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Troyes

March-May  
2027

# TEDS Thematic Challenge Spring semester @unicas



EUROPEAN  
UNIVERSITIES  
BY  
AGREEMENT  
WITH  
THE  
EUROPEAN  
COMMISSION  
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## Sustainability as the New Design Paradigm

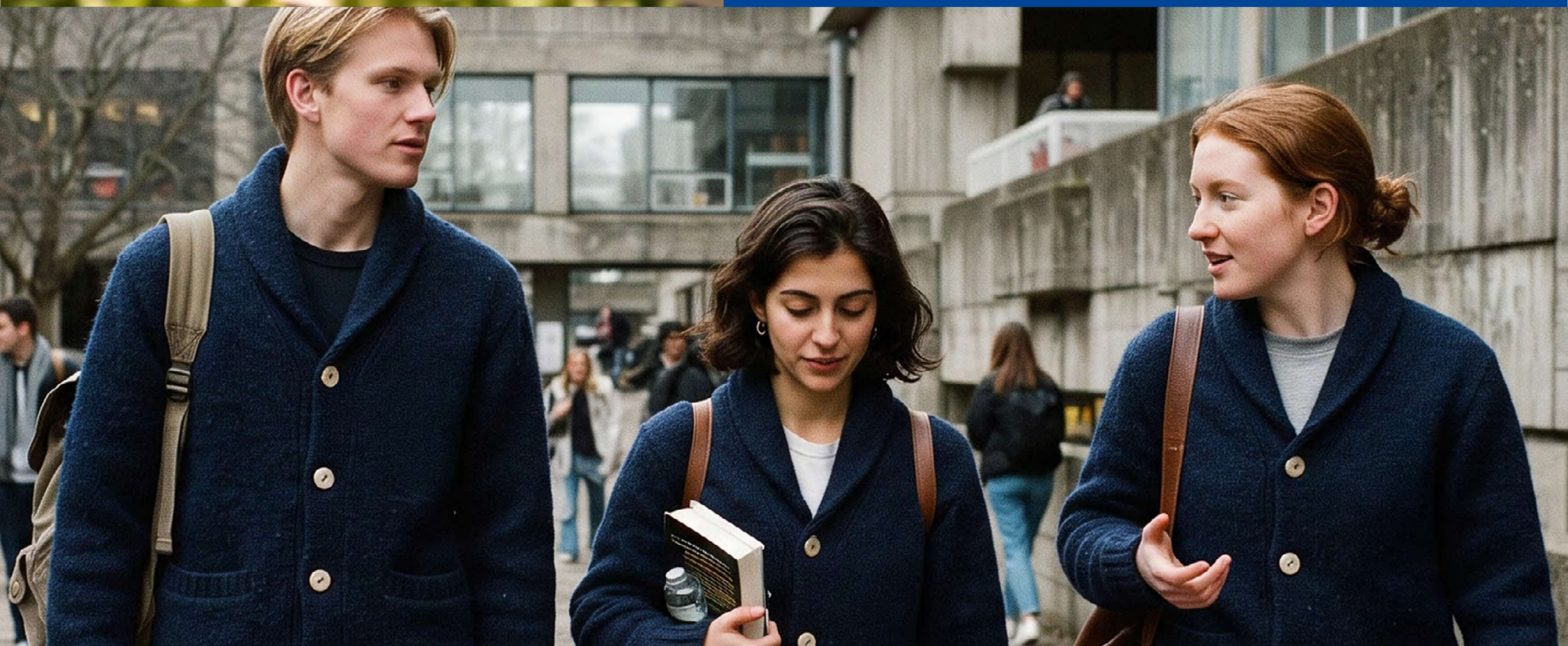
Rethink Design,  
Challenge the Present, Shape the Future

## International Bachelor Semester

Fully Integrated 30 ECTS  
English Taught Program

Go beyond conventional thinking!

TEDS Technology Studies, Engineering, and Design School is an EUT+ educational initiative that connects technical learning with design thinking, societal relevance, and realworld engineering challenges.



# Sustainability as the New Design Paradigm

## The Learning Experience

Between March and May 2027, an international cohort of students will explore how to shape sustainable practices through PSSD (product-service-system design). In laboratory settings with a Challenge-Based Learning approach, students from different backgrounds will experience Design Science's unique ways of knowing and doing. Students will learn and practice how to synergise Design, Economics, and Engineering by implementing concrete projects, co-innovating in a heterarchical VAP (Value-Adding Partnership) with companies of the Cassino Industrial District with a focus on internationalisation to China, Shanghai.



*The Cassino Industrial district hosts a diverse industrial ecosystem including major companies, alongside paper mills and a network of SMEs supporting local supply chains, as well as Industry and Business Associations (Unindustria and ANCE)*

The course will be delivered in collaboration with laboratories affiliated with the University's Technology Transfer Office (UTT) at Unicas and the Research Lab for Sustainable Business & Cultural Bridge (ResLAB SB&CB) at Tongji University, China.



## Who can take part

- **Academic Level:**

Bachelor students

- **Partner Institutions:**

Students from the European University of Technology (EUT+) alliance, international partner universities, and Italian universities participating in the Italian Erasmus

- **English Language skills**

A minimum B2 level of English proficiency is recommended

- **Degree Program**

Challenge-based learning integrating Engineering, Technology, and Design through transdisciplinary collaboration among international teams and instructors, across Civil and Environmental, Computer, Industrial and Mechanical, Management, and Telecommunication Engineering, Architecture and Design, and Economics.

Members of EUT+



# Curriculum Design & Mobility Framework

## Academic Program Structure

The semester is structured around three interconnected learning activities, combining interdisciplinary education, project-based learning, and collaboration with local businesses and industries.

| 15 ECTS<br>Challenge studio*                                                                                                                                                                                       | 3 ECTS<br>AI Studio                                          | 12 ECTS<br>Unicas Courses                                                                                                                   |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| Sustainable Innovation through Design Thinking <sup>1, *</sup><br><br>* Prof. Avril Accolla from Tongji University (China)                                                                                         | Artificial intelligence for innovative learning <sup>1</sup> | Students can tailor their academic pathway by selecting courses covering engineering, economics, and Italian language learning <sup>2</sup> |
| <sup>1</sup> The final evaluation will be held at the end of the course<br><sup>2</sup> The final exam will be held in June and July<br>Please refer to the list in syllabi of the course attached to the brochure |                                                              |                                                                                                                                             |

The programme includes approximately 180 hours of guided learning activities and independent study, combining theoretical lectures, project-based laboratory activities, and potential internship opportunities

### □ ECTS Framework

ECTS-based learning activities aligned with the European Higher Education Area (EHEA).

### □ Credit Recognition

Recognition of the full 30 ECTS programme or individual components by the student's home institution.

### □ Learning Agreement

Credit recognition agreed upon before mobility between the student, UNICAS and the home institution.

