Testi del Syllabus

Resp. Did.	**MASSI PAVAN ALESSANDRO**	**Matricola: 012665**

Docente	**MASSI PAVAN ALESSANDRO, 3 CFU**

Anno offerta:	**2026/2027**
Insegnamento:	**471MI-3 - ELECTRICAL SYSTEMS FOR THE ENERGY TRANSITION**
Corso di studio:	**IN22 - ENGINEERING FOR THE ENERGY TRANSITION**
Anno regolamento:	**2025**
CFU:	**3**
Settore:	**ING-IND/31**
Tipo Attività:	**B - Caratterizzante**
Anno corso:	**2**
Periodo:	**Primo Semestre**
Sede:	**TRIESTE**

Testi in italiano

Lingua insegnamento	English
Contenuti (Dipl.Sup.)	PHOTOVOLTAIC SYSTEMS. The role of photovoltaics in the energy transition. Classification of photovoltaic systems: domestic, commercial/industrial, utility scale; grid-connected and isolated. Photovoltaic modules, inverter and photovoltaic generator. Introduction to the electrical and empirical models of the photovoltaic cell, electrical characteristics. Inverter-photovoltaic generator design. Solar radiation and yield of a photovoltaic system: solar paths, clinometric profile, parallel rows of photovoltaic modules, performance ratio. Economic analysis: levelized cost of energy, grid and fuel parity, net present value. STORAGE SYSTEMS. The role of storage systems in the energy transition. Power applications: peak shaving and time shift. Storage types: mechanical, electrical, chemical and thermal. Definitions of basic parameters, Introduction to the electrical modeling of the cell. ENERGY MANAGEMENT SYSTEMS. The case study of the nanogrid of the University of Trieste. Energy Management Systems and energy flow optimization. Rule-based vs optimization-based EMS. Applications, objectives and constraints. Energetic, economic and environmental (3E) optimization. Emission factors and carbon intensity. Grid support and ancillary services such as peak shaving, load leveling and time shift. Optimization algorithms: Linear, Quadratic and Mixed-Integer problems. Non-linear optimization problem with heuristics. Model predictive control. Examples and optimization solutions in Matlab.
Testi di riferimento	V. Bearzi. Manuale di Energia Solare, Tecniche Nuove. Photovoltaic Solar Energy: From Fundamentals to Applications Volume 2, Wiley 2024
Obiettivi formativi	D1 - Knowledge and comprehension skills. The student will have to know the structure of the electricity supply system and the technologies involved in it. In particular, he must know and understand the operation that govern the devices and the systems (current and under development) for photovoltaic generation, and electricity storage and management. D2 - Ability to apply knowledge and understanding. The

	student must be able to draft the design of a microgrid, including the selection and rough sizing of the various components. He must be able to identify and quantify the main figures of merit for the photovoltaic and storage devices on the basis of the data available for example in the datasheets. D3 - Autonomy of judgment. The student must be able to identify the most suitable photovoltaic technologies, as well as the right storage and management of energy systems for different applications. D4 - Communication skills. The student must be able to present, clearly and using technical language, the various technologies and the functioning of the photovoltaic and electricity storage devices, their role in the electrical systems, the methods for selecting and sizing the devices. D5 - Learning skills. The student must be able to identify, procure, understand and critically discuss relevant and reliable information regarding photovoltaic and storage technologies other than those presented in the course, as well as to formulate sound hypotheses regarding the performance and functioning of such technologies.
Prerequisiti	None
Metodi didattici	Lessons and exercises also using Matlab. Part of the materials is provided using the Moodle platform. Photovoltaic laboratory.
Modalità di verifica dell'apprendimento	The examination consists of an oral exam focusing on theoretical questions and discussion of the case studies presented during the course.
Programma esteso	PHOTOVOLTAIC SYSTEMS. The role of photovoltaics in the energy transition. Classification of photovoltaic systems: domestic, commercial/industrial, utility scale; grid-connected and isolated. Photovoltaic modules, inverter and photovoltaic generator. Introduction to the electrical and empirical models of the photovoltaic cell, electrical characteristics. Inverter-photovoltaic generator design. Solar radiation and yield of a photovoltaic system: solar paths, clinometric profile, parallel rows of photovoltaic modules, performance ratio. Economic analysis: levelized cost of energy, grid and fuel parity, net present value. STORAGE SYSTEMS. The role of storage systems in the energy transition. Power applications: peak shaving and time shift. Storage types: mechanical, electrical, chemical and thermal. Definitions of basic parameters, Introduction to the electrical modeling of the cell. ENERGY MANAGEMENT SYSTEMS. The case study of the nanogrid of the University of Trieste. Energy Management Systems and energy flow optimization. Rule-based vs optimization-based EMS. Applications, objectives and constraints. Energetic, economic and environmental (3E) optimization. Emission factors and carbon intensity. Grid support and ancillary services such as peak shaving, load leveling and time shift. Optimization algorithms: Linear, Quadratic and Mixed-Integer problems. Non-linear optimization problem with heuristics. Model predictive control. Examples and optimization solutions in Matlab.
Obiettivi Agenda 2030 per lo sviluppo sostenibile	Questo insegnamento approfondisce argomenti strettamente connessi a uno o più obiettivi dell'Agenda 2030 per lo Sviluppo Sostenibile delle Nazioni Unite

