ΜΟΝΑΔΑ ΔΙΑΣΦΑΛΙΣΗΣ ΠΟΙΟΤΗΤΑΣ Α.Π.Θ.

STUDY PROGRAM

Σπουδές Επιστήμης και Μηχανικού στην Καθαρή Ενέργεια

DEPARTMENT

Bachelor of Science in Clean Energy Science and Engineering

A9
Course Outlines

File created: 16/03/26

ΜΟΔΙΠ
ΜΟΝΑΔΑ ΔΙΑΣΦΑΛΙΣΗΣ ΠΟΙΟΤΗΤΑΣ Α.Π.Θ.

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ΜΟΝΑΔΑ ΔΙΑΣΦΑΛΙΣΗΣ ΠΟΙΟΤΗΤΑΣ Α.Π.Θ.

1st Semester

GENERAL CHEMISTRY

1. GENERAL

FACULTY	Engineering		
SCHOOL	Bachelor of Science in Clean Energy Science and Engineering		
LEVEL OF STUDIES	ISCED level 6 – Bachelor's or equivalent level		
COURSE CODE	CESE01	SEMESTER	1st Semester
COURSE TITLE	GENERAL CHEMISTRY		

TEACHING ACTIVITIES If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.	TEACHING HOURS PER WEEK	ECTS CREDITS
	5	9.0

COURSETYPE Background, General Knowledge, Scientific Area, Skill Development	General Background
PREREQUISITES	**PREREQUISITES** - **General prerequisites** -
TEACHING & EXAMINATION	English
COURSE OFFERED TO ERASMUS STUDENTS	NO
COURSE URL	https://elearning.auth.gr/course/index.php?categoryid=30

2. LEARNING OUTCOMES

Learning Outcomes
Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

Upon successful completion of this course, students will be able to:

- Demonstrate fundamental knowledge across organic, inorganic, and physical chemistry
- Apply chemical principles to explain structure, bonding, reactivity, and properties of matter
- Interpret experimental and spectroscopic data
- Develop problem-solving and analytical skills appropriate for undergraduate chemistry

By the end of this course, students will be able to:

- Explain the nuclear model of the atom, the nature of electromagnetic radiation, and the basic quantum concepts related to atomic structure.
- Describe atomic orbitals, quantum numbers, electron spin, and the electronic structure of both hydrogen and many-electron atoms.
- Relate electronic structure to the periodic table and interpret major periodic trends such as atomic/ionic radii, ionization energies, and electron affinity.
- Summarize the fundamental models of chemical bonding: ionic bonding, covalent bonding and Lewis structures, VSEPR geometry, valence-bond theory, and molecular-orbital theory.
- Explain the molecular basis of the gaseous, liquid, and solid states of matter and relate macroscopic properties to intermolecular interactions.
- Describe ideal and real gas behavior and interpret deviations from ideality using qualitative models.
- Interpret phase diagrams and explain phase transitions in one- and two-component systems.
- Explain the interaction of electromagnetic radiation with matter and relate energy quantization to molecular energy levels.
- Distinguish between rotational, vibrational, and electronic molecular transitions and the regions of the electromagnetic spectrum in which they occur.
- Describe the behavior of electrolytes in solution, including ion formation, solvation, and ionic interactions.
- Explain deviations from ideal behavior in electrolyte solutions using the concepts of ionic strength and activity.

By the end of this course, students will acquire skills to:

- Write electron configurations for atoms and ions and use them to rationalize periodic trends and chemical behavior.
- Construct Lewis structures, evaluate resonance and formal charges, and predict molecular shapes using VSEPR.
- Assess bond type, polarity, and approximate bond strengths based on electronegativity and bonding models.
- Apply valence-bond and molecular-orbital theory to simple diatomic and small polyatomic molecules to determine bond order, magnetic properties, and qualitative bonding features.
- Apply gas laws and simple equations of state to calculate and predict properties of gases under different conditions.
- Analyze phase diagrams to determine stable phases and phase transitions as a function of temperature and pressure.
- Interpret basic IR, Raman, and UV–Vis spectra to extract information about molecular structure and bonding.
- Relate spectroscopic features to rotational, vibrational, and electronic energy level changes in molecules.
- Calculate and apply ionic strength and activity coefficients to describe non-ideal electrolyte solutions.
- Use conductivity and colligative property concepts to assess electrolyte behavior in solution. understand the concept of organic molecules.
- recognize the chemical structural unit of several basic organic materials.
- understand the mechanisms of fundamental organic reactions.
- realize the chemical properties and reactions of basic organic moieties.