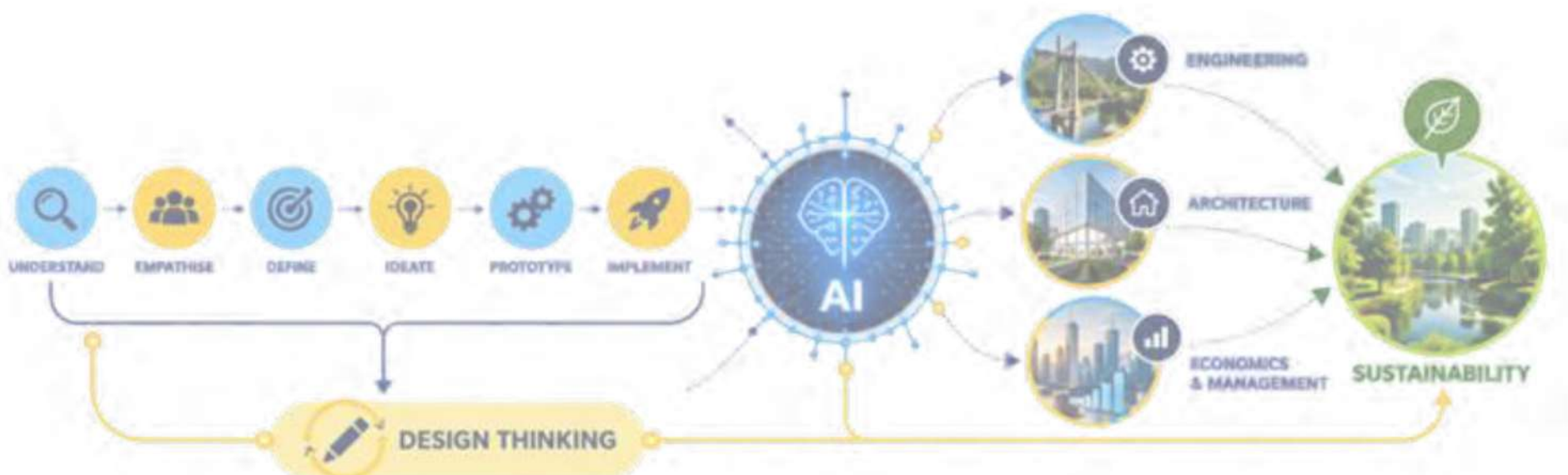
### □ Mobility Programmes

Recognition procedures in accordance with Erasmus+ or Italian Erasmus

## Additional Academic Information

- ┌ **Assessment methods:** Project work, practical activities and examinations.
- ┌ **Flexible Learning Pathway:** Flexible course selection based on academic interests and requirements.
- ┌ **Industry engagement:** Real-world projects with local and international industry partners.
- ┌ **Academic support:** Guidance on course selection and mobility.

# Expected Learning Outcome



By the end of the **TEDS Thematic Challenge @ UNICAS**, students should demonstrate ability in:

- ◆ Transdisciplinary Thinking: Integrate Engineering, Architecture, Design and Economics to address complex challenges.
- ◆ Sustainable Innovation: Apply Design Thinking and Product-Service System Design (PSSD) to develop sustainable solutions.
- ◆ AI & Digital Competences: Use AI tools critically, ethically and responsibly to support innovation and design.
- ◆ Challenge-Based Problem-Solving: Develop creative and practical solutions to real-world challenges.
- ◆ Industry Collaboration: Foster co-innovation and value creation with local and international industry partners.
- ◆ International & Intercultural Skills: Collaborate effectively in multidisciplinary and international teams.

## ACADEMIC COORDINATORS & APPLICATION INFO

- **Program local reference people:** Prof. Maura Imbimbo (m.imbimbo@unicas.it) & Prof. Assunta Pelliccio (assunta.pelliccio@unicas.it)
- **Application Procedure:** Erasmus+ Online Learning Agreement (OLA) via Erasmus Without Paper & UNICAS International Office / EUt+ Alliance.
- **Deadline:** 11 December 2026



可持续商业与文化桥梁  
Sustainable Business & Cultural Bridge

RESEARCH LAB



## SUSTAINABLE INNOVATION THROUGH DESIGN THINKING 15 CFU / ECTS

**Main Instructor:** Prof. Avril Accolla (*Co-Coordinator Master in Design Thinking and Sustainable Future, Director of the Research LAB for Sustainable Business & Cultural Bridge*)

**Tutors:** tbd from different engineering fields

**Level:** Bachelor

**Language of Instruction:** English

**Pedagogical Approach:** Challenge-Based Learning (CBL), Learn-by-Doing (LbD), Transdisciplinary & Industry-Informed

### Course Overview

The course bridges fundamental design epistemology, Product-Service System Design (PSSD), and Design Thinking to address real-world challenges. Designed for undergraduate students, the course introduces how Design, Economics, and Engineering intersect within a concrete industrial ecosystem. In laboratory settings with a Challenge-Based Learning approach, students from different backgrounds will experience Design Science's unique ways of knowing and doing. Students will learn and practice how to synergise Design, Economics, and Engineering by implementing concrete projects, co-innovating in a heterarchical VAP (Value-Adding Partnership) with companies of the Cassino Industrial District with a focus on internationalisation to China, Shanghai.

The course will be delivered in collaboration with laboratories affiliated with the University's Technology Transfer Office (UTT) at Unicas and the Research Lab for Sustainable Business & Cultural Bridge (ResLAB SB&CB) at Tongji University, China and with an interaction of the major companies and network of SMEs of the Cassino industrial district.

## Intended Learning Outcomes

By the end of the course, student should be able to:

- ◆ Transdisciplinary Thinking: Integrate Engineering, Architecture, Design and Economics to address complex challenges.
- ◆ Sustainable Innovation: Apply Design Thinking and Product-Service System Design (PSSD) to develop sustainable solutions.
- ◆ AI & Digital Competences: Use AI tools critically, ethically and responsibly to support innovation and design.
- ◆ Challenge-Based Problem-Solving: Develop creative and practical solutions to real-world challenges.
- ◆ Industry Collaboration: Foster co-innovation and value creation with local and international industry partners.
- ◆ International & Intercultural Skills: Collaborate effectively in multidisciplinary and international teams.

## Assessment and Grading Policy

The evaluation focuses on steady progression, team collaboration, and practical deliverable quality:

- *20% individual project: MY PROCESS*
- *30% individual project: MY DfA*
- *40% group project: MY DESIGN*
- *10% Class Participation & Attendance: encourage discussions and questions.*

## Course Materials & References

- **Main Textbook:**

Accolla, A. (2021). Design for All: Design Approach and Practice Catering for the Real Individual. Shanghai: Tongji University Press [(意)艾薇儿·阿科拉, 等著 (2021). 全民设计: 面向真实个体的设计. 同济大学出版社.]

Accolla, A., & Shan, X. (2025). Implementing design for all: The role of ANAs in addressing human diversity. In Design for Inclusion (Vol. 169, pp. 99–110). AHFE International. <https://doi.org/10.54941/ahfe1006159>

- **Supplementary Materials:** Introductory reading sheets, lecture slides, and case study briefs provided during the semester.



## DEPARTMENTS OF ENGINEERING - VIA G. DI BIASIO

### ARTIFICIAL INTELLIGENCE FOR INNOVATIVE LEARNING 3 CFU/ECTS

The course explores the use of Artificial Intelligence (AI) as an innovative tool in education, with a particular focus on Challenge-Based Learning (CBL), Project-Based Learning (PBL), and collaborative problem-solving.

Students will learn how Generative AI and Large Language Models (LLMs) can support the identification, analysis, and resolution of real-world challenges, fostering creativity, critical thinking, interdisciplinary collaboration, and design thinking.

Through practical activities, case studies, and team-based projects, participants will explore AI-assisted approaches to problem formulation, solution design, prototyping, and evaluation.

The course also addresses the critical assessment of AI-generated solutions, ethical considerations, and the responsible use of AI in engineering practice.