Obiettivi per lo sviluppo sostenibile

Codice	Descrizione
7	Energia pulita e accessibile
9	Industria, innovazione e infrastrutture
11	Città e comunità sostenibili
12	Consumo e produzione responsabili

Codice	Descrizione
13	Agire per il clima

Testi in inglese

Language	English
	PHOTOVOLTAIC SYSTEMS. The role of photovoltaics in the energy transition. Classification of photovoltaic systems: domestic, commercial/industrial, utility scale; grid-connected and isolated. Photovoltaic modules, inverter and photovoltaic generator. Introduction to the electrical and empirical models of the photovoltaic cell, electrical characteristics. Inverter-photovoltaic generator design. Solar radiation and yield of a photovoltaic system: solar paths, clinometric profile, parallel rows of photovoltaic modules, performance ratio. Economic analysis: levelized cost of energy, grid and fuel parity, net present value. STORAGE SYSTEMS. The role of storage systems in the energy transition. Power applications: peak shaving and time shift. Storage types: mechanical, electrical, chemical and thermal. Definitions of basic parameters, Introduction to the electrical modeling of the cell. ENERGY MANAGEMENT SYSTEMS. The case study of the nanogrid of the University of Trieste. Energy Management Systems and energy flow optimization. Rule-based vs optimization-based EMS. Applications, objectives and constraints. Energetic, economic and environmental (3E) optimization. Emission factors and carbon intensity. Grid support and ancillary services such as peak shaving, load leveling and time shift. Optimization algorithms: Linear, Quadratic and Mixed-Integer problems. Non-linear optimization problem with heuristics. Model predictive control. Examples and optimization solutions in Matlab.
	V. Bearzi. Manuale di Energia Solare, Tecniche Nuove. Photovoltaic Solar Energy: From Fundamentals to Applications Volume 2, Wiley 2024
	D1 - Knowledge and comprehension skills. The student will have to know the structure of the electricity supply system and the technologies involved in it. In particular, he must know and understand the operation that govern the devices and the systems (current and under development) for photovoltaic generation, and electricity storage and management. D2 - Ability to apply knowledge and understanding. The student must be able to draft the design of a microgrid, including the selection and rough sizing of the various components. He must be able to identify and quantify the main figures of merit for the photovoltaic and storage devices on the basis of the data available for example in the datasheets. D3 - Autonomy of judgment. The student must be able to identify the most suitable photovoltaic technologies, as well as the right storage and management of energy systems for different applications. D4 - Communication skills. The student must be able to present, clearly and using technical language, the various technologies and the functioning of the photovoltaic and electricity storage devices, their role in the electrical systems, the methods for selecting and sizing the devices. D5 - Learning skills. The student must be able to identify, procure, understand and critically discuss relevant and reliable information regarding photovoltaic and storage technologies other than those presented in the course, as well as to formulate sound hypotheses regarding the performance and functioning of such technologies.
	None

	Lessons and exercises also using Matlab. Part of the materials is provided using the Moodle platform. Photovoltaic laboratory.
	The examination consists of an oral exam focusing on theoretical questions and discussion of the case studies presented during the course.
	PHOTOVOLTAIC SYSTEMS. The role of photovoltaics in the energy transition. Classification of photovoltaic systems: domestic, commercial/industrial, utility scale; grid-connected and isolated. Photovoltaic modules, inverter and photovoltaic generator. Introduction to the electrical and empirical models of the photovoltaic cell, electrical characteristics. Inverter-photovoltaic generator design. Solar radiation and yield of a photovoltaic system: solar paths, clinometric profile, parallel rows of photovoltaic modules, performance ratio. Economic analysis: levelized cost of energy, grid and fuel parity, net present value. STORAGE SYSTEMS. The role of storage systems in the energy transition. Power applications: peak shaving and time shift. Storage types: mechanical, electrical, chemical and thermal. Definitions of basic parameters, Introduction to the electrical modeling of the cell. ENERGY MANAGEMENT SYSTEMS. The case study of the nanogrid of the University of Trieste. Energy Management Systems and energy flow optimization. Rule-based vs optimization-based EMS. Applications, objectives and constraints. Energetic, economic and environmental (3E) optimization. Emission factors and carbon intensity. Grid support and ancillary services such as peak shaving, load leveling and time shift. Optimization algorithms: Linear, Quadratic and Mixed-Integer problems. Non-linear optimization problem with heuristics. Model predictive control. Examples and optimization solutions in Matlab.
	This course explores topics closely related to one or more goals of the United Nations 2030 Agenda for Sustainable Development (SDGs)

Obiettivi per lo sviluppo sostenibile

Codice	Descrizione
7	Affordable and clean energy
9	Industries, innovation and infrastructure
11	Sustainable cities and communities
12	Responsible consumption and production
13	Climate action