UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Ingegneria
ACADEMIC YEAR	2021/2022
BACHELOR'S DEGREE (BSC)	MECHANICAL ENGINEERING
SUBJECT	ELECTRICAL DEVICES AND CIRCUITS
TYPE OF EDUCATIONAL ACTIVITY	C
AMBIT	10657-Attività formative affini o integrative
CODE	02965
SCIENTIFIC SECTOR(S)	ING-IND/31
HEAD PROFESSOR(S)	VIOLA FABIO Professore Associato Univ. di PALERMO
OTHER PROFESSOR(S)	
CREDITS	9
INDIVIDUAL STUDY (Hrs)	144
COURSE ACTIVITY (Hrs)	81
PROPAEDEUTICAL SUBJECTS	
MUTUALIZATION	
YEAR	2
TERM (SEMESTER)	2° semester
ATTENDANCE	Not mandatory
EVALUATION	Out of 30
TEACHER OFFICE HOURS	**VIOLA FABIO** Friday 9:00 13:00 Studio del docente - secondo piano, edificio 9

DOCENTE: Prof. FABIO VIOLA

PREREQUISITES	Basic principles of mathematical analysis and geometry (complex numbers; matrices and determinants; methods for solving linear systems; real functions of real variables: derivative and differential, integrals;properties and study of functions, trigonometry;differential equations) Basic principles of physical; electric and magnetic fields knowledge (field and electrostatic potential;conductors and dielectrics;electric current in conductors; Kirchhoff's laws; magnetic fields, Lorentz force, Ampere's law; Faraday's law and magnetic coupling among coils).
LEARNING OUTCOMES	D.1: KNOWLEDGE AND UNDERSTANDING Students are expected to acquire knowledge and understanding principles of the electric engineering, concerning operation of fundamental components of circuit;analysis of steady state DC and AC linear circuits. They will be able of to interpret electric schemes, and will have acquired basic notions on characteristics of magnetic materials and their use in the industrial (electric machines, electromagnets) applications. They will have learned principles of operation of more common (power static converters, transformers, inductor motors) systems of energy conversion. At the end of the course, students will have acquired basic notions on electric safety and security, technical standards on the matter, as well as basic ability tosize of electrical conductors in coordination. D.2: APPLYING KNOWLEDGE AND UNDERSTANDING At the end of the course the student will be able to analyze and to understand the operation of the basic components of the circuits, establishing besides the necessary links with the mathematical analysis and the concepts of the electromagnetism. The student will be able: to conduct the analysis and the synthesis of simple magnetic circuits and linear electric circuit in continuous or sinusoidal steady state; to choice electric machine what transformers or induction motors for industrial or civil uses; to sizing the electrical conductors in elementary distribution networks. They will have developed awareness of electric safety and security problems. D.3: MAKING JUDGMENTS Students are expected to be able to identify the most appropriate analytical techniques for the object of study applications, to critically approaching problems and make judgments as to the choice of the basic circuit components, in relation to the expected operation and the technical requirements.At the end of the course, students will be able to autonomously proceed to the choice of electric machine for industrial or civil uses, and to sizing the electrical conductors in elementary distribution networks, taking also into account of safety and security aspects. D.4: COMMUNICATION SKILLS Students are expected to clearly communicate their knowledge, analysis and conclusions concerning information, ideas, problems and solutions in the matter of analysis and synthesis of elementary circuits in continuous or sinusoidal steady state, and the most common issues concerning electrical engineering, addressing both specialist and non-specialist audiences, with correct use of language. D.5: LEARNING SKILLS Students will have acquired the methodological bases to face aspects of electrical engineering (also not specifically considered during the course of studies), retrieving and learning new information. Besides They will have acquired spendable skills to address subsequent studies with a high degree of autonomy, and to apply the acquired knowledge and skills in different contexts.
ASSESSMENT METHODS	EXAMS OUTLINE: The examination consists in a test written and an oral exam, both required. WRITTEN TEST The written test consists in solving exercises (in varying number from 2 to 4), concerning direct current circuits and alternating current; three-phase circuits, electric machines and systems. Test duration is about 1,5 hours. Written test looks at:knowledge, understanding and application of circuits analysis methods;ability to choose the most appropriate analysis techniques; accuracy and correctness of the calculations; ability to organize the concepts in orderly and coherent way. WRITTEN TEST ASSESSMENT CRITERIA.The assessment is articulated in four grades: very good; good; sufficient; not sufficient.An additional grade of evaluation (admitted with reserve) is included for not enough written test and that nevertheless potentially introduces a recoverable debt in oral exam.Written test judged "not sufficient" is considered not passed.