## LIST OF UNICAS COURSES

*(selected from UNICAS's English-taught course catalogue to fulfill the 12 ECTS requirement)*

### DEPARTMENTS OF ENGINEERING - VIA G. DI BIASIO

#### 6 CFU / ECTS COURSES

Advanced Programming Techniques

Air, Soil and Water Quality Management

Antenna Foundations

Computer Aided Design 6 CFU/ECTS / Object-Oriented-Programming

Electronics

Energy Management and Renewable Sources

Fundamentals of Chemistry

Fundamentals Machine Design

Metallurgy

#### 9 CFU/ECTS COURSES

Automatic Control

Communication Networks

Hydraulics Design

Industrial and Environmental Measurements

Manufacturing Technologies

Thermodynamic and Heat Transfer

#### 12 CFU/ECTS COURSES

General Physics

Mathematics II

## **DEPARTMENT OF ECONOMICS - CAMPUS FOLCARA**

### **6 CFU/ECTS COURSES**

Applied Econometrics

Economic Statistics

Cyber International Law

### **2 CFU/ECTS MICROCREDENTIALS**

Financial formulas in Excel

Index numbers in Economics

Life Tables and Population Age Structure

## **UNIVERSITY LANGUAGE CENTER CLA-C – CAMPUS FOLCARA**

### **6 CFU/ECTS COURSES**

Italian Language for Erasmus+/International Student

## SYLLABI OF UNICAS COURSES

*(selected from UNICAS's English-taught course catalogue to fulfill the 12 ECTS requirement)*

### DEPARTMENTS OF ENGINEERING - VIA G. DI BIASIO

#### ADVANCING PROGRAMMING TECHNIQUES 6 CFU/ECTS

The course introduces the principles of object-oriented programming and the main software development methodologies. It aims to provide conceptual and practical foundations for the design, implementation, and organization of simple software applications, promoting a modular and quality-oriented approach to code development.

#### Expected Learning Outcomes

Upon successful completion of the course, students will be able to analyze complex problems and design effective software solutions using the object-oriented programming paradigm in Java. They will gain the ability to design modular, reusable, and maintainable software architectures by correctly applying data abstraction, encapsulation, inheritance, polymorphism, and interfaces, alongside core design patterns and principles. Furthermore, students will master the use of standard Java collection frameworks and advanced data structures, handle exceptions and system resources robustly, and apply rigorous testing and debugging techniques to ensure the quality, reliability, and correctness of their code.

#### Prerequisites

To successfully attend this course, students are expected to have a solid foundation in fundamental imperative and procedural programming concepts, preferably acquired through hands-on experience with the C++ programming language.

Specifically, required prerequisites include: familiarity with basic data types, variables, operators, and control flow structures (conditionals and loops); proficiency in function decomposition, parameter passing (by value and by reference), and recursion; understanding of memory management concepts (pointers, references, and dynamic allocation); ability to design, code, and debug basic algorithms and fundamental data structures.

#### Syllabus

- Introduction to Java and its IDE.
- Computer Programming as a modeling task: Procedural programming vs. Object-Oriented Programming.
- Java Architecture and Fundamentals: The Java Virtual Machine (JVM), bytecode compilation, and execution. Memory management in Java and Garbage Collection.
- Recursive programming.
- Classes, Objects, and Methods: Object instantiation, method invocation, parameter passing, and return values.
- Object Lifecycle: Object creation, constructors, initialization, and Garbage Collection.
- Designing a Class: Interface vs. implementation. Data abstraction, encapsulation, and information hiding (access modifiers).
- Inheritance and Polymorphism: Abstract classes, single inheritance, dynamic binding, and method overriding.
- Interfaces and Generics: Interface definition and implementation, type abstraction, Generics, and parametric types.
- Exception Handling: Error handling architecture in Java (try-catch-finally, checked vs. unchecked exceptions).
- Testing and Debugging: Testing and debugging object-oriented programs, unit testing concepts (e.g., JUnit).
- Abstract Data Types and the Java Collections Framework: Core data structures (Lists, Sets, Maps) and standard collection APIs.

- Unified Modeling Language (UML): Class diagrams, associations, aggregations, compositions, and inheritance relationships.
- Design Patterns: Introduction to fundamental design and architectural patterns (e.g., Factory, Singleton, Strategy, Observer).
- Laboratory Activities: Design, coding, package structuring, testing, and debugging of Java applications.

**Assessment methods**

Student assessment consists of a written/practical examination, carried out on a computer, aimed at evaluating the ability to design and implement software solutions using Java and object-oriented programming principles. An optional oral examination may be held upon request of the student. The final grade is expressed on a 30-point scale and contributes to the final degree grade.

**Text and materials**

Absolute Java

Walter Savitch — Pearson (2018)

ISBN: 978-0134041674 (Recommended)

Big Java: Early Objects (7th ed. for Java 8-11)

Cay Horstmann — Apogeo (2020)

ISBN: 978-1119499442 (Recommended)

Any other introductory Java textbook covering the course topics is to be considered fully equivalent.

**Attendance Policy**

The course consists of face-to-face, in-person lectures.

**Course Delivery Format**

Theoretical lessons will take place in a traditional classroom, while practical exercises and lab sessions will be held in the computer lab.

## **AIR, SOIL AND WATER QUALITY MANAGEMENT 6 CFU/ECTS**

### **Expected Learning Outcomes**

At the end of the course, students will be able to identify the main physical, chemical and microbiological parameters used to assess water quality, understand water treatment processes and apply basic design criteria. They will also be able to describe soil properties and contaminant behavior, understand the main principles of environmental risk assessment, and compare remediation technologies for contaminated sites. Students will also be able to identify the main air pollutants, including PM10 and PM2.5, and understand the main technologies used to treat gaseous emissions.

### **Prerequisites**

Knowledge of mathematics, physics, and chemistry is required.

### **Syllabus**

Water supply: physical, chemical, and biological characteristics, regulations, and principles of water treatment processes. Water pollution: sources, effects, and self-purification capacity. Wastewater: physical, chemical, and biological characteristics, pollutant load, discharge requirements, regulations, principles of wastewater treatment processes, and final disposal. Soil pollution: sources, effects, and remediation. Solid waste: characteristics, regulations, management stages, and principles of disposal systems. Air pollution: PM10, PM2.5, regulatory limits, industrial flue gas treatment, and physical, chemical, and biological methods for removing pollutants from contaminated air streams using extraction and treatment systems.

### **Assessment methods**

The assessment consists of a discussion of the case studies addressed during the course, followed by an examination covering the topics discussed in lectures and practical sessions.

### **Text and materials**

C. Collivignarelli and G. Bertanza. Ingegneria Sanitaria-Ambientale (Environmental Engineering), (2012).

P. Sirini. Ingegneria Sanitaria Ambientale. McGraw-Hill.

G. d'Antonio. Ingegneria sanitaria ambientale – Esercizi e commento di esempi numerici. HOEPLI, (2007).

H. S. Peavy, D. R. Rowe and G. Tchobanoglous. Environmental Engineering. McGraw-Hill, (1985).

W. J. Masschelein. Unit Processes in Drinking Water Treatment (Environmental Science and Pollution Control Series), Marcel Dekker (1992).

### **Attendance Policy**

In person.

### **Course Delivery Format**

Lectures, classroom exercises, and guided site visits (when possible).

## **ANTENNA FOUNDATIONS 6 CFU/ECTS**

### **Expected Learning Outcomes**

The course covers the fundamentals of high-frequency radiation, reception, and free-space propagation, with applications in telecommunications engineering. Students will acquire knowledge of the main elements of antennas and free-space propagation. They will acquire the ability to understand antenna operation and signal propagation phenomena. Upon completion of the course, students will be able to formulate and solve problems related to circuits with transmitting and receiving antennas, as well as antenna connection problems.

### **Prerequisites**

To achieve the objectives, a good knowledge of the mathematics and physics concepts covered during the first two years of the course (linear algebra, algebra of real and complex fields, mathematical analysis) and the concepts covered in the courses "Circuit Theory" and "Introduction to Electromagnetism" is strongly recommended, in particular, the knowledge of transmission line theory, polarization, and plane waves.

