UNIVERSITÀ DEGLI STUDI DI TRIESTE

Dipartimento di Ingegneria e Architettura

UNIVERSITY OF TRIESTE

ACADEMIC AND TEACHING REGULATIONS

for students enrolled in the academic year 2025/26

Master's degree programme in Engineering for the Energy Transition

Classi di laurea LM-24 e LM-30

Art. 1 - Objective

1. These regulations define in detail the contents of the related General Regulations (*Ordinamento Didattico*) of the Master's degree programme in Engineering for the Energy Transition, under art. 12, s. 1 of the Ministerial Decree no. 270/2004 on "Amendments to the regulation containing the rules concerning the teaching autonomy of universities".
2. The General Regulations and the organisation of the Master's degree are defined in respect of freedom of teaching and the rights and duties of lecturers and students.

Art. 2 - Contents of the Academic and Teaching Regulations

1. The Academic and Teaching Regulations define the implementation of the General Regulations of the degree course and its organisational aspects.
2. In accordance with art. 4, s. 2 of the Teaching Regulations of the University of Trieste, the Academic and Teaching Regulations define:
   a) the list of modules (and their scientific sector), divided by year and their partition into submodules, and other teaching activities;
   b) the method for carrying out laboratory and practical activities, and traineeships;
   c) the expected learning outcomes (see annex F), the number of university credits (ECTS) and any prerequisites for modules and other teaching activities, all divided by year;
   d) the curricula available to students and, where necessary, how to present the individual study plan;
   e) the provisions on any compulsory attendance and/or any alternative learning plan for student workers and/or disabled people;
   f) the entry requirements, the procedures to verify them at enrolment and any provisions on preparatory and supplementary activities aimed at fulfilling a conditional advancement;
   g) the procedure for admission to the final examination and graduation;
   h) the procedure for verification of knowledge of the foreign language at the required level;
   i) the possible use of English as the teaching language for some modules.

Art. 3 - Structure and organisation of the Master's degree programme

The following documents and regulations set the organisation and management of the degree course:

- University Charter;
- Teaching Regulations of the University;
- General Regulations of the Master's degree; • List of taught modules and other teaching activities;
- Annual Study Plan.

Art. 4 - General Regulations of the Master's degree programme

1. The General Regulations set the structure and organisation of the Master's degree programme. In particular, they contain:
   a) the name and the ministerial class to which it belongs;
   b) the expected learning outcomes of the programme in agreement with the European qualification framework;
   c) career opportunities in relation to the activities listed by ISTAT;
   d) the plan of teaching activities in agreement with the provisions of the ministerial class to which the course belongs;
   e) the number of ECTS of all teaching activities;
   f) the entry requirements and the procedure to verify them at enrolment;
   g) the method for carrying out the final examination and graduation;
2. The General Regulations can be found in the SUA (Scheda Unica Annuale) statement of the programme.

Art. 5 - Plan of teaching activities

1. The plan of teaching activities specifies:
   a) the list of taught modules, their scientific sectors and other teaching activities;
   b) the sub-modules into which a module may be potentially subdivided and their scientific sectors;
   c) the number of ECTS of each module or teaching activity;
   d) any progression rules between modules;
2. The plan of teaching activities can be found in the SUA statement of the programme.

Art. 6 - Annual study plan

The annual study plan is updated annually and can be found in Annex A that is reported also in the SUA statement of the programme.

Art. 7 – Admissions

In order to be enrolled students must meet specific curricular requirements and must be adequately prepared. Details can be found in Annex B.

Art. 8 – Award of the degree

1. In order to graduate a student will have to acquire 120 ECTS.
2. Given that each year conventionally corresponds to 60 ECTS, the duration of the programme is two years.
3. The degree can be awarded in less than two years should the student has acquired all 120 ECTS included in their study plan.

Art. 9 - Structure of the Master's degree programme

1. The Master's degree programme entails the following types of teaching activities:
   a) core teaching activities (teaching activity of type B - TAF B);
   b) teaching activities related to the core ones, also with reference to cross-disciplinary training

(TAF C);

c) optional teaching activities (TAF D);
d) teaching activities related to the final examination and linguistic knowledge (TAF E);
e) teaching activities to improve linguistic knowledge, any traineeships, computer skills, telematic and relational skills, and all skills useful for the professional career (TAF F).

2. The number of ECTS assigned to each of the listed activities is specified in Annex A.
3. One ECTS corresponds to 25 hours of overall commitment per student. Usually, 1 ECTS corresponds to 8 hours of classroom teaching.

Art. 10 – Laboratory and practical activities, and traineeships

Such activities are promoted and coordinated by members of the Board of Studies. More details can be found in Annex C.

Art. 10bis - Foreign Languages

Verification of proficiency in spoken and written English, at least equivalent to level B2 of the Common European Framework of Reference for Language Proficiency, is part of the assessment of the applicant's personal preparation. This competence can be taken from the Curriculum studiorum or from an appropriate certificate issued by a qualified institution recognised as valid by the University. In all other cases, admission is verified by a test prepared by the University.