	ORAL EXAM The oral exam consists in an interview with essay questions on the whole course programme. To access the oral exam, the student must pass the written test. Oral exam looks at:knowledge and understanding of the course programme topics; applying such skills for problem solving concerning within the course topics or related contexts, with coherence, effectiveness and autonomy of judgment; correct use of language, clearness, fluency; ability of synthesis; concepts reinterpretation, critical faculties, and connection skills in disciplinary or interdisciplinary contexts. ORAL EXAM ASSESSMENT CRITERIA. The assessment, properly graded based on the achieved level on learning outcomes, is articulate as following: excellent results (rating 29-30L), very good results (rating 27-28), good results (rating 24-26), sufficient results (18-23); learning outcomes not sufficiently met (unranked) FINAL ASSESSMENT the attribution of the final grade, expressed in thirtieths, will take into account the levels reached in both the written test and oral exam.
EDUCATIONAL OBJECTIVES	The course aims to introduce the basic principles of the circuit models of electric and magnetic phenomena, providing methodological and theoretical tools to understand electrical engineering applications in the industrial engineering sector. In particular, the educational objectives are: - Knowing solution methods of simple DC and AC circuits, three-phase circuits, and magnetic circuits; - acquiring the operating principles and main properties of transformers, induction machines and static energy conversion systems, in order to be able to assess the conditions of employment and to face the choice for industrial and civil use; - knowing basic characteristics and functions of the electric power system, single-phase and three-phase; - sizing of electrical conductors in low voltage networks, selection of the protection as well as coordination; -raising students awareness of the electrical safety and security issues, contextually developing knowledge of the technical standards on the matter; - acquiring appropriate terminology, to clearly and properly represent the concepts and issues it is facing.
TEACHING METHODS	Lectures, lessons carried out through dialogues and interactions with students, classroom exercises. Teaching activities are organized to help the achievement learning outcomes (see learning outcomes section, descriptors D.1-D.5).Some classroom exercises will be dedicated to the simulation of the final written test.The course contents are offered emphasizing the applications and the synergy between the different topics (D.1).The exercises are aimed to assist the student in understanding and applying the theoretical acquisitions, through appropriate problems and case studies that the student will be called to discuss/resolve individually and through group work (D.2). During classroom exercises, and dialogue based lectures, students are fostered to critically analyse the proposed issues and to compare the points of strength and weakness of the different possible approaches to the solution of the same, and to identify customized solutions for engineering problems (by examining specific cases), so developingtheir analytical abilities and autonomous judgment (D.3). At the same time, the dialogue and interaction opportunities foster students to improve their skills of communication, argumentation and use of language; while continuous recalls to technical standards and their consultations in the classroom, are aimed at building a proper terminology (D.4). Through knowledge reworking, links to real and interdisciplinary applications and stimulus in facing new problems autonomously the student is encouraged to the development of learning skills, and also acquire the skill of a operational approach spendable in different disciplinary contexts(D. 5).
SUGGESTED BIBLIOGRAPHY	Testo di riferimento per la teoria (uno dei seguenti): -Allan R. Hambley: Elettrotecnica, 4a edizione: Pearson Prentice Hall, 2009. ISBN-10 : 8871925564 -G. Rizzoni: Elettrotecnica. Principi e applicazioni. McGraw-Hill ISBN-10 : 8838601291 - Chitarin, Guarnieri, Gnesotto, Elettrotecnica 1 e 2, Società Editrice Esculapio, ISBN-10 : 8893851911 ISBN-10 : 889385189X testo di riferimento per gli impianti (uno dei seguenti): - Losi, Casolino: Progettazione degli impianti elettrici di bassa tensione, Pearson - Conte: Manuale di impianti elettrici, Hoepli Per le esercitazioni:

	-Fabio Viola: Quaderno di elettrotecnica. Tangram edizioni scientifiche, ISBN-10 : 8864581146

