UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Ingegneria
ACADEMIC YEAR	2022/2023
MASTER'S DEGREE (MSC)	ELECTRONICS ENGINEERING
SUBJECT	ELECTRIC DRIVES LABORATORY
TYPE OF EDUCATIONAL ACTIVITY	D
AMBIT	20582-A scelta dello studente
CODE	18063
SCIENTIFIC SECTOR(S)	ING-IND/32
HEAD PROFESSOR(S)	DI TOMMASO ANTONINO OSCAR Professore Associato Univ. di PALERMO
OTHER PROFESSOR(S)	
CREDITS	6
INDIVIDUAL STUDY (Hrs)	96
COURSE ACTIVITY (Hrs)	54
PROPAEDEUTICAL SUBJECTS	
MUTUALIZATION	LABORATORY OF ELECTRICAL DRIVES - Corso: INGEGNERIA ELETTRICA LABORATORY OF ELECTRICAL DRIVES - Corso: ELECTRICAL ENGINEERING
YEAR	2
TERM (SEMESTER)	1° semester
ATTENDANCE	Not mandatory
EVALUATION	Out of 30
TEACHER OFFICE HOURS	**DI TOMMASO ANTONINO OSCAR** Monday 15:00 16:00 Laboratorio "EDALab" (all'interno della sala macchine) - Edificio nr. 9, ex DEIM. E' gradito un contatto (telefono o e-mail) almeno un giorno prima. Tuesday 15:00 16:00 Laboratorio "EDALab" (all'interno della sala macchine) - Edificio nr. 9, ex DEIM. E' gradito un contatto (telefono o e-mail) almeno un giorno prima. Wednesday 15:00 16:00 Laboratorio "EDALab" (all'interno della sala macchine) - Edificio nr. 9, ex DEIM. E' gradito un contatto (telefono o e-mail) almeno un giorno prima. Thursday 15:00 16:00 Laboratorio "EDALab" (all'interno della sala macchine) - Edificio nr. 9, ex DEIM. E' gradito un contatto (telefono o e-mail) almeno un giorno prima. Friday 15:00 16:00 Laboratorio "EDALab" (all'interno della sala macchine) - Edificio nr. 9, ex DEIM. E' gradito un contatto (telefono o e-mail) almeno un giorno prima.

DOCENTE: Prof. ANTONINO OSCAR DI TOMMASO

PREREQUISITES	Basic skills of physics, electrotechnics, electrical machines, power electronics and electrical drives are needed.
LEARNING OUTCOMES	- Knowledge and understanding skills At the end of the class the student will have acquired the knowledge of the working principles, mathematical models, control and design issues of industrial electrical drives. Particularly he will be able to choice and to design electric components, sensors, basing on specific requirements, in the field of electric drives. The student will be aware in advanced topics in the field of electric drives. The verification of these objectives is foreseen within the oral test, also through discussion of the exercises carried out during the course presented by each student during the examination. - Ability in applying knowledge and understanding The student will be able to use the mathematical, physical and engineering instruments for the investigation, the design and the realization of systems, or parts of them, within industrial electrical drives. He will be able to pose or hold reasonings dealing with the study, the application, the design and the setting up of electrical drives. To achieve these objectives, the course includes lectures, case studies, guided classroom exercises, autonomous exercises, use of specialized software, use of commercial catalogs. The verification of these objectives is foreseen within the oral test. - Autonomy of judgement The student will be able to know and interpret the main electromechanical data and parameters of electrical machines, sensors, power converters; he will be able to collect the data in order to carry out the correct sizing, to interpret their operation and to evaluate their correct operation during service. He will be able even to acquire a sufficient general knowledge of many aspects dealing with the electrical drives. The verification of these objectives is foreseen within the oral test, also through discussion of the exercises carried out during the course presented by each student during the examination. - Communication skills The student will acquire skills to communicate information and ideas and to express issues related to the course topics. In addition, he will be not only able to hold discussions on topics concerning the design of electrical drives, but also to highlight problems on the choice and on the adequate use of electrical machines, power converters, sensors and control systems, proposing possible solutions. To achieve these objectives the course includes lectures, discussion of case studies. The verification of these objectives is foreseen within the oral test. - Learning skills The student will gain learning skills on further comprehension of electrical drives, power electronics, sensors and control systems and their operating principles. He will acquire the ability to synthesize information and to judge the interactions between different topics and between the fundamental branches of knowledge regarding electrical engineering. These abilities will allow the student to continue the study with higher autonomy and discernment. To achieve these objectives the course includes lectures and numerical applications. The achievement of these objectives will be verified during the oral exam.
ASSESSMENT METHODS	The assessment is performed by means of an oral exam, with the presentation and discussion of the numeric exercises carried out during the course (30 minutes of average duration) which consists of: • at least 3 essay questions chosen from the whole course program; • the discussion of the reports on the tests carried out during the course. During the exam it will be evaluated: • knowledge and understanding of the course program; • ability to apply the knowledge for problem solving within the course or related contexts; • concepts reinterpretation, critical aptitudes and connection skills in disciplinary or interdisciplinary contexts; • correct use of language and writing, clearness, fluency. Marks are out of 30 and the minimum mark for passing the test is 18/30. The mark is awarded considering to what extent the student has achieved the learning outcomes. The following scheme can be assumed for reference: 28-30 with distinction Full contents mastery; no errors; self-corrections/integrations of inaccuracies/ omissions; correct and rigorous approach to problems; correct, complete and effective solutions; some originality evidence; effective concepts reworking,