Art. 11 - Teaching activities preparing for the final examination

1. In agreement with its learning outcomes and assigned number of ECTS, the final examination is an extensive project or methodological work presented together with a report (Master's dissertation). The graduating student will have to prove through the dissertation that they master the topic, they can work independently and can communicate effectively. The topic needs to be pertinent to the traineeship or to issues studied throughout the programme and will be developed with the supervision of an academic staff (supervisor) and, if necessary, with the help of co-supervisors; the latter may be an academic staff of an external expert, especially if the dissertation is written during a traineeship to the premises of an external partner (either a company or an institution other than the University of Trieste).
2. The dissertation is presented and discussed during a pre-graduation examination in front of a Board nominated by the Head of Department. The Board consists of at least 3 members, one of which is the supervisor; others members can be either academic staff or external lecturers or experts. The committee assesses the content and the presentation and marks (maximum 30 marks).
3. The final mark of the Master's degree programme (a mark out of 110) is calculated through following formula:

$$L = \frac{110}{30}\,\frac{N_{cr} * E + n * P}{N_{cr} + n} + \Delta$$

with

$$\Delta = t + d + l + c \qquad \Delta = 0 \div 6$$

where

N_{cr} sum of the number of ECTS of modules or teaching activities for which a mark is assigned;
N number of ECTS of the final examination;
E weighted average of the marks of modules or teaching activities for which a mark is assigned;
P examination mark assigned by the Pre-graduation Board;
increment determined by:
- t type of dissertation, with t = 0; 1; 2 (0: literature-review; 1: design, workshop; 2: research project);
- d duration of enrolment in the programme, with d = 0; 1 (0: duration> 2.5 years (i.e. beyond extraordinary session of Year 2); 1: all other cases);
- l value based on number of marks "30 *cum laude*", with l = 0; 1; 2 (0: no. "30 cum laude" < 4; 1: 4 ≤ no. "30 cum laude" < 8; 2: no. "30 cum laude"≥ 8);
- c additional mark assigned by the Graduation Board, with c = 0; 1.

The final mark L is rounded off (e.g. 107.49 becomes 107 and 107.50 becomes 108).

4. The number of ECTS assigned to the final examination is specified in Annex A.

Art. 12 - Examination progression

1. In order to guarantee an appropriate teaching and learning path, the progression between examinations must be respected in accordance with the Teaching Regulations of the University.
2. The list of progression of examinations can be found in Annex D.

Art. 13 - Specific curricula

1. Within the programme, modules and teaching activities can be combined to offer specific curricula and to fulfil different cultural or professional needs.
2. Any specific curricula can be found in Annex A.

Art. 14 - Submission of an individual study plan

1. As an alternative to the regular procedure, a student can present an individual study plan for each academic year which includes from a minimum of 48 to a maximum of 84 ECTS, including those foreseen in the study plan of the student in the previous year and not yet acquired, with the constraint that the number of ECTS corresponding to modules or other teaching activities for which attendance has yet to be acquired should not exceed 60.
2. The Board of Studies may allow students to replace their modules with other modules offered from the University of Trieste or from other programmes of foreign Universities (either Bachelor's or Master's degrees) based on the coherence with the expected learning outcomes of the programme and the number of ECTS.

Art. 15 - Assessment

1. *Criteria for the arrangement of examination boards.* The examination board consists of two members: the module leader and another expert that can be either an academic staff or an expert of the subject. Non-academic staff experts are authorised by the Departmental Council. If the module is composed of two or more sub-modules with different leaders, they all must be part of the examination board.
2. *Assessment of taught modules and other teaching activities.* Assessment can take place with either ongoing tests or a final test to be held at the end of the module or activity.
3. *Recording of the mark for examination composed of multiple tests.* When an examination is composed of multiple tests, recording of the mark is performed only when the final mark is available.
4. *Rules for repeating failed examinations during the same academic year.* Students can repeat a failed examination in all the exam sessions of the academic calendar.

Art. 16 - Mandatory attendance

Attendance is not mandatory with the exception of any mandatory activities specified for each course.

Art. 17

Abrogated.

Art. 18 - Criteria for recording ECTS for activities and skills obtained prior to the enrolment

The Board of Studies can recognise a number of ECTS for activities performed or skills obtained prior to the enrolment to the Master's degree, if such activities are deemed coherent with the teaching activities and the expected learning outcomes of the programme as well as the duration, as specified in Annex E.

Art. 19 - Minimum number of ECTS to be acquired by the student in an established lapse Any requirements

Art. 20 - Nature of these Regulations

These Regulations are defined as Academic and Teaching Regulations under art. 12 of the Ministerial Decree no. 270/2004.