### **Syllabus**

Reminders of Maxwell's equations

Radiation and antennas: elementary dipole, far-field approximation, radiation characteristics of an antenna.

Electrodynamic potentials. Elementary dipole. Reciprocity and receiving antennas.

Antenna transmission parameters: Directivity, Gain, Effective Area, EIRP

Antenna reception parameters: Input impedance, effective height

Friis connection formula.

Uniqueness theorem.

Elementary loop.

Wire antennas. Short antenna. Half-wave antenna. Marconi antenna.

Microstrip antenna

Array

Aperture antennas, horn, parabolic antennas, lens antennas

### **Assessment methods**

The exam consists of a written test followed by a discussion of the written work.

### **Texts and materials**

Course notes

Kildal-Foudations of Antennas (<https://www.kildal.se/downloads/>)

### **Attendance Policy**

Class attendance is not mandatory but strongly recommended.

### **Course Delivery Format**

The course is delivered entirely through in-person lectures and classroom exercise sessions.

## COMPUTER AIDED DESIGN 6 CFU/ECTS (OBJECT-ORIENTED-PROGRAMMING 6 CFU/ECTS)

### Expected Learning Outcomes

*Knowledge and Understanding.* Students acquire knowledge of the principles of technical drawing, the main standards for technical representation, and three-dimensional modelling techniques using CAD tools.

*Applying Knowledge and Understanding.* Students can interpret and produce technical drawings, model mechanical components and assemblies, and generate corresponding technical documentation using CAD tools.

*Making Judgements.* Students develop the ability to select the most appropriate representation and modelling methods.

*Communication Skills.* Students can present and document technical work clearly, using appropriate technical terminology and graphical conventions.

*Learning Skills.* Students develop the ability to independently deepen their knowledge of technical drawing methodologies and CAD tools.

### Prerequisites

Basic knowledge of geometry, algebra, and trigonometry.

Basic familiarity with computer use.

Ability to read and understand English.

### Syllabus

The course covers the fundamental principles of technical drawing and graphical representation, with particular emphasis on orthographic projections, sections, axonometric projections, dimensioning, dimensional and geometrical tolerances, surface finish indications, and the main international standards. The course also introduces the fundamental concepts of Computer-Aided Design (CAD), the use of parametric three-dimensional modelling tools for mechanical components, the creation and management of assemblies, and the definition of assembly constraints. Finally, the course includes the preparation of technical drawings from three-dimensional models, including views, sections, dimensions, tolerances, and technical annotations, as well as assembly drawings and the corresponding bills of materials.

### Assessment methods

Assessment will consist of a practical computer-based examination in which students will be required to use CAD software to create three-dimensional models of an assigned mechanical component and assembly, and subsequently produce the corresponding technical drawings.

### Texts and materials

Lecture slides and supplementary teaching materials available on Google Classroom.

Manuals and technical documentation for the CAD software used during the course.

Simmons, C. H., Maguire, D. E., Phelps, N., Manual of Engineering Drawing: British and International Standards.

### Attendance Policy

Attendance is not mandatory but is strongly recommended, given the practical exercises aimed at developing proficiency in the use of CAD tools.

### Course Delivery Format

The course combines theoretical lectures and practical exercises. Theoretical lectures introduce the principles of graphical representation, the main technical drawing standards, and the fundamental concepts of three-dimensional modelling and CAD software use. Practical exercises allow students to apply the acquired knowledge using CAD software to create three-dimensional models of mechanical components and assemblies and produce the corresponding technical drawings.

## **ELECTRONICS 6 CFU/ECTS**

The course aims to provide the basic concepts of analog and digital electronics for the design of electronic systems. Special attention will be paid to operational amplifiers and their applications, such as instrumentation amplifiers, Schmitt triggers, and active filters. Boolean algebra, logic gates, and reduction techniques will be introduced, along with the basics of VHDL for programming an FPGA.

### **Expected Learning Outcomes**

The course will provide basic knowledge of the design of analog and digital electronic systems, including the use of Operational Amplifiers and FPGA programming. The students will be able to design analog circuits with Operational Amplifiers, simulate them, and test them experimentally using laboratory instrumentation. They will also learn how to program an FPGA by writing VHDL code. Students will work in groups during the practical classes, and everyone is expected to adopt a critical mindset and demonstrate proficiency in the course topics.

### **Prerequisites**

The expected prerequisites are knowledge of the principles of electrotechnics, circuit theory, and signal theory.

### **Syllabus**

- Signal amplification
- Basic amplification circuits
- Operational Amplifier and basic configurations
- Frequency response of the Op Amp configurations
- Non-idealities of Op Amp: dc offset and slew rate
- Generalities on active filters
- Sallen-Key filter
- Binary system
- Boolean algebra and basic logic gates;
- FPGA architecture and VHDL programming language;
- Binary Half-adder and Full-adder.

### **Assessment Method**

The exam is divided into two parts. First, students are requested to write reports on two practical experimental exercises on analog electronics and to solve one Boolean algebra exercise, including VHDL implementation. The report consists of a technical description of the adopted design procedures and of the experimental activity. Second, during the exam, there will be an oral discussion of the reports, including theory questions, and of the exercise on Digital Electronics. Prova scritta, orale e di laboratorio

### **Texts and materials**

Sedra-Smith, "Microelectronic Circuits", 6th edition. Slides of the course.

### **Attendance Policy**

Attendance at lectures is not mandatory, but it is strongly recommended.

### **Course Delivery Format**

The course is delivered entirely in person and includes theoretical lessons, computer exercises conducted in the classroom, and laboratory classes.

## **ENERGY MANAGMENT AND RENEWABLE SOURCES 6 CFU/ECTS**

### **Expected Learning Outcomes**

Upon completing the course, students will be able to analyze complex energy systems, taking into account factors related to energy efficiency in both industrial and civil sectors. They will also be prepared to address key regulatory and tariff issues, and to conduct technical and economic evaluations of systems aimed at the rational use of energy and energy savings.

### **Prerequisites**

Basic knowledge of: Thermodynamics Heat transfer Engineering economics Energy systems

### **Syllabus**

Tools and methodologies for energy management Introduction, preliminary concepts, and the national and European energy and regulatory framework. Overview of the national electricity and gas grid and the tariff system. Economic feasibility analysis of energy investments. Energy management systems, ISO 50001 standards, and energy audits. Practical applications of energy audits and energy efficiency analysis.

### **Assessment Method**

The final oral exam consists of an oral discussion to assess your understanding of the theoretical concepts covered during the course. The oral exam will last approximately 30 minutes. The assessment of the oral discussion will consider several factors, including: the level and quality of knowledge of the topics, the ability to critically analyze the issues addressed in the course, the coherence and logic of the reasoning, the ability to apply theories and concepts to specific contexts, and the use of appropriate disciplinary language.

Oral exam

### **Text and materials**

Multimedia lessons (downloadable or accessible directly from Google Classroom) Lecture notes and completed exercises

### **Attendance Policy**

Attendance at lectures is not mandatory, but it is strongly recommended.

### **Course Delivery Format**

The course is entirely delivered in person and includes theoretical lessons and classroom-based exercises.

## FUNDAMENTAL OF CHEMISTRY 6 CFU/ECTS

### PART I

#### Expected Learning Outcomes

The study of the topics of the course will allow the students to know the fundamentals of the features of the matter and the law ruling their transformations.

#### Prerequisites

No prerequisites are required.

