# UNIVERSITÀ DEGLI STUDI DI PALERMO

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| **DEPARTMENT** | Ingegneria |
| **ACADEMIC YEAR** | 2021/2022 |
| **BACHELOR'S DEGREE (BSC)** | ENERGY ENGINEERING AND RENEWABLE ENERGIES |
| **SUBJECT** | RENEWABLE SOURCES DISTRIBUTED POWER PRODUCTION |
| **TYPE OF EDUCATIONAL ACTIVITY** | B |
| **AMBIT** | 50298-Ingegneria elettrica |
| **CODE** | 16981 |
| **SCIENTIFIC SECTOR(S)** | ING-IND/33 |
| **HEAD PROFESSOR(S)** | FAVUZZA SALVATORE Professore Ordinario Univ. di PALERMO |
| **OTHER PROFESSOR(S)** | |
| **CREDITS** | 6 |
| **INDIVIDUAL STUDY (Hrs)** | 96 |
| **COURSE ACTIVITY (Hrs)** | 54 |
| **PROPAEDEUTICAL SUBJECTS** | |
| **MUTUALIZATION** | |
| **YEAR** | 3 |
| **TERM (SEMESTER)** | 2° semester |
| **ATTENDANCE** | Not mandatory |
| **EVALUATION** | Out of 30 |
| **TEACHER OFFICE HOURS** | **FAVUZZA SALVATORE**<br>Monday 12:00 13:30 Studio proprio sito al terzo piano del DEIM (ex DIEET) - edificio 9<br>Wednesday 14:00 15:00 Polo decentrato di Caltanissetta |

**DOCENTE:** Prof. SALVATORE FAVUZZA

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| **PREREQUISITES** | The knowledge of: Principles of Electrical Engineering, Components for Electroenergetic systems and Power Systems. |
| **LEARNING OUTCOMES** | Knowledge and understanding<br>The student at the end of the course will have acquired knowledge and understanding regarding: methodologies for choosing and designing distributed generation (DG) systems, for choosing the protection devices as well as for implementing measures to limit the issues due to the connection of distributed generators to the grid, overall renewables based. To achieve these objectives, the course will include lectures, discussion of case studies, guided exercises. The verification of these objectives is expected within the final oral exam.<br><br>Applying knowledge and understanding<br>The student at the end of the course will be able to apply his knowledge and understanding to identify the methodologies for choosing and designing DG systems, for choosing the protection devices as well as for implementing measures to limit the issues due to the connection of distributed generators to the grid.<br>To achieve these objectives, the course will include lectures, discussion of case studies, classroom exercises.<br>The verification of these objectives is expected within the final oral examination, including the discussion on the excercises book that each student presents.<br><br>Making judgments<br>The student at the end of the course will have acquired the ability to gather and interpret all the data necessary for the identification and analysis of the main issues related related to the penetration of DG from renewables in power systems. On the basis of the collected data and theoretical knowledge and acquired practices, he will be able to make independent judgments about the effectiveness of different design solutions applicable to the examined case.<br>To achieve these objectives, the course will include lectures, discussion of case studies, classroom exercises.<br>The verification of these objectives is expected within the final oral examination.<br><br>Communication skills<br>The student at the end of the course will have acquired the ability to communicate with competently, consistencly and using a correct language on the various issues and problems concerning the distributed generation from renewables, identifying connections with the topics covered in other courses, as well as speaking profitably on these topics with specialists from other branches of engineering, highlighting problems and offering solutions.<br>To achieve these objectives, the course will include lectures, discussion of case studies. The verification of these objectives is expected within the final oral examination.<br><br>Learning ability<br>The student at the end of the course will have acquired knowledge and skills not only on issues related to the the functioning and behavior of the distributed generators from renewables, but also about on the need to work always and in any case a continuous self- study, because of the constant changes in regulations and legislation and the technical and technological progress. He will be able, therefore, to continue his engineering studies with greater autonomy, awareness and discernment, recognizing that independent learning will characterize throughout his professional life.<br>To achieve these objectives, the course will include lectures, discussion of case studies, tutorials. The verification of these objectives is expected within the final oral examination. |
| **ASSESSMENT METHODS** | The assessment of acquired competences is carried out during an oral exam including the correction of the exercises collected in the exercise book that each student must provide. The oral exam consists on a discussion during which the student must answer to at least four/five open questions on the entire program of the course, including questions on the resolution of at least one exercise similar to those applied in the classroom and reported on the exercise-book.<br>Oral exam looks at:<br>- the degree of knowledge and understanding of course programme;<br>- the ability to apply the knowledge gained with competence, consistency, efficiency and independence of judgment, to solve problems or applications related to course and/or related contexts;<br>- the ability to reprocess the knowledge and skills acquired by identifying disciplinary and interdisciplinary links;<br>- the clearness capacity and correct use of language.<br>The evaluation is done at the end of the exam depending of the overall results achieved according to what follows:<br>- 28-30/30 e lode<br>The student demonstrates a very good / excellent knowledge and understanding |