General Skills

Name the desirable general skills upon successful completion of the module

Search, analysis and synthesis of data and information,
ICT Use,Adaptation to new situations,
Decision making,
Autonomous work,
Teamwork,
Working in an international environment,
Working in an interdisciplinary environment, Production of new research ideas

Project design and management
Equity and Inclusion
Respect for the natural environment
Sustainability
Demonstration of social, professional and moral responsibility and sensitivity to gender issues
Critical thinking
Promoting free, creative and inductive reasoning

Practical application of knowledge
Search, analysis and synthesis of data and information, ICT Use
Adaptation to new situations
Decision making
Autonomous work
Teamwork
Working in an international environment
Working in an interdisciplinary environment
Production of new research ideas
Promoting free, creative and inductive reasoning

3. COURSE CONTENT

Part 1 – Introductory Inorganic Chemistry

- The nuclear model of the atom; Electromagnetic radiation; Atomic spectra
- Radiation, quanta, and photons; The wave-particle duality of matter; The uncertainty principle; Wavefunctions and energy levels
- The principal quantum number; Atomic orbitals; Electron spin; Electronic structure of hydrogen
- Orbital energies; The building-up principle; Electronic structure of many-electron atoms and the periodic table
- The periodicity of atomic properties - Atomic radius; Ionic radius; Ionization energy; Electron affinity; The inert-pair effect; Diagonal relationships; The general properties of the elements
- Ionic bonds - Lewis symbols of ions; The energetics of ionic bond formation; Interactions between ions
- Covalent bonds - Lewis structures; Resonance; Formal charge; Radicals; Expanded and incomplete valence shells; Electronegativity and polarizability; Bond strengths and lengths
- The VSEPR Model
- Valence-bond theory - Sigma and pi Bonds; Hybridization of orbitals; Characteristics of multiple bonds
- Molecular orbital theory - Molecular orbitals; Electron configurations of diatomic molecules; Bonding in homonuclear and heteronuclear diatomic molecules; Orbitals in polyatomic molecules
- Introduction to the solid state – Covalent network structures; Structures based on the packing of spheres; Metallic bonding; Ionic bonding and lattice enthalpy
- Acids and bases – Brønsted-Lowry acids and bases; Lewis acids and bases

Part 2 – Introductory Physical chemistry

- States of matter – Gases, liquids, and solids; Macroscopic and molecular descriptions of matter
- The gaseous state – Ideal gas laws; Kinetic molecular theory of gases; Molecular speed distributions; Deviations from ideal behavior and real gases
- Intermolecular forces
- The liquid state – Structure of liquids; Viscosity; Surface tension; Vapor pressure
- The solid state – Crystalline and amorphous solids; Unit cells; Packing efficiency; Introduction to phase transitions
- Phase equilibria – Phase changes; Phase diagrams;
- Light mater interaction – The electromagnetic spectrum; Absorption and emission processes; Selection rules (qualitative)
- Molecular rotation – Rotational energy levels; Rotational spectra of diatomic molecules
- Molecular vibration – Vibrational energy levels; Infrared spectroscopy; Normal modes of vibration
- Raman spectroscopy – Raman scattering; Complementarity of IR and Raman spectroscopy
- Electronic transitions – UV–visible spectroscopy; Electronic excitation and molecular structure
- Spectroscopy as a structural tool – Qualitative interpretation of molecular spectra
- Electrolyte solutions – Formation of ions in solution; Solvation and hydration
- Strong and weak electrolytes – Degree of dissociation; Acid–base behavior in aqueous solution

Part 3 – Introductory Organic chemistry

- Structure and Bonding, Orbital Theories

- An Overview of Organic Molecules: Names and Properties
- An Overview of Organic Reactions
- Stereochemistry at Tetrahedral Centers
- Hydrocarbons: Alkanes, Alkenes and Alkynes, Stereochemistry
- Halogenoalakanes: Properties and reactivity.
- Nuclear Megnetic Resonance (NMR) Spectroscopic and its application in Materials.
- Benzene and Aromaticity, Polyaromatic compounds. Structure, properties.
- Characteristic Main Polar Groups in Organic Materials: Alcohols, Carbonyl Compounds, Acids, Amines.

4. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD Face to face, Distance learning, etc.	Face to face
USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) Use of ICT in Teaching, in Laboratory Education, in Communication with students	**USE OF ICT** • Use of ICT in Teaching • Use of ICT in Laboratory Education • Use of ICT in Communication with students • Use of ICT in Evaluation of students **Description** ICT will be used in teaching the course, and in communication with students: teaching of the course with modern distance learning (ZOOM) and asynchronous education tools via elearning platform of AUTH, communication with students via email, ZOOM, and elearning platform of AUTH.
TEACHING ORGANIZATION The ways and methods of teaching are described in detail. Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research& analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc. The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards	
STUDENT EVALUATION Description of the evaluation process Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others	**Description** The assessment language is English. The course uses the following Assessment methods: • Multiple choice tests: three midterm exams to check recall of definitions, concepts, and terminology on core concepts of chemistry. • Problem solving assignments: three written assignments in which students review course material, analyze literature data, and solve problems on fundamentals of chemistry. • Final written exam: it combines short answers, problem solving, and data interpretation questions to evaluate cumulative understanding on core concepts of chemistry. Weighting • Multiple choice tests): 20% • Problem solving