#### Syllabus

Atomic structure of matter. Fundamental laws of chemistry (Lavoisier, Proust, multiple proportions). Atoms, molecules, atomic and molecular mass, chemical formulae. Elements of structure of atom, protons, electrons and neutrons. Periodic table of the elements. Chemical bond, ionic bond, covalent bond, metallic bond, hydrogen bond, dipole-dipole interactions, van der Waals interactions. Oxidation number. Chemical compounds: definitions and nomenclature. Chemical reactions: definitions, types and their energetic aspects. Stoichiometric coefficients and balance of a chemical reaction. Stoichiometric computations. Intermolecular interactions and state of aggregation of matter, relations between structure and physical properties. Gaseous state, Boyle, Charles, Gay Lussac laws, principle of Avogadro, absolute temperature, state equation of perfect gas. Elements of kinetic theory of gas and real gas. Solid state, general properties. Covalent, molecular, metallic, ionic solids. Polymorphism and allotropy. Amorphous solids, inorganic and organic glasses. Phase transitions. Liquid state, vapor pressure and its dependence on T, phase equilibria, solutions properties, Raoult law, colligative properties of solutions. Chemical kinetics, reaction rate and its dependence on reactants concentration and temperature, reaction mechanisms, elementary processes, activation energy, catalysts. Chemical equilibrium and its dependence on T, P, V and concentration. Equilibrium constant, equilibrium shift. Equilibria in aqueous solution, acids and bases. Heterogeneous equilibria and solubility product (K<sub>sp</sub>). Effect of an ion in common and pH on solubility. Redox reactions. Elements of electrochemistry, piles and electrolysis, potentials of reduction.

#### Assessment Method

During the term, on which the exam is based, questions concerning the program of the course will be addressed to the student. The teacher will assess from the answers if the student has sufficiently studied and the degree of comprehension of the topics treated during the course. Esame orale Esame scritto

#### Text and materials

Chemistry: The Molecular Nature of Matter and Change Martin S. Silberberg, Patricia G. Amateis Mc Graw Hill

#### Attendance Policy

Attendance at lectures is not mandatory, but it is strongly recommended.

#### Course Delivery Format

The course will be performed through traditional lesson wherein theory and numerical exercises will be developed.

### PART II

#### Expected Learning Outcomes

Numerical exercises in chemistry are of fundamental importance for the consolidation of theory, for the development of logical and analytical reasoning, for the acquisition of practical skills, and for the preparation of the final exam.

#### Prerequisites

Basic knowledge of mathematics. Inorganic chemistry rudiments are welcome but not required

### **Syllabus**

Introduction to the history of chemistry and fundamental laws. Particle interpretation of matter and classical atomic models. Atomic number and mass number. Isotopes and atomic mass units. Introduction to the wave-mechanical theory: orbitals and quantum numbers. Aufbau principle. Electronic configuration: Pauli principle and Hund's rule. Atomic combination ratio, calculation of moles and Avogadro's number. Periodic properties of the elements: atomic radius, ionization energy and electron affinity. Inter and intra-molecular chemical bonds. Covalent bond according to the VB theory. Electronegativity and polar covalent bond. Dative (or coordination) bond. Ionic bond. Metallic bond. Physical and chemical properties of substances characterized by various types of chemical bond. States of aggregation of matter. Empirical and molecular formulas. Chemical reactions, reaction coefficients and stoichiometric ratios. Limiting reagent and excess reagent. Redox reactions: definitions and balancing rules using the half-reaction method. Aqueous solutions: general definitions, concentration measurements, solubility and colligative properties. Experimental laws on gases. Equation of state of ideal gases and its applicability. Gaseous mixtures and Dalton's law. Liquid state: Vapor pressure and its temperature dependence. Boiling and its dependence on external pressure. Concept of Equilibrium: homogeneous and heterogeneous equilibria, gaseous and aqueous chemical equilibria. Law of mass action (Guldberg-Waagee) and equilibrium constants. Determination of the equilibrium state through the reaction quotient. Definition of acids and bases according to Arrhenius and according to Bronsted-Lowry. Calculation of pH and salt hydrolysis.

### **Assessment Method**

The written part of the exam contains theoretical and practical topics. More specifically, the exam paper consists of 8 exercises usually divided into 2 or 3 theoretical topics and the rest into numerical calculations. The exam is scheduled for 1.5 hours. Esame scritto

### **Texts and materials**

Chemistry: The Molecular Nature of Matter and Change Martin S. Silberberg, Patricia G. Amateis Mc Graw Hill

### **Attendance Policy**

Attendance at classes is not mandatory but strongly recommended.

### **Course Delivery Format**

The lessons will be delivered on the Google Meet platform Didattica a distanza.

## **FUNDAMENTAL OF MACHINE DESIGN 6 CFU/ECTS**

### **Expected Learning Outcomes**

At the end of the course, the student will be able to: -To analyze the mechanical behavior of structural components subjected to static and quasi-static loads, including the effects of geometric discontinuities, thermal and residual stresses, and elastic instability. -To design mechanical components subjected to cyclic loading by evaluating fatigue strength, the effect of mean stress, stress concentration, and the proper selection and verification of connecting elements such as shafts, keys, keyways, and threaded joints.

### **Prerequisites**

The content of the following course: Mechanics of materials and structures

### **Syllabus**

Internal stress states. Elastic deformations, stiffness, and stability. Failure criteria and safety factor. High-cycle fatigue. Basic mechanical components: shafts and transmission shafts; shaft-hub connections; threaded fasteners.

### **Assessment method**

A written exam will be used to assess the student's theoretical knowledge and the ability to apply it to the solution of simple problems. Written exam

### **Texts and materials**

R.C. Juvinall – K. M. Marshek, Fundamentals of Machine Component Design. Course slides.

### **Attendance Policy**

Attendance at the course, although not compulsory, is strongly recommended to allow for better teacher-student interaction.

### **Course Delivery Format**

The course will be delivered through the following methods: a) Lectures providing the theoretical foundations; b) Exercises in which the analyzed theory will be applied to solve simple problems.

## **METALLURGY 6 CFU/ECTS**

### **Expected Learning Outcomes**

Students will have a basic knowledge of the main damage mechanisms in ferrous alloys, with notions of crystal lattices, and of micro- and macro-structural defects, showing the correlation between the latter and the former. Students will also have a basic knowledge of the iron-carbon diagram, of TTT and CCT diagrams, and of the main heat treatments useful to induce transformations in the microstructure of metallic materials, and, consequently, influence the mechanical characteristics

### **Prerequisites**

There are no prerequisites for this course.

### **Syllabus**

Topics of the course: Basic knowledge of static mechanical properties, fatigue (Wohler diagrams), crack and crack propagation. Basic knowledge of tensile test, hardness test, Charpy test, fracture toughness test, fatigue test and fatigue crack propagation test. Material microstructure. Microstructural defects. Strengthening mechanisms. Phase diagrams. Fe-C and Fe-Fe<sub>3</sub>C diagrams. Cooling of cast iron. Cooling of steel. Metallographic analysis. Austenitisation: heating. Austenitisation: cooling. TTT and CCT diagrams. Annealing, quenching, tempering, normalising and other heat treatments. Practical lesson on tensile test data interpretation.

### **Assessment Method**

The objective of the examination is to verify the degree to which the learning objectives have been achieved. The student is assessed on the basis of a written test and an oral discussion of a report on the practical activity, with the former preliminary to the latter. The report is intended to test the student's ability to apply the notions learned from the theoretical lectures to real cases and problems, while the written test is intended to test the student's level of knowledge of the notions taught in the lectures. The report consists of a presentation in which the student outlines the case study assigned to him/her, and the results obtained. The written test consists of a multiple-choice questionnaire composed of 32 questions with 4 choices each, which the student must complete in 20 minutes. The assessment is carried out according to the following criteria: each correct answer carries one point, and each incorrect answer or no answer carries zero points. The written test is passed with a minimum score of 18/30, and allows access to the oral test. The final mark is awarded on the basis of the results obtained in both tests. Valutazione di un progetto Esame orale Esame scritto

### **Text and materials**

Jon L. Dossett. Practical Heat Treating: Basic Principles, ASM International, 2020. R.E. Smallman, A.H.W. Ngan. Modern Physical Metallurgy, Butterworth-Heinemann, 2014. Course notes.

