory. The overall examination grade is assigned according to the adequacy and completeness of exposure of the required subjects and to the student's ability to rework and apply learned concepts to real problems, for instance examining a commercial circuit. The assigned grade is based on a 30-point scale according to the following criteria: (30-30 cum laude, ECTS grade A): 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; (27-29, ECTS grade B): good knowledge of the topics, good use of technical language, the student is able to apply knowledge to solve the proposed problems; (24-26, ECTS grade C): 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; (21-23, ECTS grade D): 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; (18-20, ECTS grade E): minimal knowledge of the main topics and basic use of technical language, very little or no ability to independently apply the acquired knowledge; (Fail, ECTS grade F): the student does not have a minimum acceptable knowledge of the topics covered in the course.
TEACHING METHODS	The course includes a number of lectures illustrating the main functional blocks present in modern electronic equipment, as well as the basic methodologies for the analysis and the design of circuits. During the course many numerical exercises (in the classroom) and practical exercises (in the Didactic Laboratory of Electronics) are carried out, related to the circuits treated in the lectures.

MODULE
INDUSTRIAL ELECTRONICS AND LABORATORY

Prof. GIANPAOLO VITALE

SUGGESTED BIBLIOGRAPHY

- Ned Mohan, Tore M. Undeland, William P. Robbins Power Electronics converters, applications and design , Wiley 2nd ed. (ISBN 0-471-22693-9) Accessibile presso UNIPA Discovery Service: https://eds.b.ebscohost.com/eds/detail/detail?vid=7&sid=f58da594-96c3-486d-9073-7e6cfa7960f6%40sessionmgr4007&bdata=Jmxhbmc9aXQmc2l0ZT1lZHMtbGl2ZSZzY2000648709&db=cat06211a- Educational material distributed during the course

Reference books:
- B. N. Mohan, Power Electronics - a first course: Wiley.
(ISBN 978-1-118-07480-0) Accessibile presso UNIPA Discovery Service: https://eds.b.ebscohost.com/eds/detail/detail?vid=5&sid=f58da594-96c3-486d-9073-7e6cfa7960f6%40sessionmgr4007&bdata=Jmxhbmc9aXQmc2l0ZT1lZHMtbGl2ZSZzY2001140865&db=cat06211aF. - M. H. Rashid, Power Electronics: Circuits, Devices, and Applications, 3rd Edition, Prentice-Hall, 2003.
(ISBN 978-0-273-76908-8) Accessibile presso UNIPA Discovery Service: https://eds.b.ebscohost.com/eds/detail/detail?vid=6&sid=f58da594-96c3-486d-9073-7e6cfa7960f6%40sessionmgr4007&bdata=Jmxhbmc9aXQmc2l0ZT1lZHMtbGl2ZSZzY2001140813&db=cat06211a- C. Ang S. Oliva A, “Power-switching converters”, CRC press, Boca Raton FL, USA, 2011.

AMBIT	50364-Ingegneria elettronica
INDIVIDUAL STUDY (Hrs)	108
COURSE ACTIVITY (Hrs)	42

EDUCATIONAL OBJECTIVES OF THE MODULE

The student, at the end of the module, will acquire knowledge and methodologies for the analysis and design of power converters that use electronic devices for switching and will acquire the theoretical and practical tools for the design and implementation of conversion systems . The student will achieve an overview knowledge of modern research topics in industrial and academic field and the main problems related to the construction of an electric power conversion system with high performance and high efficiency . The student will be able to finalize the design of the system to a specific application, using the most appropriate solutions for the proposed case. Finally, the student will also be able to use the dedicated software for the design and simulation of electronic circuits among the most widely adopted in the field of academic and industrial research in power eletronics.
During the module, practice on design and simulation of conversion systems in PSIM simulation environment will be developed with the supervision of the Head Professor of the integrated course.

SYLLABUS

Hrs	Frontal teaching
2	Introduction to the course. Analysis of non-linear circuits containing electronic power components operated in switching mode.
2	Power electronic components : diodes, BJTs, thyristors, MOSFETs, IGBTs.
4	The AC / DC conversion. Single-phase and three-phase rectifiers
6	The DC / DC conversion. Non- isolated converters, basic topologies, high gain converters
4	The DC / DC conversion. Small signal model of a converter, control systems and the stability criteria. Stability analysis. Design criteria of a compensation network .
4	The DC / DC conversion. Non-isolated converters , derived topologies. Isolated converters .
2	Resonant Converters
6	The conversion DC / AC: single-phase and three-phase inverter
2	The conversion DC / AC: multilevel inverters
4	Grid Side Converters for connection to the electricity distribution network
2	Losses analysis and minimization
2	Thermal design

Hrs	Practice
2	Analysis in simulation through PSIM software of the main circuits studied during the course

Hrs	Workshops
6	Experimental measurements on a buck converter employing the TPS40200 integrated circuit: Vin measured at the converter input (DC value and AC ripple), Vout measured at the converter output (DC value and AC ripple), Input current by the sensing resistance (DC value and AC ripple) , Voltage at the diode-mosfet-inductance node with two different timescales to highlight the overshoot and its frequency, Voltage at the inductor’s terminals (differential mode), Duty cycle.

MODULE
APPLIED ELECTRONICS AND LABORATORY

Prof. GIUSEPPE LULLO

SUGGESTED BIBLIOGRAPHY

- Maurizio Di Paolo Emilio, "Microelectronics - From Fundamentals to Applied Design", Springer, e-book available on UniPa Discovery Service, eBook ISBN: 978-3-319-22545-6
- Sedra-Smith, "Microelectronic Circuits", 7th Edition, Oxford University Press, ISBN-10: 0199339147
- Paul H. Young: "Electronic Communications Techniques", 5th Ed., Pearson - Prentice Hall, ISBN-10: 0130482854
- H.L.Kraus, C.W. Bostian, F.H. Raab: "Solid state radio engineering", Wiley & Sons, ISBN: 0-471-03018-X
- Notes and datasheets supplied by the lecturer.

AMBIT	50364-Ingegneria elettronica
INDIVIDUAL STUDY (Hrs)	153
COURSE ACTIVITY (Hrs)	72

EDUCATIONAL OBJECTIVES OF THE MODULE

The course provides the methods for the analysis and the design of the main circuits used in today's complex electronic systems.

SYLLABUS

Hrs	Frontal teaching
1	Introduction and presentation of the "Applied Electronics and Laboratory" course.
7	Basic concepts for the analysis and the design of simple linear power supplies.
6	Analogue modulation techniques for a sinusoidal carrier: amplitude and angle modulations.
9	Frequency mixers.
13	Modulators and demodulators for analogue transmissions. Hints on modulators for digital signals. Structure of a superheterodyne receiver.
2	Basic concepts on noise. Understanding the S /N ratio in analogue systems and to B.E.R. in digital systems
9	The phase locked loop (PLL): analysis and design of the circuits. Digital PLL circuits.
1	The lock-in amplifier. Signal generators by Direct Digital Synthesis (DDS).

Hrs	Practice
3	Excercises on the design of dissipative power supplies and their simulation.
3	Excercises on the design of passive and active mixer circuits and their simulation.
3	Excercises on the design of frequency modulator circuits and their simulation.
3	Excercises on the design of phase locked loop (PLL) circuits and their simulation.

Hrs	Workshops
3	Laboratory activity on testing dissipative power supplies.
3	Laboratory activity on testing passive and active mixer circuits.
3	Laboratory activity on testing frequency modulator circuits.
3	Laboratory activity on testing phase locked loop (PLL) circuits.