Activity	Workload/semester
Lectures	65
Laboratory	15
BibliographyAnalysis	10
writingProject	70
Other	80
Examinations	3
Total	**243**

Please indicate all relevant information about the course assessment and how students are informed	assignments: 20% • Final written exam: 60% Student information Students are informed about the assessment process through: • The course outline distributed in the first lecture. • Detailed instructions for the written assignment and presentation posted on the course website. • A dedicated assessment briefing during tutoring time where expectations and criteria are explained **Student Evaluation Languages** English **Student evaluation methods** • MultipleChoice (Formative) • ProblemSolving (Formative) • EssayDevelopmentQuestions (Formative, Summative)

5. SUGGESTED BIBLIOGRAPHY

EUDOXUS

1. Andrew Burrows, John Holman, Andrew Parsons, Gwen Pilling, Gareth Price, Chemistry³: Introducing inorganic, organic and physical chemistry

Additional bibliography for study

1. Teaching material slides

CALCULUS

1. GENERAL

FACULTY	Engineering		
SCHOOL	Bachelor of Science in Clean Energy Science and Engineering		
LEVEL OF STUDIES	ISCED level 6 – Bachelor's or equivalent level		
COURSE CODE	CESE02	SEMESTER	1st Semester
COURSE TITLE	CALCULUS		

TEACHING ACTIVITIES If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.	TEACHING HOURS PER WEEK	ECTS CREDITS
	4	6.0

COURSETYPE Background, General Knowledge, Scientific Area, Skill Development	General Background
PREREQUISITES	**PREREQUISITES** - **General prerequisites** Αγγλικά
TEACHING & EXAMINATION	English
COURSE OFFERED TO ERASMUS STUDENTS	NO
COURSE URL	https://elearning.auth.gr/course/index.php?categoryid=30

2. LEARNING OUTCOMES

Learning Outcomes
Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

By the end of this course, students will be able to:

1. Manipulate well-known real-valued functions—such as exponential, trigonometric, hyperbolic functions and their inverses.
2. Differentiate real functions accurately and apply differentiation techniques to identify local and global extrema.
3. Understand and use the concept of the differential in applications involving linear approximations.
4. Understand elementary concepts of sequences and series, and apply them to power series—especially in constructing Taylor polynomials and Taylor series.
5. Understand and apply the basic principles of integral calculus, compute definite, indefinite, and improper integrals, and use integration in applications.

6. Understand elementary notions of analytic geometry in order to work with multivariable functions.
7. Compute partial and directional derivatives, understand differentiability, use differentials for linear approximations and determine tangent planes.
8. Use partial differentiation to identify local and global extrema of multivariable functions.

General Competences
- Search for analysis and synthesis of data and information, with the use of the necessary technology
- Application of knowledge in practice.
- Decision-making
- Work autonomously
- Modeling and solving real-world problems
- Be critical and self-critical
- Promotion of free, creative and inductive thinking.

General Skills

Name the desirable general skills upon successful completion of the module

Search, analysis and synthesis of data and information,
ICT Use,Adaptation to new situations,
Decision making,
Autonomous work,
Teamwork,
Working in an international environment,
Working in an interdisciplinary environment, Production of new research ideas

Project design and management
Equity and Inclusion
Respect for the natural environment
Sustainability
Demonstration of social, professional and moral responsibility and sensitivity to gender issues
Critical thinking
Promoting free, creative and inductive reasoning

Practical application of knowledge
Search, analysis and synthesis of data and information, ICT Use
Decision making
Autonomous work
Working in an interdisciplinary environment
Critical thinking
Promoting free, creative and inductive reasoning

3. COURSE CONTENT

Review of functions and graphs. Real fuctions of a single variable: Exponentials, Cyclic, hyperbolic and their inverses. Introduction of limits and continuity. Differential Calculus:
Derivatives, derivatives and rate of change and applications in optimization and motion.
Differentials and applications involving linear approximations. Tangent lines. Introduction
on sequences and series. Power series. Taylor polynomials and Taylor series. Integral Calculus: Definite and indefinite integrals. The fundamental Theorem of Calculus. Improper integrals. Applications in area, curve length and volume of surfaces of revolution.
Multivariable functions. Partial derivatives. The notion of gradient. Directional derivatives and differentiability. Differentials and applications involving local approximations, tangent planes and normal lines. Local and global extrema.
Lagrange multipliers.

4. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD Face to face, Distance learning, etc.	Face to face
USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) Use of ICT in Teaching, in Laboratory Education, in Communication with students	**USE OF ICT** • Use of ICT in Teaching • Use of ICT in Laboratory Education • Use of ICT in Communication with students • Use of ICT in Evaluation of students **Description** Use of ICT in communication with students: eclass, email, ZOOM. Also, use ICT in teaching using asynchronous education (eclass) and, if necessary, using tools of modern distance learning (ZOOM). Use of ICT in student assessment: Electronic grading (e-learning, universis).
TEACHING ORGANIZATION The ways and methods of teaching are described in detail. Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research& analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc. The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards	
STUDENT EVALUATION Description of the evaluation process Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others Please indicate all relevant information about the course assessment and how students are informed	**Description** Written Exam with Problem Solving (Summative) **Student Evaluation Languages** English **Student evaluation methods** • ProblemSolving (Summative)

Activity	Workload/semester
Lectures	52
Other	107
Examinations	3
Total	**162**

5. SUGGESTED BIBLIOGRAPHY

EUDOXUS

1. Calculus. R. Larson and Bruce Edwards. Cengage Learning, 2023.
2. Calculus. Early Trannscendentals. J. Stewart, 8th edition, Cengage Learning, 2016.
3. Thomas Calculus and Early Transcendentals. George Thomas, Maurice D. Weir, Joel Hass, Pearcon Education Inc, 13th edition, 2014.
4. Calculus. Gilbert Strang. Wellesley-Cambridge Press, 3rd Edition.

Additional bibliography for study

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ΜΟΝΑΔΑ ΔΙΑΣΦΑΛΙΣΗΣ ΠΟΙΟΤΗΤΑΣ Α.Π.Θ.

PHYSICS FOR ENERGY MATERIALS ENGINEERS

1. GENERAL

FACULTY	Engineering		
SCHOOL	Bachelor of Science in Clean Energy Science and Engineering		
LEVEL OF STUDIES	ISCED level 6 – Bachelor's or equivalent level		
COURSE CODE	CESE03	SEMESTER	1st Semester
COURSE TITLE	PHYSICS FOR ENERGY MATERIALS ENGINEERS		

TEACHING ACTIVITIES If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.	TEACHING HOURS PER WEEK	ECTS CREDITS
	4	6.0

COURSETYPE Background, General Knowledge, Scientific Area, Skill Development	General Background
PREREQUISITES	**PREREQUISITES** - **General prerequisites** Αγγλικά
TEACHING & EXAMINATION	English
COURSE OFFERED TO ERASMUS STUDENTS	NO
COURSE URL	https://elearning.auth.gr/course/index.php?categoryid=30

2. LEARNING OUTCOMES

Learning Outcomes
Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

Upon successful completion of the course, students will be able to:

- Demonstrate a solid understanding of the core principles of classical mechanics, electricity, and introductory magnetism, as encountered and required in scientific and engineering contexts.
- Apply fundamental principles of classical mechanics, electricity, and magnetism to analyze systems relevant to energy production, conversion, transport, and storage.
- Formulate and solve quantitative physics problems commonly encountered in energy engineering, including force balance, work–energy relations, electric circuits, and magnetic interactions, at the basic level.

- Explain how mechanical, electrical, and magnetic phenomena underpin key energy technologies, such as rotating machinery, generators, electric motors, transmission systems, and energy-storage components.
- Use mathematical models and physical reasoning to predict the behavior of particles, rigid bodies, and electrical systems under various operational conditions.
- Evaluate the performance and limitations of physical systems used in clean-energy applications, based on an understanding of forces, motion, fields, energy, and power.

General Skills

Name the desirable general skills upon successful completion of the module

Search, analysis and synthesis of data and information,
ICT Use,Adaptation to new situations,
Decision making,
Autonomous work,
Teamwork,
Working in an international environment,
Working in an interdisciplinary environment, Production of new research ideas

Project design and management
Equity and Inclusion
Respect for the natural environment
Sustainability
Demonstration of social, professional and moral responsibility and sensitivity to gender issues
Critical thinking
Promoting free, creative and inductive reasoning

Practical application of knowledge
Search, analysis and synthesis of data and information, ICT Use
Autonomous work
Promoting free, creative and inductive reasoning

3. COURSE CONTENT

This course provides a comprehensive introduction to the core areas of physics required for further study in Clean Energy Science and Engineering. Beginning with mathematical tools and kinematics, the course develops a solid foundation in classical mechanics, including Newton's laws, force modelling, work and energy, momentum, collisions, rotational dynamics, and oscillatory motion. These topics establish the physical reasoning and problem-solving framework that underpins much of scientific and engineering analysis. Building on this foundation, the course introduces the principles of electricity through electrostatics, electric fields, electric potential, and capacitors. Students learn how electric circuits operate through the study of current, voltage, resistance, and basic circuit laws. A light introduction to magnetism and electromagnetic induction provides conceptual understanding of magnetic forces, magnetic fields generated by currents, and the qualitative meaning of Faraday's law. While magnetism is not treated in full depth, students gain the necessary insight to understand simple electromagnetic interactions and to prepare for more advanced courses in electromagnetism or energy systems.
Throughout the course, physical concepts are illustrated with examples, problem-solving exercises, and short applications relevant to scientific and engineering contexts. By the end of the semester, students will have developed a coherent understanding of the fundamental laws governing mechanical, electrical, and magnetic systems, forming a strong foundational platform for subsequent studies in energy engineering, materials science, thermodynamics, and modern physics.