### **Attendance Policy**

Class attendance is not compulsory but strongly recommended.

### **Course Delivery Format**

The learning module consists of theoretical lectures, in which the notions required to tackle real problems are taught, and practical lectures, in which the knowledge acquired from the theoretical lectures is applied for determining optimised solutions to real case studies. The course includes lectures on the topics of the program and practical exercises.

## **AUTOMATIC CONTROL 9 CFU/ECTS**

### **Expected Learning Outcomes**

At the end of the course, the student will be able to understand and describe the concept of a dynamic system, identifying its fundamental components: input, state, and output. They will be able to represent and analyze dynamic systems using mathematical models, including input-state-output (ISO) and input-output (IO) models. They will be capable of determining the equilibrium conditions of a system and assessing its stability in both the time and frequency domains. The student will be able to perform free and forced response analysis of systems, identify modes of evolution, and recognize canonical responses. They will correctly use the Laplace transform for the analysis of linear systems, determine the transfer function, and construct representative block diagrams. They will be able to analyze polynomial and sinusoidal responses and interpret the harmonic response function. Finally, they will be able to formulate and understand the control problem, distinguishing between open-loop and feedback control. They will analyze steady-state accuracy for polynomial inputs, determining the system type and degree of astatism.

### **Prerequisites**

Mathematical analysis. Fundamentals of physics, mechanics and electrical engineering.

### **Syllabus**

System's notion. Input, state, output. Mathematical models. Equilibrium and stability of equilibrium. Linear systems and linearization. Analysis in the time domain. Free and forced response. Modal evolution. Canonical responses. Laplace transform. Transfer function. Stability criterion. Block schemes. Polynomial and sinusoidal response. Frequency response. The Control problem. Feedforward and feedback control. Polynomial steady-state error: system type and astatism. Stability of feedback systems and Nyquist criterion. Stability margins.

### **Assessment Method**

The assessment includes a written test. The written test aims to verify the student's ability to correctly solve, also numerically, problems of analysis of the response of dynamic systems and design of feedback control systems. The written test consists of numerical exercises and open answers related to the topics of the course.  
Written exam

### **Texts and Materials**

Norman S. Nise, CONTROL SYSTEMS ENGINEERING, Wiley Editor

### **Attendance Policy**

Not mandatory

### **Course Delivery Format**

Theoretical lessons. Classroom exercises with the help of Matlab.

## **HYDRAULIC DESIGN 9 CFU/ECTS**

### **Expected Learning Outcomes**

The course aims at providing theoretical and practical elements for understanding the behavior of the main hydraulic structures and for their design.

### **Prerequisites**

Hydraulics background

### **Syllabus**

The course provides the student with the knowledge and means to design the main hydraulic infrastructures. The base analysis for design and optimal management of water systems will be provided, informing the students of the tenets of the optimal design of hydraulic systems along with the application of optimal rehabilitation strategies for extant infrastructure. Technical knowledge obtained during the course will find natural application in subsequent courses.

### **Assessment methods**

The final exam consists in two written and oral tests. To be admitted to the oral test it is required to overcome the written test, which is considered without a remark. The presentation of the projects /exercitations done during the course is also required.

### **Text and materials**

Water Distribution System Handbook

Larry W. Mays

McGraw-Hill: New York, San Francisco, Washington, D.C., Auckland, Bogotá, Caracas, Lisbon, London, Madrid, Mexico City, Milan, Montreal, New Delhi, San Juan, Singapore, Sydney, Tokyo, Toronto

Copyright / Pub. Date: 2000 The McGraw-Hill Companies, Inc.

ISBN: 9780071342131

Wastewater Hydraulics: Theory and Practice

Willi H. Hager

Springer Heidelberg Dordrecht London New York, 2010

ISBN - 978-3-642-11382-6

Hydraulic Structures

Novak P., Moffat A.I.B., Nalluri C., Narayanan R.

E&FN SPON, an imprint of Chapman&Hall, 2-6 Boundary Row, London SE1 8HN, UK, 1990,1996

ISBN 0419200703

Analysis of Flow in Water Distribution Networks,

Bhave P.R.

Technomic publication, 1991

ISBN 877627320

Notes

### **Attendance Policy**

It is highly recommended to be present at theory lessons and design exercitations.

### **Course Delivery Format**

The course comprises theory and practical exercises on real case studies.

## **INDUSTRIAL AND ENVIRONMENTAL MEASUREMENTS 9 CFU/ECTS**

### **PART I**

#### **Expected Learning Outcomes**

By the end of the course, students will be able to: • Describe the classification and behavior of airborne particles, including the influence of particle size, transport mechanisms and settling velocity on their movement and deposition. • Explain the operating principles and applications of the main techniques used to measure airborne particles, including gravimetric samplers, optical instruments and particle counters, and interpret basic particulate matter data in environmental and industrial contexts. • Compare the operating principles, applications and performance of temperature sensors, including resistance temperature detectors (RTDs), thermocouples and thermistors, and identify the main calibration procedures and sources of measurement error.

#### **Prerequisites**

Courses in Mathematics I, General Physics I

#### **Syllabus**

1. Environmental Measurements. Airborne Particles: introduction and definitions. Dynamics of airborne particulates. Measurement of airborne particles. Exercise on airborne particles. 2. Temperature Measurements. Temperature Sensors: Measurement Principles and Performance. Resistance Temperature Detectors (RTDs), Thermocouples, and Thermistors. Exercise on Temperature Measurements.

#### **Assessment Method**

The oral exam generally consists of three questions: i) one on the fundamentals and dynamics of airborne particles; ii) one on measurement methods and instruments for airborne particles; iii) one on temperature measurement principles and sensors. A lack of basic knowledge in any of these areas may prevent the student from passing the exam. Esame orale

#### **Texts and Materials**

Doebelin, E. O., & Manik, D. N. (2007). Measurement systems: application and design.

#### **Attendance Policy**

Attendance is not mandatory but highly recommended.

#### **Course Delivery Format**

The course is delivered in person and includes theoretical lectures and numerical exercises carried out in the classroom, while experimental activities are conducted in the laboratory.

### **PART II**

#### **Expected Learning Outcomes**

At the end of the course, students will have an in-depth understanding of the fundamental principles of metrology. They will be able to perform both direct and indirect measurements, evaluate measurement uncertainty, conduct critical analysis of measurement errors, and effectively operate basic instrumentation for electrical and electronic quantities (digital multimeter, digital counter, digital oscilloscope). Through laboratory sessions and collaborative work, students will enhance their independent judgment and analytical skills in interpreting experimental data. Furthermore, they will be able to communicate technical results clearly and accurately using appropriate scientific terminology, and will develop the ability to pursue further studies autonomously, thereby establishing a strong foundation for advanced coursework and professional applications.

#### **Prerequisites**

Courses in Analysis I, Physics, Fundamentals of Electrical Engineering.

**Syllabus**

The international system of units. Metrological traceability. Direct and indirect measurements. Measurement theory: elements of statistics and probability; statistical tests; Gauss theory; measurement uncertainty. Static and dynamic characteristics of measurement instruments. Instrumentation consumption. Numerical multimeter. Volt-amperometric measurements. Wheatstone bridge. Numerical counter. Numerical oscilloscope. Analog-digital conversion. Numerical and laboratory exercises on the topics covered.