Annexes

Ann. A: Annual study plan
Ann. B: Entry requirements
Ann. C: Traineeships
Ann. D: Progression rules
Ann. E: Recognition of previously-acquired skills or qualifications
Ann. F: Learning outcomes and teaching activities: tuning matrix

Annex A – Plan of Study

The **Engineering for the Energy Transition Master's Degree Program** has two curricula:

- Sustainable Building Design and Technology
- Sustainable Industrial Systems

The courses are classified based as follows (type of educational activity, "TAF"):

TAF A = base courses
TAF B = characterizing courses
TAF C = complementary courses
TAF D = elective courses
TAF E = final thesis
TAF F = other activities

Curriculum "Sustainable Building Design and Technology"					
1st Year – 54 credits ("CFU")					
Course	*Modules*	*Code*	*Disciplinary Area "SSD"*	*TAF LM24/30*	*CFU*
Fundamentals of the Energy Sector and Renewables	Fundamentals of the Energy Sector		ING-IND/09	C/B	3
	Renewable Energy Technologies		ING-IND/09	C/B	6
Industrial Energy Management			ING-IND/08	C/B	6
Economics, Evaluations, Legislation, and Social Aspects for the Energy Transition	Environmental Economics		SECS-P/06	B/C	3
	Economic Evaluation of Projects for the Energy Transition		ICAR/22	B/C	3
	Legislation and Social Change		IUS/10	B/C	3
Fundamentals of modern Power Systems			ING-IND/33	B/B	9
Building HVAC Systems	HVAC System Design		ING-IND/10	B/B	6
	HVAC Load Calculation		ING-IND/10	B/B	3
Environmental Hydraulics: Pollutants, Emissions and Global Warming			ICAR/01	B/C	6
Elective Courses				D/D	6
2nd Year – 66 credits ("CFU")					
Course	*Modules*	*Code*	*Disciplinary Area "SSD"*	*TAF*	*CFU*
Building Envelopes and Structural Integration	Technologies for Building Skins		ICAR/10	B/C	3
	Structural Design		ICAR/09	B/C	9
Materials and Systems for the Energy Transition	Materials for the Energy Transition		ING-IND/22	C/C	3
	Electrical Systems for the Energy Transition		ING-IND/31	B/C	3
Photovoltaics and E-Mobility	Photovoltaic Systems		ING-IND/31	B/C	3
	E-Mobility		ING-IND/32	C/B	3
Integrated Ecosystem Design	Regenerative and Smart Building Technologies		ICAR/10	B/C	6
	Regulatory Framework and Building Energy Design		ING-IND/10	B/B	3
	Informative 3D Modeling for Project Design and Management		ICAR/17	B/C	3
Building Energy Simulation			ING-IND/10	B/B	6
Elective Courses				D/D	6
Other Activities				F/F	6
Final Thesis				E/E	12

Curriculum "Sustainable Industrial Systems"					
1st Year – 63 credits ("CFU")					
Course	*Modules*	*Code*	*Disciplinary Area "SSD"*	*TAF LM24/30*	*CFU*
Fundamentals of the Energy Sector, Renewables and Energy Systems	Fundamentals of the Energy Sector		ING-IND/09	C/B	3
	Renewable Energy Technologies		ING-IND/09	C/B	6
	Elements of Fluidmachinery and Energy Systems		ING-IND/09	C/B	6
Industrial Energy Management			ING-IND/08	C/B	6
Economics and Evaluations for the Energy Transition	Environmental Economics		SECS-P/06	B/C	3
	Economic Evaluation of Industrial Projects		ING-IND/10	B/B	3
Fundamentals of modern Power Systems			ING-IND/33	B/B	9
Design and Simulation of HVAC Systems	HVAC System Design		ING-IND/10	B/B	6
	HVAC Load Calculation		ING-IND/10	B/B	3
	Introduction to Computational Fluid Dynamics		ING-IND/10	B/B	3
Environmental Hydraulics: Pollutants, Emissions and Global Warming			ICAR/01	B/C	6
Elective Course				D/D	9
2nd Year – 57 credits ("CFU")					
Course	*Modules*	*Code*	Disciplinary Area "SSD"	TAF	CFU
Alternative Energy Technologies 1	Electrical Energy Storage		ING-IND/31	B/C	3
	Materials for the Energy Transition		ING-IND/22	C/C	3
	Electrical Systems for the Energy Transition		ING-IND/31	B/C	3
Alternative Energy Technologies 2	Wind Energy and Fundamentals of Nuclear Energy		ICAR/08	B/C	3
	Wave and Tidal Power Plants		ICAR/01	B/C	3
	Hydrogen and Fuel Cells		ING-IND/08	C/B	6
Integrated Spatial and Energy Planning	Spatial Planning for Photovoltaic Systems		ICAR/20	B/C	3
	E-Mobility		ING-IND/32	C/B	3
Design for Sustainability of Products and Processes	Design for sustainability of processes and LCA		ING-IND/24	C/C	3
	Sustainable materials: selection and design		ING-IND/22	C/C	3
Models and Data for the Electricity Market	Electricity Market Modeling		ING-IND/31	B/C	3
	Data Analytics in the Electricity Market		ING-IND/33	B/B	3
Other Activities				F/F	6
Final Thesis				E/E	12

In the study plan, students must register for elective courses (TAF D). **Students enrolled in one curriculum can also choose any elective course from the other curriculum without requiring approval.** Moreover, all courses listed in the table below do not require approval; students can add them directly through the online system "esse3". Students may propose other elective courses, but these are subject to approval. However, students cannot enroll in an elective course if they have already taken the same or equivalent exam in previous courses of study.

