



UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Ingegneria
ACADEMIC YEAR	2023/2024
MASTER'S DEGREE (MSC)	ELECTRICAL ENGINEERING
SUBJECT	ELECTRIC INSULATION SYSTEMS DIAGNOSTICS
TYPE OF EDUCATIONAL ACTIVITY	B
AMBIT	50363-Ingegneria elettrica
CODE	22270
SCIENTIFIC SECTOR(S)	ING-IND/31
HEAD PROFESSOR(S)	ROMANO PIETRO Professore Associato Univ. di PALERMO
OTHER PROFESSOR(S)	
CREDITS	6
INDIVIDUAL STUDY (Hrs)	96
COURSE ACTIVITY (Hrs)	54
PROPAEDEUTICAL SUBJECTS	
MUTUALIZATION	
YEAR	2
TERM (SEMESTER)	2° semester
ATTENDANCE	Not mandatory
EVALUATION	Out of 30
TEACHER OFFICE HOURS	ROMANO PIETRO Monday 09:00 12:00 Laboratorio LEPRE - DEIM, Edificio 9 Tuesday 09:00 12:00 Laboratorio LEPRE - DEIM, Edificio 9 Wednesday 09:00 12:00 Laboratorio LEPRE - DEIM, Edificio 9 Thursday 09:00 12:00 Laboratorio LEPRE - DEIM, Edificio 9 Friday 09:00 12:00 Laboratorio LEPRE - DEIM, Edificio 9

<p>PREREQUISITES</p>	<p>Mandatory: no. Recommended: Knowledge of basic topics of electrical systems courses and electrical measurements.</p>
<p>LEARNING OUTCOMES</p>	<p>D.1: KNOWLEDGE AND UNDERSTANDING SKILLS After completing the course, the student will acquire knowledge on the composition and behavior of materials adopted in electrical engineering and in particular on the dielectric materials used in the production of electrical insulation systems. Furthermore, it will be able to distinguish the material characteristics in relation to the specific application to which it is intended and to know how to detect and evaluate electrical parameters useful to characterize the status of an insulation system and assess the level of reliability. To achieve this objective, the course includes: lectures and analysis and discussion of case studies during laboratory exercises. Assessment of the achievement of this objective will be through a final examination during which the student will present the topics covered in the course and laboratory exercises.</p> <p>D.2: SKILLS TO APPLY KNOWLEDGE AND UNDERSTANDING The student, at the end of the course, will be able to perform the main tests for the characterization of electrical insulation systems and to develop and / or apply original ideas for the evaluation of the behavior of materials, both in the company and in a research context. To achieve this goal, during laboratory exercises, summaries will be given to the student who must supplement them with data acquired during the laboratory activities. The achievement of this objective will be through the presentation, in the examination, the reworked laboratory sheets by the student.</p> <p>D.3: JUDGING AUTONOMY The student will have acquired the autonomy to be able to interpret and / or perform the characterization of an insulation system during design and during the diagnostic evaluation of the in service components. To achieve this goal, during laboratory exercises, the student will be required to propose new solutions and improvements compared to those adopted. The achievement of this objective will be through the presentation of a short thesis on a topic chosen by the student on several research topics proposed by the teacher and the independently reworked laboratory cards by the student.</p> <p>D.4: ENABLE COMMUNICATION The student will have acquired the ability to communicate and express with good properties of language the fundamental aspects related to the characterization of electrical insulation systems, interacting with interlocutors specialists and non-specialists. To achieve this goal the course, both in lectures and in the laboratory exercises, especially cure the methods of presentation and exhibition of the topics addressed and will leave ample room for debate among students. Verification of this objective will be carried out during the oral examination.</p> <p>D.5: LEARNING CAPACITIES The student will have acquired a high operational capability in the field of materials, electrical insulation systems and tests on high voltage apparatus, enabling him to work independently and to take responsibility for the development and / or application of original ideas, even in a research context. To achieve this goal, this capacity will be developed urging the student to draw independently from theoretical sources and information, other than those proposed during the course, drawing on texts, regulations, laws, websites, scientific articles, etc. . in which the arguments are handled in languages other than Italian, and also according to different cultural and technological approaches. The ability to learn will be verified by the analysis of the short thesis developed independently by the student and in the final examination through and during which the student will demonstrate the achieved awareness and critical capacity of analysis and synthesis of theoretical and applied aspects of discipline studied.</p>
<p>ASSESSMENT METHODS</p>	<p>Short Thesis, laboratory tests report and oral exam. The short thesis consists of the preparation of a paper in a conference paper format (about 4 A4 pages) on research topics proposed by the teacher. The report on laboratory tests involves the preparation of as many ballots as were the tutorials in which the student describes the laboratory tests and comment independently the choices made and the results obtained. In the written tests will assess: - mastery and ability to use the concepts learned during the course; - Ability to argue and analyze your choices. The oral test consists of an interview which concerns the description of the subject of the short thesis, laboratory exercises and open-ended questions on the entire course program. In the oral examination are evaluated: knowledge and understanding of the course content and the ability to apply these skills to problems and applications in their areas of the course and / or related to it; of language and clarity of presentation and argumentation; capacity 'to connect and build upon their skills, and build and make judgments in disciplinary and / or interdisciplinary contexts. The final grade takes into account the clarity, completeness, ownership of language and ability to synthesis expressed in the</p>