Topic-based outline:
1. Foundations (1 week): Units, dimensions, measurement, vector algebra and components, kinematics in one and two dimensions
2. Classical Mechanics (6 weeks):
(a) Dynamics: Newton's laws of motion, Force modelling: gravity, normal force, tension, friction, drag (qualitative), Free-body diagrams and systematic problem solving
(b) Work, Energy, Momentum: Work–energy theorem, Potential energy and conservative forces, Impulse and momentum conservation, Collisions (elastic and inelastic)
(c) Rotational Motion: Angular kinematics and dynamics, Torque, angular momentum, Rotational inertia and rolling motion

(d) Oscillations and Waves: Simple harmonic motion, Damping and driving (qualitative), Wave properties: speed, wavelength, superposition, Standing waves and resonance
3. Electricity (3 weeks):
(a) Electrostatics: Electric charge, Coulomb's law, Electric fields and superposition, Electric potential, Capacitance and stored electrostatic energy
(b) Electric Circuits: Current, voltage, resistance, Ohm's law, Kirchhoff's rules, RC circuits (qualitative transient behavior)
4. Magnetism (Light Treatment, 2 weeks): Magnetic fields and field lines, Lorentz force (conceptual and simple cases), Magnetic fields generated by currents, Faraday's law and Lenz's law (conceptual understanding), Simple induction examples
5. Review and Integration (1 week): Mixed-problem solving, Conceptual synthesis across topics, Preparation for final examination.

4. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD Face to face, Distance learning, etc.	Face to face
USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) Use of ICT in Teaching, in Laboratory Education, in Communication with students	**USE OF ICT** • Use of ICT in Teaching • Use of ICT in Laboratory Education • Use of ICT in Communication with students • Use of ICT in Evaluation of students **Description** Information and Communication Technologies (ICT) are systematically integrated into all instructional activities. Synchronous online teaching is supported through the ZOOM platform, while asynchronous instruction and learning materials are delivered via the institutional eClass platform. ICT-based educational tools (e.g., Excel) are employed to support demonstrations, numerical examples, and student exercises. ICT is also utilized in student assessment through electronic submission, automated or electronic grading, and the use of platforms such as eClass and Universis. Communication with students is conducted through eClass announcements, institutional email, and ZOOM for virtual meetings or consultations.
TEACHING ORGANIZATION The ways and methods of teaching are described in detail. Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research& analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc. The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards	
STUDENT EVALUATION Description of the evaluation process Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in	**Description** Assessment Language: English Assessment Methods: • Written exam (70%) • Problem Solving (30%) **Student Evaluation Languages** English

Activity	Workload/semester
Lectures	52
BibliographyAnalysis	35
Other	75
Total	**162**

audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others Please indicate all relevant information about the course assessment and how students are informed	**Student evaluation methods** • EssayDevelopmentQuestions (Summative) • ProblemSolving (Summative)

5. SUGGESTED BIBLIOGRAPHY

EUDOXUS

1. Serway & Jewett: Physics for Scientists and Engineers, 10th ed. (2018), BROOKS COLE PUB CO, ISBN: 978-1337553278
2. Halliday, Resnick & Walker: Principles of Physics, 12th ed. (2023), Wiley, ISBN: 978-1119820611

Additional bibliography for study

1. Jaffe & Taylor: The Physics of Energy, (2018), Cambridge University Press, ISBN: 978-1107016651

ΜΟΝΑΔΑ ΔΙΑΣΦΑΛΙΣΗΣ ΠΟΙΟΤΗΤΑΣ Α.Π.Θ.

INTRODUCTION TO PROGRAMMING

1. GENERAL

FACULTY	Engineering		
SCHOOL	Bachelor of Science in Clean Energy Science and Engineering		
LEVEL OF STUDIES	ISCED level 6 – Bachelor's or equivalent level		
COURSE CODE	CESE04	SEMESTER	1st Semester
COURSE TITLE	INTRODUCTION TO PROGRAMMING		

TEACHING ACTIVITIES If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.	TEACHING HOURS PER WEEK	ECTS CREDITS
	5	9.0

COURSETYPE Background, General Knowledge, Scientific Area, Skill Development	General Background
PREREQUISITES	**PREREQUISITES** - **General prerequisites** -
TEACHING & EXAMINATION	English
COURSE OFFERED TO ERASMUS STUDENTS	NO
COURSE URL	https://elearning.auth.gr/course/index.php?categoryid=30

2. LEARNING OUTCOMES

Learning Outcomes
Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

Upon successful completion of the course, students will:

- Formulate algorithms to solve engineering problems.
- Write structured, efficient, and reusable Python programs.
- Use libraries such as NumPy, Pandas, and Matplotlib for numerical analysis and visualization.
- Automate workflows and prepare input/output files for simulations.
- Apply programming skills to case studies in mechanics, thermodynamics, and materials science

General Skills Name the desirable general skills upon successful completion of the module	
Search, analysis and synthesis of data and information, ICT Use,Adaptation to new situations, Decision making, Autonomous work, Teamwork, Working in an international environment, Working in an interdisciplinary environment, Production of new research ideas	Project design and management Equity and Inclusion Respect for the natural environment Sustainability Demonstration of social, professional and moral responsibility and sensitivity to gender issues Critical thinking Promoting free, creative and inductive reasoning

Practical application of knowledge
Search, analysis and synthesis of data and information, ICT Use
Autonomous work
Teamwork
Working in an interdisciplinary environment
Promoting free, creative and inductive reasoning

3. COURSE CONTENT

This course provides a comprehensive introduction to programming, focusing on Python as a modern, versatile, and opensource language widely used in science and technology. Students are trained to think algorithmically, design structured solutions, and implement them in Python. The course emphasizes clarity, reproducibility, and hands-on practice through interactive coding sessions and computer labs.
The content covers both fundamental programming concepts and their application to scientific problem solving. Students begin with general knowledge about computers, operating systems, and programming languages, before progressing to Python syntax, data structures, and libraries. They learn how to design algorithms, write efficient code, and apply computational methods to analyze data, visualize results, and simulate scientific systems.
Special attention is given to the use of NumPy, Pandas, and Matplotlib, as well as Jupyter notebooks for interactive workflows. By combining lectures, labs, and projects, the course ensures that students acquire both theoretical understanding and practical skills.
Weekly Program

- Weeks 1–2: General introduction to computers, operating systems, and programming languages. Problem solving strategies and the concept of algorithms. Introduction to Python environment and Jupyter notebooks.
- Weeks 3–4: Python basics: variables, data types, operators, control structures (loops, conditionals). First problem solving examples.
- Weeks 5–6: Functions, modules, and structured programming. Numerical examples from physics and chemistry.
- Weeks 7–8: Arrays and numerical computing with NumPy; plotting and visualization with Matplotlib.
- Weeks 9–10: Data handling with Pandas; file I/O and preparation of input/output for simulations.
- Weeks 11–12: Case studies in scientific applications (e.g., thermodynamics, materials properties, statistical physics)
- Week 13: Student projects integrating Python workflows; final presentations.

4. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD Face to face, Distance learning, etc.	Face to face

USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT)

Use of ICT in Teaching, in Laboratory Education, in Communication with students

USE OF ICT

- Use of ICT in Teaching
- Use of ICT in Laboratory Education
- Use of ICT in Communication with students
- Use of ICT in Evaluation of students

Description

ICT is integrated into all teaching activities. ZOOM supports live classes, while eClass provides asynchronous materials. Tools such as Excel, Python programming, Jupyter notebooks, online databases, and visualization software are used for demonstrations, numerical examples, and student exercises.
Student assessment is managed through electronic submission, digital grading, and platforms like eClass and Universis.
Communication with students takes place via eClass announcements, institutional email, and ZOOM meetings.

TEACHING ORGANIZATION

The ways and methods of teaching are described in detail. Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research& analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc.

The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards

Activity	Workload/semester
Lectures	65
Laboratory	52
BibliographyAnalysis	81
writingProject	42
Examinations	3
Total	**243**

STUDENT EVALUATION

Description of the evaluation process

Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others

Please indicate all relevant information about the course assessment and how students are informed

Description

Assessment Language: English Assessment Methods: • Written exam (40%) • Laboratory assignments (30%) • Final project report and presentation (30%)

Student Evaluation Languages

English

Student evaluation methods

- LaboratoryAssignment (Formative, Summative)
- PublicPresentation (Formative, Summative)
- EssayDevelopmentQuestions (Formative, Summative)

5. SUGGESTED BIBLIOGRAPHY

EUDOXUS

1. Προγραμματισμός Python για Μηχανικούς και Επιστήμονες: Ένας πόρος μάθησης που αλλάζει το παιχνίδι (https: //pythonnumericalmethods.berkeley.edu/notebooks/Index.html)

Additional bibliography for study

1. Προγραμματισμός Python για Μηχανικούς και Επιστήμονες: Ένας πόρος μάθησης που αλλάζει το παιχνίδι (https: //pythonnumericalmethods.berkeley.edu/notebooks/Index.html)

2nd Semester

TECHNICAL MECHANICS

1. GENERAL

FACULTY	Engineering		
SCHOOL	Bachelor of Science in Clean Energy Science and Engineering		
LEVEL OF STUDIES	ISCED level 6 – Bachelor's or equivalent level		
COURSE CODE	CESE05	SEMESTER	2nd Semester
COURSE TITLE	TECHNICAL MECHANICS		