ELECTIVE COURSES					
Course	*Modules*	*Code*	*Disciplinary Area "SSD"*	*TAF*	*CFU*
Fenomeni di trasporto			ING-IND/24	D	9
Computational Fluid Dynamics and Heat Transfer	Introduction to Computational Fluid Dynamics		ING-IND/10	D	3
	Computational Methods for Fluid Dynamics and Heat Transfer		ING-IND/10	D	6
Fondamenti e Metodi per la progettazione			ING-IND/08	D	6
Control Theory			ING-INF/04	D	9
Embedded Systems			ING-INF/01	D	6
Entrepreneurship & Business Modelling			SECS-P/08	D	9
Mathematical Optimization			MAT/09	D	6
GIS (Geographic Information Systems);			ICAR/06	D	6
Strategic and Critical Materials	Strategic and Critical Raw Materials		CHIM/07	D	3
	Substitution of Critical Materials		ING-IND/22	D	3
Water waves and shore protection			ICAR/01	D	3
Meccanica avanzata e dinamica delle strutture			ICAR/08	D	6
Computational structural mechanics			ICAR/08	D	3
Analisi multidisciplinare, progetto e ottimizzazione di sistemi complessi			ING-IND/08	D	3
Manutenzione e simulazione degli impianti industriali			ING-IND/17	D	6
Impianti di abbattimento delle emissioni			ING-IND/17	D	6
Battery management systems			ING-INF/04	D	9

EVALUATION

The level of knowledge will be evaluated by oral and/or written exams, as detailed by each instructor in the syllabus and at the beginning of the course.

FURTHER INFORMATION

1. The master degree ("Laurea magistrale") in Engineering for the Energy Transition is an interclass degree ("corso di Laurea interclasse"), i.e. it can be conferred in one of two different "degree classes" of the Italian system ("classi di laurea"): either Building Systems Engineering (LM-24), or Energy and Nuclear Engineering (LM-30). The student is required to choose the degree class before the beginning of the second year;
2. Courses marked as "TAF B/C" are "characterizing" for one class and "complementary" for the other;
3. The final thesis consists in an original and independent work in the field of building systems and/or of energy engineering. It can take the form of an extensive analysis of the scientific literature on a current relevant topic, or a design project, or a research project based on experiments, theory, or computational simulation. The work can be carried out entirely at the University of Trieste and/or in collaboration with other universities, research centers, and industries – both domestic and international.

Annex B – Entry Requirements

Enrollment in the CdS in Engineering for the Energy Transition is subject to the fulfillment of curricular requirements and the verification of the student's knowledge base.

Curricular requirements

In order to be admitted to the CdS in Engineering for the Energy Transition, candidates must hold a Bachelor's degree in one of the following classes: Industrial Engineering (Class 10 of DM509/1999 and Class L-9 of DM270/2004) or Civil and Environmental Engineering (Class 08 of DM509/1999 and Class L-7 of DM270/2004).
As an alternative to holding a Bachelor's degree in one of the classes listed above, graduates in possession of a Bachelor's degree in Engineering are admitted to the CdS, provided that their curriculum includes specific minimum numbers of CFU (credits) in sets of scientific-disciplinary areas as defined below:

- at least 18 CFU in mathematics or in the following SSDs: MAT/03, MAT/05, MAT/06, MAT/07, MAT/08;
- at least 9 CFU in physics or in the following SSDs: FIS/01, FIS/02;
- at least 6 CFU in chemistry or in the following SSDs: CHIM/03, CHIM/07;
- at least 6 CFU in electrical engineering or in the following SSDs: ING-IND/31, ING-IND/32, ING-IND/33, or in FIS/01 and FIS/02 (additional to the previous 9 mentioned in point 2) or FIS/03;
- at least 6 CFU in energy engineering or in the following SSDs: ING-IND/08, ING-IND/09, ING-IND/10, ING-IND/11;
- at least 6 CFU in construction science or in the following SSD: ICAR/08.

With reference to the "Sustainable Building Design and Technology", the curriculum of students must include at least 9 CFU in one of the following scientific disciplinary areas: ICAR/06, ICAR/09, ICAR/10 or ICAR/17.

Students with degrees obtained abroad are admitted to the CdS if their degree is recognized as suitable in relation to the above-mentioned Bachelor's degrees, or if they have the minimum number of CFU in certain SSDs as indicated above following the conversion of credits or titles held. To this end, a Commission appointed by the Course Board of Studies (CCS) will evaluate university certificates and check the following information: the results obtained in the exams as in grades and credits, and the syllabus.