SYLLABUS

Hrs	Frontal teaching
1	Objectives of the discipline and its subdivision. Diversification of the analysis of electrical circuits: circuits with concentrated and distributed parameters. Analysis and synthesis and learning curve: from the application of circuit analysis techniques to the realization of electrical projects.
4	The electric bipole. Voltage and current. Associated reference conditions. Electric power. Energy function. Resistor, capacitor, inductor, open circuit, short circuit, diode. Cartesian plans for defining bipoles, correlations between voltage and current. Linear bipoles invariant time and time variations. Bipoles in series and in parallel. Graphical interpretation. Star-delta transformation. Network design based on requirements.
2	Active elements: voltage and current generators. Parallel and series of generators: admissible and non admissible cases. Real generators.
4	Network definitions: node and branch, ring and mesh. Kirchhoff principles. Examples of application of the Kirchhoff principles. Branch current method for linear and non-linear networks.
6	Linear networks and reduced methods. Main methods and theorems for the analysis of electrical circuits. Overlapping method of effects, applicability and validity (voltages and currents). Ring current method, applicability and advantages. Node potential method, requirements and applications. Thevenin theorem and real generators, shutting down an electrical network. Norton's theorem, duality with Thevenin's theorem. Millman's theorem. Voltage and current divider formulas.
2	First order elementary circuits: structure, constitutive relations and properties of inductors and capacitors; first order transients. Mechanical and hydraulic analogy. Block diagram for the definition of control.
4	Series and parallel RLC circuits of the second order. Response to the associated homogeneity. Over-damped, with critical and under-damped performance. Mechanical analogy. Answer to the step.
5	Periodic functions. Definition of sinusoidal network. Traditional resolution methods by means of trigonometric laws. Phasor transform. Application of Kirchhoff's laws in the domain of phasors. Derivation and integration operation in the phasor domain. Transformation of bipoles into the domain of phasors. Analysis of electricity networks in sinusoidal regime.
6	Phase shift and power factor. Sinusoidal power: active, reactive and apparent power. Impedance triangle, tension triangle, power triangle. The power on resistors, inductors and capacitors. Power factor correction. Maximum power transfer theorem. Boucherot's theorem and Boucherot's algebra. False position method.
4	Principles of electromechanical energy conversion: rotating electrical machines and physical relationships in a rotating loop in the presence of a constant magnetic field. Chain flow method and cut force line method. Brush and collector system: sinusoidal and pseudo continuous waveform.
4	Three-phase systems. Definitions of direct and reverse triad. Terna of voltages and currents. Star loading and triangle loading. Types of resolution of a three-phase system with and without neutral. Sinusoidal power: active and apparent. Technical-economic advantages of using three-phase systems. Power factor correction in three-phase systems. Equivalent single phase. Elements of solution of unbalanced and unbalanced systems.
3	Magnetic properties of matter. Recalls of electromagnetism: circuit law, Gauss's law, Lenz and Faraday-Henry's laws, Lorentz's laws; magnetic properties of materials; ferromagnetism; magnetic hysteresis; eddy currents; energy associated with magnetic fields; energy / power losses in ferromagnetic materials. Mortgage couplings.
4	Transformer: construction aspects, ideal single-phase transformer, operating principle and equivalent circuit of the real transformer, no-load and short-circuit test, determination of machine parameters, efficiency, industrial voltage drop, parallel of transformers, autotransformer, three-phase transformer, group schedule.
4	Induction motor: construction aspects, Galileo Ferraris rotating magnetic field principle, equivalent circuit, no-load and short-circuit tests, mechanical characteristic, wound rotor and cage rotor, speed regulation, single-phase asynchronous motor.
4	General information on the electrical power system with particular reference to low voltage networks. Sizing criteria and methods and verification of low voltage power distribution lines in cables. Switching and protection devices for systems.
3	Electronic power converters: rectifier circuits, choppers and inverters. Type of electronic elements used. Natural and forced shutdown. Harmonics problem.
2	The dangers of electricity for humans; low voltage protection systems according to technical and legal regulations

Hrs	Practice
2	Applications of Kirchhoff's laws to generic circuits. Evaluation of equivalent resistances. Circuit synthesis.
4	Application of methods of node potentials and ring currents. Application of Thevenin and Norton theorem. Application of effects overlap. Power balance.
4	Application of Kirchhoff's laws in a sinusoidal regime. Network resolution using the main methods and theorems. Power evaluation. Connection of users to a power panel: evaluation.
3	Resolution of three-phase networks with and without neutral. Balanced and unbalanced loads, phasor diagrams.
6	Electrical systems. Transformer sizing, feeder sizing, protection sizing. Transformer positioning. Electric pump sizing. Small photovoltaic system sizing.