TEACHING ACTIVITIES If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.	TEACHING HOURS PER WEEK	ECTS CREDITS
	4	6.0

COURSETYPE Background, General Knowledge, Scientific Area, Skill Development	General Background
PREREQUISITES	**PREREQUISITES** - **General prerequisites** -
TEACHING & EXAMINATION	English
COURSE OFFERED TO ERASMUS STUDENTS	NO
COURSE URL	https://elearning.auth.gr/course/index.php?categoryid=30

2. LEARNING OUTCOMES

Learning Outcomes
Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

By the end of this course, students will be able to:

- Construct and Utilize Free-Body Diagrams.
- Analyze Internal Forces in Structures.
- Apply Friction Principles
- Calculate Stress and Strain in structures

• Understand Elastic Behavior
General Skills Name the desirable general skills upon successful completion of the module Search, analysis and synthesis of data and information, ICT Use,Adaptation to new situations, Decision making, Autonomous work, Teamwork, Working in an international environment, Working in an interdisciplinary environment, Production of new research ideas Project design and management Equity and Inclusion Respect for the natural environment Sustainability Demonstration of social, professional and moral responsibility and sensitivity to gender issues Critical thinking Promoting free, creative and inductive reasoning
Practical application of knowledge Search, analysis and synthesis of data and information, ICT Use Adaptation to new situations Decision making Autonomous work Working in an interdisciplinary environment Project design and management Promoting free, creative and inductive reasoning

3. COURSE CONTENT

This course is the foundation of engineering analysis, covering the principles of force systems on bodies. Focus on drawing Free-Body Diagrams, calculating Internal Forces (shear/moment) in structures, and analyzing friction. The second part introduces Stress and Strain concepts to understand material deformation, elasticity, and structural integrity.

Key topics:

- Free Body Diagrams & Equilibrium: Modeling and balancing forces.
- Internal Forces: Axial/Shear force and bending moment calculations.
- Stress & Strain: Material response to load
- Elasticity: Understanding material deformation and stiffness

4. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD Face to face, Distance learning, etc.	Face to face
USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) Use of ICT in Teaching, in Laboratory Education, in Communication with students	**USE OF ICT** • Use of ICT in Teaching • Use of ICT in Laboratory Education • Use of ICT in Communication with students • Use of ICT in Evaluation of students **Description** Use of ICT in Course Teaching, Use of ICT in Communication with Students Description: Use of Information and Communication Technologies (ICT) in

	teaching the course with tools of modern distance learning (MS-Teams) and asynchronous education (e-learning). Use of learning aids based on ICT: Excel Use of ICT in student assessment: Electronic grading (e-learning). Use of ICT in communication with students: e-leaning, email, MS-Teams.
TEACHING ORGANIZATION The ways and methods of teaching are described in detail. Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research& analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc. The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards	<table><tr><th>Activity</th><th>Workload/semester</th></tr><tr><td>Lectures</td><td>52</td></tr><tr><td>writingProject</td><td>50</td></tr><tr><td>BibliographyAnalysis</td><td>50</td></tr><tr><td>Examinations</td><td>10</td></tr><tr><td>Total</td><td>162</td></tr></table>
STUDENT EVALUATION Description of the evaluation process Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others Please indicate all relevant information about the course assessment and how students are informed	**Description** Written Exams with Problem Solving with Short Answer Written Exams with Problem Solving (Summative) **Student Evaluation Languages** English **Student evaluation methods** • ProblemSolving (Summative) • EssayDevelopmentQuestions (Summative)

5. SUGGESTED BIBLIOGRAPHY

EUDOXUS

1 Beer, F. P., Johnston, E. R., Jr., DeWolf, J. T., & Mazurek, D. F. (2015). Mechanics of materials (7th ed.). McGraw-Hill Education.
2. Beer, F. P., Johnston, E. R., Jr., Mazurek, D. F., & Cornwell, P. J. (2013). Vector mechanics for engineers: Statics (10th ed.). McGraw-Hill Education.
3. Philpot, T. A. (2017). Mechanics of materials: An integrated learning system (4th ed.). Wiley

Additional bibliography for study

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PHYSICAL CHEMISTRY FOR ENERGY SYSTEMS

1. GENERAL

FACULTY	Engineering		
SCHOOL	Bachelor of Science in Clean Energy Science and Engineering		
LEVEL OF STUDIES	ISCED level 6 – Bachelor's or equivalent level		
COURSE CODE	CESE06	SEMESTER	2nd Semester
COURSE TITLE	PHYSICAL CHEMISTRY FOR ENERGY SYSTEMS		