Personal preparation verification

Admission to the CdS in Engineering for the Energy Transition requires verification of adequate individual preparation. A degree grade of 95/110 or higher (converted in the case of a degree obtained abroad) is considered sufficient to attest to adequate individual preparation.
For those who have received a degree grade of less than 95/110, admission is subject to an interview, which may also be conducted online, with a Commission appointed by the CCS in order to evaluate the preparation of candidates on energy and electrical topics. Based on the outcome of the interview, admission to the CdS is accepted or refused.

Linguistic skills

The verification of the knowledge, in written and oral form, of the English language, corresponding at least to level [B2] of the Common European Framework of Reference for Languages, is part of the verification of the individual preparation of candidates. This competence may be inferred from the curriculum or from an appropriate certificate issued by a language center recognized by the University of Trieste. In all other cases, admission is subject to an evaluation through an interview with a Commission appointed by the CCS.

Annex C – Traineeships

Internship activity (area F) is subject to the supervision of a tutor and must be appropriately documented. It is approved (or not) by a committee composed of the tutor and another professor. Approved internship activity is worth 3 CFU if it corresponds to a minimum of 75 hours, as specified in the Study Plan. No grades are awarded for the activity itself. If the student carries out the internship outside the university, at a company, he must contact the Teaching Secretariat of the Department of Engineering and Architecture before starting the internship. The Secretariat will provide them with insurance coverage and will draw up a specific agreement.

Annex D – Progression rules

Course	Preparatory Course
Alternative Energy Technologies 2	Industrial Energy Management

Annex E - Recognition of previously-acquired skills or qualifications

The Course of Study Council (CCS) may recognize some credits for activities carried out or skills acquired prior to enrollment in the Master's degree course. This is based on the congruency of the didactic and/or training activities followed with the educational objectives of the Master's degree course and the correspondence of the relative teaching loads, as indicated below:

- Professional skills and abilities may be recognized in area F up to a maximum of 3 CFU;
- Computer skills and abilities may be recognized in area F up to a maximum of 3 CFU;
- The Training Modules offered by the University of Trieste will be recognized in area D up to a maximum of 6 CFU;
- Credits for post-secondary training activities, in the design and implementation of which the University of Trieste has participated, may be recognized in area D up to a maximum of 12 CFU. With regard to transfers from other Master's degree courses, even from other universities, the CCS evaluates the recognition of credits on a case-by-case basis, possibly using interviews to verify the knowledge actually possessed or by means of integrative tests/exams; any failure to recognize credits is adequately motivated.