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| | of the course contents, which declines in absence of errors and with selfcorrection of some inaccuracies; the answers to the questions posed are organized with a rigorous approach by providing complete solutions and demonstrating good / excellent application capabilities with a high degree of autonomy. The ability to communicate is characterized by very good / excellent clearness, fluency and use of language and articulated arguments which show a full ability to rielaborate and make judgments both in the same discipline and in interdisciplinary fields.<br>- 24-27<br>The student demonstrates a satisfactory / good knowledge and understanding of the course contents, which declines with few minor errors or omissions partially corrected or integrated by means the professor guide; the answers to the questions posed are basically correct, showing a satisfactory / good ability of independent analysis. The ability to communicate is characterized by a satisfactory / good consistency in connecting the concepts both in the same discipline and in interdisciplinary fields; adequate clearness and substantially correct use of language.<br>- 18-23<br>The student demonstrates a sufficient/decent knowledge and understanding of discipline contents, which declines with no several and critical errors and/or omissions; the answers, even if adequate, are characterize by a limited level of autonomy and effectiveness. The ability to communicate is of acceptable level of clearness, fluency and use of language, but with some limitations of concepts reinterpretation and connection in disciplinary context.<br>- below 18<br>The student shows to have not reached the minimum level of learning outcomes. Insufficient knowledge, with many several and siginificant errors or inaccuracies; insufficient capacity in the analysis and resolution of the problems, lack of autonomy in the methodological approach, inability to orient in an autonomous way or to conduct disciplinary and interdisciplinary links; deficient presentation skills and argumentation, unclear and inadequate use of language. |
| **EDUCATIONAL OBJECTIVES** | Aim of the course is to provide the basic concepts necessary for understanding the principle of operation, the design and protection criteria and the connection and authorization issues of DG devices, overall renewables based.<br>The educational objectives consist in the acquisition of language skills and competences that are covered by the activity of the industrial iunior engineers in the electrical engineering field:<br>a) activities based on the application of science, sometimes in cooperation for design activities;<br>b) direct and instrumental surveys of technical parameters related machinery and equipment;<br>c) activities that involve the use of standardized methodologies, such as the design of distributed generators.<br>A further objective is to gain awareness about the need to make a continuos selfstudy during the whole of the future professional activity, because of the constant changes in regulations and legislation and the technical and technological progress. |
| **TEACHING METHODS** | Lectures, exercises, case studies analysis, seminars and classroom discussion. Teaching activities are organized to help the achievement of learning outcomes and educational objectives. The course is characterized by theoretical contents and practical aspects; it is done in order to stimulate the participation of students by providing interactive lectures, in which priority is given not only to the connections among topics of the same course, but even those interdisciplinary; during exercises and discussion of case studies, the student is encouraged to critically analyze the issues proposed by developing their skills of analysis, of independent evaluation, communication, argumentation and of use of language, being called to deal with the professor and other students. |
| **SUGGESTED BIBLIOGRAPHY** | -Dispense del docente<br>-TICA – Testo Integrato delle Connessioni Attive<br>-Norma CEI 0-21, ultima edizione<br>-Norma CEI 0-16, ultima edizione<br>-Impianti fotovoltaici, Guida Blu, Edizioni TNE<br>- Fotovoltaico negli edifici - Edizioni Ambiente |

## SYLLABUS

| Hrs | Frontal teaching |
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| 7 | Distributed Generation: definitions, generality, types of generators, RES-based distributed generators (wind, photovoltaic, hydro). |
| 7 | Impact of distributed generation: short-circuit current increase, power reverse flow, voltage regulation, operation and coordination of overcurrent protection relays, power losses, hosting capacity, presence of harmonics. |

# SYLLABUS

| Hrs | Frontal teaching |
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| 6 | Reference technical framework: TIC, TICA, TISSPC, technical standards (CEI 0-21, CEI 0-16, IEEE Standard 1547), operating rules, reference regulatory framework for the authorization of distributed generators, Royal Decree 1775/33. |
| 10 | Connection layouts: connection layout of generators to the distribution grid, characteristic parameters of the connection, interface protective devices, generator protective device, general protective device, line protective device, energy meters' installation. |
| 8 | Safety: choice of the earth-leackage protective devices, earthing of RES-based generators in presence of electric energy storage systems and DC circuits, protection against direct and indirect contacts. |
| 5 | System's design: choice of the connection layout, choice of the generator's layout, sizing and choice of the devices, sizing of the electric energy storage syste, power factor correction, protection criteria. |

| Hrs | Practice |
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| 3 | Design of DG plants |
| 2 | Sizing of the storage. |
| 2 | Power factor correction. |
| 3 | Choice of the protections for DG plants. |

| Hrs | Others |
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| 1 | Presentation of course, objectives, exams outline, texts. |