	coherent and autonomous approaches and judgments, disciplinary/ interdisciplinary connections; very clear presentation, structured arguments, correct use of language. 24-27 Good knowledge and understanding of course contents; few minor errors, partially fostered self-corrections or integrations; good approach to problems, essentially correct solutions; good coherence in linking concepts and approaching disciplinary or related subjects; good presentation, adequate use of language. 18-23 Sufficient knowledge of contents; feasible approach to problems although with limited autonomy, acceptable solutions; errors or omissions not serious; sufficient concepts links within disciplinary contexts, although tentative and guided; basic presentation and use of language. Below 18 Learning outcomes are not sufficiently met.
EDUCATIONAL OBJECTIVES	The course has a substantial applicative character and face the study of Electrical Drives and Converters actually employed on both industry applications and traction, privileging the main operative issues. The learning objectives consist in giving to student adequate skill to: - chose and assembly different components and structures of an Electrical Drive; - planning and realizing verification and trial for Electrical Drives and Static power converters; - apply properly strategy of problem solving through mathematical modeling, computer simulations and experimental testing concerning the study and the development of Electrical Drives and Power converters with particular reference to VSIs; - simulate and implement on DSP and microcontrollers traditional and innovative control strategies for VSI and speed controlled electrical drives; - realize a self-evaluation of his own tracks and patterns and on the applied study methods; - gain a confident application of tools and methodologies learned within the course, in his future professional experiences.
TEACHING METHODS	The course includes the following teaching activities: lectures, class exercises, laboratory exercises. The above activities are organized such a way to facilitate the achievement of learning objectives and learning outcomes, reported in the appropriate frameworks of this form. In particular, during the laboratory exercises each student is guided: - to analyze, through mathematical models, computer simulations and experimental verification, the behavior of the main electrical power components, both at steady-state and during transients; - to acquire the ability to apply methodologies allowing analyze and solve typical problems of design, development and fine-tuning of the systems, even operating autonomous choices.
SUGGESTED BIBLIOGRAPHY	1) Presentazioni utilizzate dal docente in formato digitale (notes in digital form provided by teacher); 2) Dispense del corso in formato digitale (lecture note booklets in digital form provided by teacher); 3) Leonhard W.: Control of Electrical Drives, Springer Verlag, Edition 3, 2001; Hardcover ISBN978-3-540-41820-7, Softcover ISBN978-3-642-62609-8, eBook ISBN 978-3-642-56649-3, DOI https://doi.org/10.1007/978-3-642-56649-3. 4) N. Mohan, T. Undeland, W. Robbins “Power Electronics: Converters, Applications, and Design", 3rd Edition, John Wiley and Sons, NY 2002, ISBN: 978-0-471-22693-2, website https://www.wiley.com/en-us/Power+Electronics%3A+Converters%2C+Applications%2C+and+Design%2C+3rd+Edition-p-9780471226932.

SYLLABUS

Hrs	Frontal teaching
4	Introduction to the course, ideal model of a power transistor, dynamical model of a power inverter including DC Link equations.
8	Classical Space Vector modulation, implementation of Space Vector Modulation through the duty cycle and a low computation algorithm.
3	State space equations of a a.c. electrical machines.
4	Recalls on standard regulators, PI, PID, P, PD, tuning methods, model matching tuning rules.

Hrs	Workshops
7	Implementation of the induction motor model, scalar control implementation and simulations. PM synchronous motor model implementation. Tuning and simulation of regulators for Permanent Magnet Motor Drives. Tuning and simulation of regulators for Permanent Magnet Motor Drives.

Hrs	Workshops
6	Numerical Simulations (in the Simulink environment) of modulated VSI and DC and AC Drive control.
6	Use of the dSPACE and Arduino Due systems to implement sinusoidal PWM, Space Vector PWM.
16	Scalar Control and Field oriented control of AC Drives with induction motors and synchronous (PM) motors with dSPACE and Arduino Due systems.