MATRICE DI TUNING - CURRICULUM SUSTAINABLE BUILDING DESIGN AND TECHNOLOGY

RISULTATI DI APPRENDIMENTO ATTESI			I ANNO						II ANNO					ALTRE ATTIVITA' E INSEGNAMENTI A SCELTA								
Aree di apprendimento	**Descrittori di Dublino**	**Dettaglio descrittori**	**Renewable Energy Technologies**	**Industrial Energy Management**	**Economics and Evaluation for the Energy Transition**	**Fundamentals of modern Power Systems**	**Fundamentals of the Energy Sector and Building HVAC Systems**	**Environmental Hydraulics: Pollutants, Emissions and Global Warming**	**Building Envelopes and Structural Integration**	**Materials and Systems for the Energy Transition**	**Photovoltaics and E-Mobility**	**Integrated Ecosystem Design**	**Building Energy Simulation**	**Transport Phenomena**	**Computational Fluid Dynamics and Heat Transfer**	**Foundation and Methods for Engineering Design**	**Control Theory**	**Embedded Systems**	**Entrepreneurship**	**Mathematical Optimization**	**GIS - Geographic Information Systems**	**Conoscenza lingua straniera**
Area di apprendimento delle discipline trasversali *(quadro A4.b.2 della SUA-CdS)*	**Conoscenza e capacità di comprensione (knowledge and understanding)** insieme di fatti, principi, teorie e pratiche trasversali	*Comprensione delle relazioni complesse tra i sistemi energetici, quelli economici, l'ambiente, il paesaggio e il contesto locale*			x		x	x		x										x	x
		Conoscenza delle tecniche usate per le valutazioni economiche o multicriteria dei progetti energetic			x					x						x			x	x		x
		Conoscenza dei sistemi elettrici per la produzione, distribuzione e utilizzazione dell'energia elettrica nonché la comprensione delle tecnologie abilitanti la transizione energetica verso le fonti rinnovabili di energia, il vettore energia elettrica, la generazione distribuita e la mobilità elettrica				x	x			x	x										x
		Conoscenza delle tecnologie utilizzate per sfruttare le fonti rinnovabili di energia e la comprensione del ruolo degli specifici scenari energetici e ambientol	x				x			x	x	x										x
		Conoscenza dei sistemi fotovoltaici e di quelli elettrochimici e termici per l'accumulo dell'energia nonché la comprensione delle condizioni ambientali e delle modalità di utilizzo dell'energia elettrica	x				x			x	x	x										x
	Conoscenza e capacità di comprensione applicate (applying knowledge and understanding) azioni e procedimenti la cui padronanza è ritenuta indispensabile per applicare le conoscenze e risolvere determinati compiti	*Desumere le implicazioni e l'impatto dell'evoluzione di fattori chiave nello scenario energetico, nonché di applicarne la conoscenza allo sviluppo dei progett*			x		x	x		x												x
		Interpretare la complessità delle relazioni tra sistemi economici, ambiente contesto sociale e quella di effettuare la valutazione economica dei progetti.			x																	x
		Progettare gli impianti elettrici a servizio degli impianti energetici e quella di scegliere le tecnologie più utili alla loro gestione				x				x							x	x				x
		Effettuare valutazioni preliminari di tipo quantitativo per impianti alimentati da diverse fonti rinnovabili in funzione dell'applicazione e delle condizioni ambientali specifich	x				x			x				x	x							x
		Dimensionare un impianto fotovoltaico e il rispettivo sistema di accumulo ottimizzando il sistema dal punto di vista energetico ed economico								x	x											x
Area di apprendimento specifica delle discipline relative ai sistemi edilizi *(quadro A4.b.2 della SUA-CdS)*	**Conoscenza e capacità di comprensione (knowledge and understanding)** insieme di fatti, principi, teorie e pratiche nell'ambito dei sistemi edilizi	*Conoscenza approfondita riguardo i materiali e i procedimenti utilizzati per la realizzazione degli involucri edilizi e riguardo la loro integrazione strutturale*							x													x
		Comprensione rigorosa degli ecosistemi e del loro impatto sugli edifici dal punto di vista ambientale, funzionale e nell'ottica della minimizzazione dei consumi energetic										x	x									x
		Conoscenza approfondita del bilancio energetico degli edifici, degli effetti dell'involucro edilizio, dell'interazione con gli impianti e degli effetti climatici					x						x									x
		Conoscenza della normativa sul risparmio energetico e degli impianti termotecnici per il riscaldamento, il condizionamento e la refrigerazione, e la comprensione dell'impatto che questi hanno sulle condizioni di benessere delle persone					x					x	x									x