	<p>preparation of the short thesis and laboratory exercises for which I put on a rating which competed with the oral examination to determine the final grade.</p> <p>EVALUATION CRITERIA For each test, the voting attribution depends on the overall level of achievements. The elements that contribute to the vote formation are attributable to the following diagram (see the context of expected learning outcomes, D.1-D.5 descriptors). - 28-30 / 30 cum laude D.1 / D.2: full mastery of contents; absence of errors; correcting inaccuracies or integration of the responses independently; sound and rigorous approach of the problems; complete solutions, correct and effective; elements of originality. D.3 / D4 / D5: Effective knowledge reproduction, autonomy and coherence orienting or comment on disciplinary / interdisciplinary contexts; excellent clarity, articulate arguments; full property of language. - 24-27 D.1 / D.2: good command of the contents; a few minor errors / omissions, corrections / additions partially guided; good set of problems, substantially correct solutions. D.3 / D4 / D5: good consistency in connecting the concepts and orienting in disciplines or related to them; good clarity in, correct properties of language. - 18-23 D.1 / D.2: sufficient knowledge of the content, acceptable approach to the problems, being adequate solutions; limited autonomy, errors / omissions are not serious; D.3 / D4 / D5: orienting consistency and connect concepts in disciplinary matters, although so uncertain and driven; sufficient property of language, acceptable exposure. - Less than 18 (not attributed vote) D.1-D.5: learning outcomes inadequate.</p>
EDUCATIONAL OBJECTIVES	<ul style="list-style-type: none"> • Theoretical and practical knowledge of the methods for the assessment of the state of organic insulating materials. • Capacity 'to develop and / or apply original ideas for the evaluation of the behavior of electrical insulating materials. • Acquisition of skills related to the analysis of the phenomena involved in the phenomenon of partial discharge. • Ability to deal autonomously the study and the reliability evaluation of insulation systems of the main electrical components in medium and high voltage.
TEACHING METHODS	<p>The above activities are organized in order to facilitate the achievement of the expected learning outcomes.</p> <p>In detail, the contents of the course are offered through lectures and laboratory exercises, emphasizing the practical aspects and the synergy between theoretical aspects, the knowledge of materials and the use of high-voltage equipments. The covered Topics are gradually applied through laboratory tests, thus stimulating the development of the ability to apply knowledge and skills acquired.</p> <p>During lectures (partly carried out through dialogues and interactions with students), exercises and activities related to projects/case studies, students are fostered to critically analyze the proposed issues; this helps the development of students analytical abilities and autonomous judgment. At the same time, the dialogue and interaction opportunities foster students to improve their skills of communication, argumentation and use of language. Finally, all course activities contribute to the development of learning skills, through knowledge reworking, links to real and interdisciplinary applications and stimulus in facing new problems autonomously.</p>
SUGGESTED BIBLIOGRAPHY	<p>- Dispense fornite dal docente;</p> <p>- L. Simoni: Proprieta' dielettriche e scarica nei materiali isolanti elettrici. Ed. CLEUB – Bologna; ISBN 978-88-8091-432-7 qualsiasi edizione</p> <p>- High Voltage and Electrical Insulation Engineering. Wiley-IEEE Press; ISBN 978-04-7060-961-3</p> <p>Altri testi</p> <p>- L. Simoni: Resistenza alle sollecitazioni dei materiali isolanti solidi. Ed. CLEUB – Bologna; ISBN 978-88-491-2768-3; qualsiasi edizione</p> <p>- W. F. Smith, J. Hashemi: Scienza e tecnologia dei materiali. Ed. McGraw-Hill; ISBN 978-88-3861-536-8; qualsiasi edizione</p> <p>Il ricevimento degli studenti potrà essere effettuato, su prenotazione, anche su piattaforma Teams.</p>

SYLLABUS

Hrs	Frontal teaching
5	<p>Course introduction, summary of the topics covered, classification of materials, atomic bonds, types of structures and crystalline geometries, electrical properties of conductive materials, semiconductors, insulators, gaseous dielectrics, dielectric liquid, solid dielectrics; organic polymers, thermoplastics, thermosets, elastomers; phenomena polymerization, linear, branched and cross-linked (examples), process technology of polymer processing; synthetic resins, epoxy resins.</p>

SYLLABUS

Hrs	Frontal teaching
1	Dielectric strength insulation materials, IEC 60156 Insulating Liquids - Determination of the discharge voltage at power frequency - Test method.
4	Polarization phenomena in dielectrics, atomic polarization, electronic, dipolar, dielectric permittivity, loss factor, loss and relaxation, equivalent circuit models.
1	Analysis of dielectric material properties: the dielectric spectroscopy.
3	The insulation discharges, gas discharge for small distances, discharge in liquids, discharge in solids.
1	Dielectric strength in solid insulating materials - Determination of the discharge voltage at power frequency - Test method.
4	Partial discharges and analysis of dielectrics subjected to combined stress.
2	Partial discharge, IEC 60270 Techniques in high voltage measurement - Measurements of partial discharge.
2	Aging mechanisms of the organic materials. Models and accelerated tests. the estimated useful lives of electrical materials and insulation systems.
3	Denoising methods and pattern recognition of partial discharge signals based on innovative techniques.
3	Techniques for high-voltage testing, IEC 60060. Tests with lightning impulse voltages.
5	Overview on the most recent research topics in insulating materials and high-voltage measurements. Presentation of the subjects of the final short thesis.
Hrs	Workshops
3	Dielectric strength insulation materials, IEC 60156 Insulating Liquids - Determination of the discharge voltage at power frequency - Test method.
3	Analysis of dielectric material properties: the dielectric spectroscopy.
3	Dielectric strength in solid insulating materials - Determination of the discharge voltage at power frequency - Test method.
8	Partial discharge, IEC 60270 Techniques in high voltage measurement - Measurements of partial discharge.
3	Techniques for high-voltage testing, IEC 60060. Tests with lightning impulse voltages.