**Assessment Method**

The oral exam is generally divided into three questions: i) a question about measurement theory; ii) a question about a measurement method; iii) a question about a measurement instrument. Complete ignorance of even one of the proposed topics is considered such as not to allow passing the exam. Esame orale

**Texts and materials**

- Slides and lecture notes (available on the Classroom platform). - S. Tumanski, Principles of Electrical Measurement, Taylor & Francis, 2006.

**Attendance Policy**

Attendance is not mandatory but strongly recommended.

**Course Delivery Format**

The course is entirely delivered in presence and includes theoretical lessons and numerical exercises carried out in the classroom, while the experimental exercises will be carried out in the laboratory.

**PART III****Expected Learning Outcomes**

Through laboratory sessions and collaborative work, students will enhance their independent judgment and analytical skills in interpreting experimental data.

**Prerequisites**

Courses in Analysis I, Physics, Fundamentals of Electrical Engineering.

**Syllabus**

Numerical and laboratory exercises on the topics covered.

**Assessment Method**

The oral exam is generally divided into three questions: i) a question about measurement theory; ii) a question about a measurement method; iii) a question about a measurement instrument. Complete ignorance of even one of the proposed topics is considered such as not to allow passing the exam. Esame orale

**Texts and materials**

Slides and lecture notes (available on the Classroom platform).  
S. Tumanski, Principles of Electrical Measurement, Taylor & Francis, 2006

**Attendance Policy**

Attendance is not mandatory but strongly recommended.

**Course Delivery Format**

The course is entirely delivered in presence and includes theoretical lessons and numerical exercises carried out in the classroom, while the experimental exercises will be carried out in the laboratory.

## **MANUFACTURING TECHNOLOGIES 9 CFU/ECTS**

### **Expected Learning Outcomes**

**Knowledge:** Knowledge of the main manufacturing processes of metallic materials. Knowledge of machines, tools, and equipment.

**Skills:** Ability to read, analyze, and plan a traditional manufacturing process of a workpiece in metallic material, starting from the rough and finished drawings or CAD models.

### **Prerequisites**

No prerequisite

### **Syllabus**

Manufacturing processes: the concept of production, production organization, manufacturing processes and classification methods. Relationships between products and technologies. The role of metallic materials in industrial production: material types and mechanical properties.

Geometrical Product Specifications (GPS): dimensional, geometrical and surface (micro-geometrical) tolerances.

Overview of the main manufacturing technologies: casting, metal forming, and machining (chip-removal processes).

Machining (chip-removal processes): fundamentals of metal cutting, the single-point cutting tool, cutting models, machining technologies and machine tools, cutting tools. Tools: materials and properties, tool wear and Taylor's tool life equation. Turning, milling, drilling and grinding.

Metal forming: fundamentals of hot and cold forming, bulk forming, sheet metal forming.

Metal casting processes: Sand casting, permanent-mold casting, centrifugal casting, investment casting, lost-foam casting, pressure die casting, low-pressure casting and squeeze casting.

Process planning (working cycle): functions and general approach, choice of the stock/blank, choice of process parameters, identification of the clamping and locating (datum) surfaces of the part, definition of the sequence of elementary operations, and machining time calculation.

Welding technologies: fusion welding and brazing/soldering. Thermal effects in welding.

Laboratory sessions: hands-on laboratory sessions are planned to show how to plan the machining process for a mechanical part and how to carry out the corresponding operations on a lathe or a milling machine.

### **Assessment methods**

The objective of the exam is to verify the level of achievement of the previously indicated learning objectives. The exam will lead to the final evaluation.

### **Text and materials**

S. Kalpakjian and S.R. Schmid, "Manufacturing, Engineering and Technology" Ed. Pearson Paravia Mondadori, 2008.

A.Y. Helmi, H.A. El-Hofy, M.H. Ahmed, Manufacturing Technology, Materials, Processes, and Equipment, CRC Press, 2023.

### **Attendance Policy**

Attendance at lectures and workshops is recommended but not mandatory.

### **Course Delivery Format**

The course includes a series of lectures, some numerical exercises in the classroom, and a laboratory on chip removal technologies.

## **THERMODYNAMIC AND HEAT TRANSFER 9 CFU/ECTS**

### **Expected Learning Outcomes**

By the end of the course, the student is expected to: - Know and understand the principles of thermodynamics and heat transfer; - Be able to apply this knowledge to solve problems in thermodynamics and heat transfer; - Communicate effectively using the technical terminology specific to engineering physics; - Be capable of independently utilizing this foundational knowledge in other courses within the master's degree program.

### **Prerequisites**

Basic concepts of chemistry and physics

### **Syllabus**

The course develops and deepens the principles of thermodynamics and heat transfer, focusing on both methodological and applied aspects. In particular, it provides students with the necessary tools to describe the thermodynamic behavior of the main components of thermal systems and the different modes of heat transfer. The skills students are expected to acquire include: • calculating thermodynamic properties and transformations; • evaluating first and second law balances in open and closed systems; • assessing the thermodynamic performance of components; • estimating energy exchanges through various heat transfer mechanisms.

### **Assessment Method**

The final exam consists of a written test and an oral test. The written test aims to assess the student's proficiency in the thermodynamic analysis of closed or open systems, thermodynamic components, and solving problems involving combined heat transfer mechanisms. The oral test, which follows the written test, is designed to evaluate the student's understanding of the theoretical and practical concepts covered during the course. The written test includes three numerical exercises, while the oral test, with an indicative duration of 20 minutes, comprises at least three questions. The written test is graded on four levels, identified by the letters A to D. The final grade is calculated as the average of the scores from the written and oral tests. Both the written and oral tests will take place on the same day. Esame orale Esame scritto

### **Texts and materials**

Yunus Cengel, Michael Boles and Mehmet Kanoglu - Thermodynamics: An Engineering Approach, McGraw Hill  
Yunus A. Çengel - Heat Transfer: A Practical Approach, McGraw-Hill

### **Attendance Policy**

Lecture attendance is not compulsory but is strongly recommended

### **Course Delivery Format**

Lectures, practical exercises

## **MATHEMATICS II**

### **Expected Learning Outcomes**

Learn math language Learn how to use the main techniques to solve exercises Develop a broad understanding of basics of linear algebra, geometry and calculus 2

### **Prerequisites**

The students are advised to follow firstly mathematics I. Fundamentals of mathematical logic. Polynomials. Algebraic operations with polynomials. First and second degree algebraic equations. Properties of powers and logarithms. Elementary functions. Notions of trigonometry. Integer and fractional algebraic inequalities. Inequalities with radicals. Inequalities with absolute values. Inequalities with exponentials and logarithms. Notions of plane geometry. Equation of the straight line. Condition of parallelism and orthogonality of two lines.

### **Syllabus**

Linear algebra and analytic geometry. Vector spaces (including linear independence, bases, vector subspaces), matrices, determinants, range of a matrix, inverse of a matrix, systems of linear equations (including Gaussian elimination, Cramer's rule), linear applications, endomorphism and their eigenvalues and eigenvectors, diagonalization, analytic geometry in the plane or in the space, surfaces in the space. Mathematical analysis: real functions of several real variables (graph, contour lines, limits, continuity, derivatives and differential, Hessian matrix and Taylor's expansion), vector-valued functions (including Jacobian matrix, differential calculus), implicit function theorem, curves in the plane/space, unconstrained and constrained optimization, double and triple integrals, surfaces and integration over surfaces, line integrals, vector fields (including Stokes theorem, divergence theorem, Green formula), an introduction to sequences and series of functions, power series (and convergence analysis) and Fourier series, (mainly first and second order) ordinary differential equations.