	Conoscenza e capacità di comprensione applicate (applying knowledge and understanding) azioni e procedimenti la cui padronanza è ritenuta indispensabile per applicare le conoscenze e risolvere determinati compiti	*Progettare l'involucro edilizio e la sua integrazione strutturale*							x													x
		Condurre l'analisi delle esigenze traducendole in requisiti prestazionali del progetto edilizio						x				x										x
		Scegliere il metodo e il software adatti alla specifica applicazione ed eseguire i calcoli energetici degli edific											x									x
		Progettare gli involucri edilizi e gli impianti di climatizzazione nel rispetto delle norme vigent		x			x															x
Area di apprendimento specifica delle discipline relative ai sistemi industriali *(quadro A4.b.2 della SUA-CdS)*	**Conoscenza e capacità di comprensione (knowledge and understanding)** insieme di fatti, principi, teorie e pratiche nell'ambito dei sistemi industriali	*Conoscenza approfondita dei principi fondamentali per la progettazione di impianti eolici e alimentati dalla fonte marina*																				x
		Conoscenza dei sistemi energetici utilizzati negli impianti industria per la produzione, distribuzione e utilizzazione del calore e dei vettori energetici non convenzionali, per il recupero del calore residuo e per la generazione del fredd		x			x								x	x						x
		Conoscenza approfondita dei sistemi fotovoltaici e dei sistemi di stoccaggio dell'energia elettrica in accumulatori elettrochimici e nell'idrogeno, oltre a quella relativa ai sistemi di gestione dell'energia								x	x											x
		Conoscenza delle caratteristiche e del funzionamento dei reattori nucleari di IV generazione e della fusione nuclear																				x
		Conoscenza teorica e pratica per impostare e risolvere studi di Life Cycle Assesment (LCA) e utilizzarne i risultati per la scelta dei materiali, dei prodotti e dei processi attraverso criteri di sostenibilità																				x
		Conoscenza dello sviluppo e del funzionamento del mercato dell'energia elettrica				x	x													x		x
		Conoscenza delle macchine a combustione esterna per la generazione distribuita e il recupero energetico, delle microturbine a gas e delle pompe di calore usate in ambito industriale		x			x															x
	Conoscenza e capacità di comprensione applicate (applying knowledge and understanding) azioni e procedimenti la cui padronanza è ritenuta indispensabile per applicare le conoscenze e risolvere determinati compiti	*Dimensionare gli elementi strutturali di un impianto eolico e quelli degli impianti di energia marina e di valutarne le prestazioni*																				x
		Risolvere problemi di analisi energetica in ambito industrial		x											x	x						x
		Progettare i sistemi fotovoltaici e quelli di accumulo dell'energia e di determinarne le performance								x	x											x
		Valutare le potenzialità dei reattori nucleari di IV generazione e della fusione nucleare																				x
		Effettuare analisi LCA e di selezionare i materiali con criteri di sostenibilità utilizzando software professiona																				x
		Comprendere gli effetti di una politica energetica e di analizzare la convenienza economica di investimenti nel settore della produzione di energia elettrica					x															x
		Effettuare delle valutazioni preliminari quantitative riguardo l'utilizzo delle microturbine a gas e delle pompe di calor		x			x															x
		Scegliere fluidi di lavoro e macchine per la generazione di energia elettrica, freddo e caldo e relativi scambiatori di calore		x			x								x							x
Competenze trasversali *(quadro A4.c della SUA-CdS)*	**Autonomia di giudizio (making judgements)**	*Capacità di integrare le conoscenze acquisite*	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
		Capacità di gestire la complessità dei progetti energetici includendo gli aspetti tecnici, economici, ambientali e socia	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	Abilità comunicative (communication skills)	*Capacità di comunicare chiaramente e senza ambiguità le proprie scelte progettuali*	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x			x
		Capacità di sintetizzare ed esporre chiaramente i propri elaborati	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	Capacità di apprendere (learning skills)	*Capacità di affrontare in modo efficace le mutevoli condizioni lavorative legate alla dinamica dell'innovazione tecnologica, dell'ambiente e dei sistemi economico e social*	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
		Capacità di riconoscere la necessità dell'apprendimento autonomo	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

MATRICE DI TUNING - CURRICULUM SUSTAINABLE INDUSTRIAL SYSTEMS

RISULTATI DI APPRENDIMENTO ATTESI			I ANNO						II ANNO					ALTRE ATTIVITA' E INSEGNAMENTI A SCELTA								
Aree di apprendimento	Descrittori di Dublino	Dettaglio descrittori	Renewable Energy Technologies, Elements of Fluidmachinery	Industrial Energy Management	Economics and Evaluation for the Energy Transition	Fundamentals of modern Power Systems	Fundamentals of the Energy Sector and Building HVAC Systems	Environmental Hydraulics: Pollutants, Emissions and Global Warming	Advanced Alternative Technologies	Materials and Systems for the Energy Transition	Sustainability of Products and Processes	Photovoltaics, Storage and Mobility	Models and Data for the Electricity Market	Transport Phenomena	Computational Fluid Dynamics and Heat Transfer	Foundation and Methods for Engineering Design	Control Theory	Embedded Systems	Entrepreneurship	Mathematical Optimization	GIS - Geographic Information Systems	Conoscenza lingua straniera
Area di apprendimento delle discipline trasversali *(quadro A4.b.2 dello SUA-CdS)*	**Conoscenza e capacità di comprensione (knowledge and understanding)** insieme di fatti, principi, teorie e pratiche trasversali	*Comprensione delle relazioni complesse tra i sistemi energetici, quelli economici, l'ambiente, il paesaggio e il contesto locale*			x		x	x		x											x	x
		Conoscenza delle tecniche usate per le valutazioni economiche o multicriterio dei progetti energetic			x					x						x			x	x		x
		Conoscenza dei sistemi elettrici per la produzione, distribuzione e utilizzazione dell'energia elettrica nonché la comprensione delle tecnologie abilitanti la transizione energetica verso le fonti rinnovabili di energia, il vettore energia elettrica, la generazione distribuita e la mobilità elettrica				x	x			x		x										x
		Conoscenza delle tecnologie utilizzate per sfruttare le fonti rinnovabili di energia e la comprensione del ruolo degli specifici scenari energetici e ambientali	x				x			x		x										x
		Conoscenza dei sistemi fotovoltaici e di quelli elettrochimici e termici per l'accumulo dell'energia nonché la comprensione delle condizioni ambientali e delle modalità di utilizzo dell'energia elettrica	x				x			x		x										x
	Conoscenza e capacità di comprensione applicate (applying knowledge and understanding) azioni e procedimenti la cui padronanza è ritenuta indispensabile per applicare le conoscenze e risolvere determinati compiti	*Desumere le implicazioni e l'impatto dell'evoluzione di fattori chiave nello scenario energetico, nonché di applicarne la conoscenza alla sviluppo dei progett*			x		x	x		x												x
		Interpretare la complessità delle relazioni tra sistemi economici, ambiente contesto sociale e quella di effettuare la valutazione economica dei progetti			x																	x
		Progettare gli impianti elettrici a servizio degli impianti energetici e quella di scegliere le tecnologie più utili alla loro gestione				x				x							x	x				x
		Effettuare valutazioni preliminari di tipo quantitativo per impianti alimentati da diverse fonti rinnovabili in funzione dell'applicazione e delle condizioni ambientali specifich	x				x			x				x	x							x
		Dimensionare un impianto fotovoltaico e il rispettivo sistema di accumulo ottimizzando il sistema dal punto di vista energetico ed economico								x		x										x
Area di apprendimento specifica delle discipline relative ai sistemi edilizi *(quadro A4.b.2 dello SUA-CdS)*	**Conoscenza e capacità di comprensione (knowledge and understanding)** insieme di fatti, principi, teorie e pratiche nell'ambito dei sistemi edilizi	*Conoscenza approfondita riguardo i materiali e i procedimenti utilizzati per la realizzazione degli involucri edilizi e riguardo la loro integrazione strutturale*																				x
		Comprensione rigorosa degli ecosistemi e del loro impatto sugli edifici dal punto di vista ambientale, funzionale e nell'ottica della minimizzazione dei consumi energetic										x										x
		Conoscenza approfondita del bilancio energetico degli edifici, degli effetti dell'involucro edilizio, dell'interazione con gli impianti e degli effetti climatici					x															x
		Conoscenza della normativa sul risparmio energetico e degli impianti termotecnici per il riscaldamento, il condizionamento e la refrigerazione, e la comprensione dell'impatto che questi hanno sulle condizioni di benessere delle persone					x					x										x
	Conoscenza e capacità di comprensione applicate (applying knowledge and understanding) azioni e procedimenti la cui padronanza è ritenuta indispensabile per applicare le conoscenze e risolvere determinati compiti	*Progettare l'involucro edilizio e la sua integrazione strutturale*																				x
		Condurre l'analisi delle esigenze traducendole in requisiti prestazionali del progetto edilizio						x				x										x
		Scegliere il metodo e il software adatti alla specifica applicazione ed eseguire i calcoli energetici degli edific																				x
		Progettare gli involucri edilizi e gli impianti di climatizzazione nel rispetto delle norme vigent		x			x															x
Area di apprendimento specifica delle discipline relative ai sistemi industriali *(quadro A4.b.2 dello SUA-CdS)*	**Conoscenza e capacità di comprensione (knowledge and understanding)** insieme di fatti, principi, teorie e pratiche nell'ambito dei sistemi industriali	*Conoscenza approfondita dei principi fondamentali per la progettazione di impianti eolici e alimentati dalla fonte marina*							x													x
		Conoscenza dei sistemi energetici utilizzati negli impianti industria per la produzione, distribuzione e utilizzazione del calore e dei vettori energetici non convenzionali, per il recupero del calore residuo e per la generazione del freddo		x			x								x	x						x
		Conoscenza approfondita dei sistemi fotovoltaici e dei sistemi di stoccaggio dell'energia elettrica in accumulatori elettrochimici e nell'idrogeno, oltre a quella relativa ai sistemi di gestione dell'energia								x		x										x
		Conoscenza delle caratteristiche e del funzionamento dei reattori nucleari di IV generazione e della fusione nuclear							x													x
		Conoscenza teorica e pratica per impostare e risolvere studi di Life Cycle Assesment (LCA) e utilizzarne i risultati per la scelta dei materiali, dei prodotti e dei processi attraverso criteri di sostenibilità									x											x
		Conoscenza dello sviluppo e del funzionamento del mercato dell'energia elettric				x	x						x							x		x
		Conoscenza delle macchine a combustione esterna per la generazione distribuita e il recupero energetico, delle microturbine a gas e delle pompe di calore usate in ambito industriale	x	x			x															x
	Conoscenza e capacità di comprensione applicate (applying knowledge and understanding) azioni e procedimenti la cui padronanza è ritenuta indispensabile per applicare le conoscenze e risolvere determinati compiti	*Dimensionare gli elementi strutturali di un impianto eolico e quelli degli impianti di energia marina e di valutarne le prestazioni*							x													x
		Risolvere problemi di analisi energetica in ambito industriale		x											x	x						x
		Progettare i sistemi fotovoltaici e quelli di accumulo dell'energia e di determinarne le performance								x		x										x
		Valutare le potenzialità dei reattori nucleari di IV generazione e della fusione nucleare							x													x
		Effettuare analisi LCA e di selezionare i materiali con criteri di sostenibilità utilizzando software professionali									x											x
		Comprendere gli effetti di una politica energetica e di analizzare la convenienza economica di investimenti nel settore della produzione di energia elettrica					x						x									x
		Effettuare delle valutazioni preliminari quantitative riguardo l'utilizzo delle microturbine a gas e delle pompe di calore		x			x															x
		Scegliere fluidi di lavoro e macchine per la generazione di energia elettrica, freddo e caldo e relativi scambiatori di calore	x	x			x								x							x
Competenze trasversali *(quadro A4.c della SUA-CdS)*	**Autonomia di giudizio (making judgements)**	*Capacità di integrare le conoscenze acquisite*	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
		Capacità di gestire la complessità dei progetti energetici includendo gli aspetti tecnici, economici, ambientali e sociali	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	Abilità comunicative (communication skills)	*Capacità di comunicare chiaramente e senza ambiguità le proprie scelte progettuali*	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x				x
		Capacità di sintetizzare ed esporre chiaramente i propri elaborati	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	Capacità di apprendere (learning skills)	*Capacità di affrontare in modo efficace le mutevoli condizioni lavorative legate alla dinamica dell'innovazione tecnologica, dell'ambiente e dei sistemi economico e sociale*	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
		Capacità di riconoscere la necessità dell'apprendimento autonomo	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x