### **Assessment Method**

There will be a written and a oral examination. The written exams include exercises and some theoretical questions (definitions, theorems/propositions/lemmas and proofs). The exams regard all the topics of the program (linear algebra, geometry and mathematical analysis). Esame orale Esame scritto

### **Texts and materials**

A first course on linear algebra, K. Kuttler (available online) Calculus, D. Guichard (available online) Calculus, G. Strang (available online) Some notes and exercises are available at google classroom code: lumltlk.

### **Attendance Policy**

Not mandatory but highly encouraged

### **Course Delivery Format**

Traditional classes in the lecture rooms. The course includes some exercises classes. For course materials and information, see also Google classroom code lumltlk.

The course is held by prof. Scarinci, Prof. Quaremba and dr. Romeo. Some lessons are available also on EDUNEXT website. Didattica a distanza

## DEPARTMENT OF ECONOMICS - CAMPUS FOLCARA

### APPLIED ECONOMETRICS 6 CFU/ECTS

#### Expected Learning Outcomes

Ability to perform data analysis on cross-sectional data (variability, outliers) and on time series data (trend, seasonality, structural breaks, outliers) Ability to forecast using univariate models (ARIMA) Select the appropriate model for multivariate analysis of time series Understand the basics in panel data analysis

#### Prerequisites

Excellent knowledge of descriptive statistics. Good knowledge of inferential statistics (estimators and their properties, hypothesis testing). Good knowledge of matrix algebra. Knowledge of macroeconomics.

#### Syllabus

This course aims to introduce the students to econometrics, with special emphasis on time series econometrics. We will start from how to visualize the data for exploratory analysis, focusing on the identification of outliers, trends, seasonality. We next move to the analysis of the multiple regression model, covering the properties of Ordinary Least Squares estimation, and related statistics. Particular attention is given to testing for normality, homoscedasticity, auto-correlation, parameter stability, exogeneity. In the next part of the course we introduce time series analysis, discussing ARIMA models for forecasting. We next move to multi-variate forecasting using stationary variables (VARs). Finally, we introduce modern econometric techniques for time series analysis: the general-to-specific approach in model specification, cointegration using the Engle-Granger, VECM, and ADL approach. Particular attention will be given to the problem of parameter identification in structural models.

#### Assessment Method

The instructor will use two criteria for assessing your work. Any questions about the requirements should be discussed directly with your faculty well in advance of the due date for each assignment. FORM OF ASSESSMENT VALUE Class Participation 15% Final Exam 85% ASSESSMENT OVERVIEW: Class Participation: This grade will be calculated to reflect your participation in class discussions, your capacity to introduce ideas and thoughts dealing with the texts, your ability use language effectively, and to present your analysis in intellectual, constructive argumentation. If you cannot attend classes your participation can be shown by interacting with your instructor during office hours, i.e. by asking about specific subjects of the syllabus and discussing assignments. Final Exam: Students will be required to submit a short paper on one assigned topic. Students will need to discuss their paper at the exam, to show they have fully grasped each step of the procedure required to complete the assignment. In order to pass, students need to show their comprehension of all of the aspects of their work (i.e. be able to explain what is being tested, what is the result of a test, what is the implication, etc.).

#### Texts and Materials

J.M. Wooldridge, Introductory econometrics: a modern approach, Cengage Learning, 2015 W. Enders, Applied econometric time series, Wiley, 2010 or later edition

#### Attendance Policy

In presence

#### Course Delivery Format

Lectures, on-line training

## **ECONOMICS STATISTICS 6 CFU/ECTS**

### **Expected Learning Outcomes**

The aim of the course is to provide understanding and knowledge of economic phenomena through statistics tools. Students will be gradually introduced to the formalism, the terminology, and tools for the knowledge of measurement systems and statistical analysis of the main phenomena of our economic and official statistical data systems. The program is divided into two parts. In the first part will be treated the introduction of the statistical tools used in economics and the economic theories that influence the behavioral and decision-making models of economic agents. In the second part will be introduced time series models. At the end of the course, students will be able to quantify the main economic phenomena and compare the most widely used measurement methods also in a historical perspective and international comparison.

### **Prerequisites**

The statistical elements required are those of the basic statistics and economics courses.

### **Syllabus**

The course will cover following topics:

#### **FIRST PART: BASIC STATISTICAL METHODS FOR THE ANALYSIS OF ECONOMIC FLUCTUATIONS**

##### **THE MAIN PRODUCERS OF ECONOMIC STATISTICS:**

- The National Statistical System;
- The European Statistical System.

##### **THE MAIN OFFICIAL ECONOMIC STATISTICS:**

- The official statistics;
- The permanent census;
- Structural business statistics and Short-term business statistics.

##### **FUNDAMENTAL CONCEPTS, DEFINITIONS:**

- The economic system;
- Economic agents; Economic aggregates;
- Values at current prices and constant prices;
- Introduction to National Accounts.

##### **INDEXES FOR TEMPORAL AND TERRITORIAL COMPARISONS:**

- Construction of temporal indexes;
- Inflation and money value;
- Territorial comparison for monetary values.

#### **SECOND PART: MODELS FOR TIME SERIES ANALYSIS**

##### **CLASSIC METHOD:**

- Introduction to time series;
- Decomposition method;
- The moving averages method;
- Census X11 program.

##### **STOCHASTIC ANALYSIS:**

- Introduction to stochastic processes;
- Stationary processes;
- Non-stationary processes.

##### **EXAMPLES OF APPLICATION TO REAL DATA FOR TIME SERIES ANALYSIS WITH R PROGRAMMING**

### **Assessment Method**

Written exam with oral supplementation optional.

### **Text and Materials**

Course material will be delivered during lessons, in Google classroom course page. Useful reference books are:

- Giovannini E. (2008) “Understanding Economic Statistics: An OECD Perspective”, OECD Publishing, Paris, <https://doi.org/10.1787/9789264046986-en> (for the 1st Part)
- Di Fonzo T., Lisi F. (2001) “Complementi di Statistica Economica: analisi delle serie storiche univariate”, Cleup Editrice (for the 2nd Part)
- Cryer J.D., Chan K. (2008) “Time Series Analysis, With Applications in R”, 2nd Ed. Springer. (for the 2nd Part)

### **Attendance Policy**

Attendance of the course is not mandatory but is strongly recommended.

### **Course Delivery Format**

Frontal lessons and practical sessions with statistical software R Studio.

## **MICROCREDENTIALS**

### **Financial formulas in Excel 2 CFU/ECTS**

By the end of the course, the student will be able to: • Understand and master the logic of the basic tools of finance, along with the information individuals need to make important financial decisions; • Apply Excel formulas to identify key financial variables, such as the IRR of a series of cash flows, the NPV of an investment, the market price of securities paying periodic interest, and many others."

### **Index numbers in Economics 2 CFU/ECTS**

By the end of the course, students will be able to: • Understand and apply index numbers to measure changes in prices, quantities, and costs, gaining the ability to interpret key economic indicators such as inflation and cost-of-living indexes. • Use index numbers to analyze real-world data and make informed comparisons across time and sectors, developing skills that are essential for careers in economics, business, and policy-making.

### **Life Tables and Population Age Structure 2 CFU/ECTS**

• Construct and interpret life tables to measure mortality, survival, and life expectancy, and use them to understand demographic dynamics. • Analyze population age structures to explain key economic and social challenges—such as ageing populations, labor force trends, and healthcare needs—and apply this knowledge to real data.