TEACHING ACTIVITIES If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.	TEACHING HOURS PER WEEK	ECTS CREDITS
	5	7.0

COURSETYPE Background, General Knowledge, Scientific Area, Skill Development	General Background
PREREQUISITES	**PREREQUISITES** - **General prerequisites** -
TEACHING & EXAMINATION	English
COURSE OFFERED TO ERASMUS STUDENTS	NO
COURSE URL	https://elearning.auth.gr/course/index.php?categoryid=30

2. LEARNING OUTCOMES

Learning Outcomes
Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

Knowledge
After successfully completing the course, students will be able to:

- Explain the fundamental thermodynamic principles (energy, entropy, Gibbs free energy) governing the behavior of gases, liquids and solids in energy-relevant systems.
- Describe chemical and phase equilibria in multicomponent mixtures and analyze how temperature and pressure influence equilibrium in processes such as combustion, reforming, water splitting and gas–liquid transitions.
- Understand solution thermodynamics and electrolyte behavior, including ionic activity, colligative properties and the application of the Nernst equation to simple electrochemical systems.

- Interpret basic electrochemical concepts relevant to energy conversion and storage, including electrode potentials, cell operation and ion transport.
- Describe the fundamental principles of chemical kinetics and catalysis, with emphasis on reaction rates and mechanisms central to clean-energy processes.

Skills

Upon completion, students will be able to:

- Apply thermodynamic, equilibrium and kinetic models to analyze the behavior and efficiency of elementary energy systems.
- Quantify thermodynamic and kinetic parameters based on experimental or provided data.
- Perform basic physical-chemistry laboratory measurements relevant to energy systems.
- Evaluate laboratory data, identify sources of error and extract meaningful physical and chemical parameters.

Abilities / Competences

Students will develop the ability to:

- Integrate thermodynamic, electrochemical and kinetic principles to interpret and predict the behavior of simple clean-energy processes (e.g., electrolysis, catalytic reactions, gas-phase equilibria).
- Assess how physical-chemical factors (temperature, pressure, composition, phase changes, ionic strength) influence the performance of energy systems.
- Identify the fundamental mechanisms that govern chemical reactivity, stability and efficiency in clean-energy technologies.
- Communicate scientific reasoning, laboratory findings and quantitative analyses in a clear and coherent manner.
- Connect foundational physical chemistry concepts with advanced CESE subjects such as electrochemical energy storage, hydrogen technologies, catalysis and renewable energy conversion.

General Skills

Name the desirable general skills upon successful completion of the module

Search, analysis and synthesis of data and information,
ICT Use,Adaptation to new situations,
Decision making,
Autonomous work,
Teamwork,
Working in an international environment,
Working in an interdisciplinary environment, Production of new research ideas

Project design and management
Equity and Inclusion
Respect for the natural environment
Sustainability
Demonstration of social, professional and moral responsibility and sensitivity to gender issues
Critical thinking
Promoting free, creative and inductive reasoning

Practical application of knowledge
Search, analysis and synthesis of data and information, ICT Use
Autonomous work
Teamwork
Working in an interdisciplinary environment
Promoting free, creative and inductive reasoning

3. COURSE CONTENT

This course introduces the essential principles of Physical Chemistry that govern the behavior of chemical and electrochemical systems used in modern clean-energy technologies. Core topics include the thermodynamic properties of gases, liquids and solids; the First, Second and Third Laws of Thermodynamics; and chemical and phase equilibria in multicomponent systems relevant to energy processes. Students explore the properties of solutions and electrolytes, ionic activity, and introductory electrochemistry, with emphasis on electrochemical potentials and energy conversion. Fundamental concepts of chemical kinetics and catalysis are also covered, focusing on reaction rates, temperature effects and mechanisms central to combustion, electrolysis, hydrogen production

and catalytic conversion pathways.
Laboratory exercises introduce key experimental techniques for the characterization of physical and chemical behavior, including calorimetry, conductivity measurements, equilibrium studies and basic electrochemical diagnostics.

4. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD Face to face, Distance learning, etc.	Face to face
USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) Use of ICT in Teaching, in Laboratory Education, in Communication with students	**USE OF ICT** • Use of ICT in Teaching • Use of ICT in Laboratory Education • Use of ICT in Communication with students • Use of ICT in Evaluation of students **Description** Use of ICT • Use of ICT in Teaching • Use of ICT in Communication with students Use of ICT – Description • elearning.auth.gr: educational materials available to students along with exercises • Teaching electronic presentations (slides, video, etc.) • Communication via elearning.aut.gr and emails
TEACHING ORGANIZATION The ways and methods of teaching are described in detail. Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research& analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc. The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards	
STUDENT EVALUATION Description of the evaluation process Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others Please indicate all relevant information about the course assessment and how students are informed	**Description** Written Assignment (Summative), Performance / Staging (Summative), Written Exam with Problem Solving (Summative) **Student Evaluation Languages** English **Student evaluation methods** • WrittenAssignment (Summative) • EssayReport (Summative)

Activity	Workload/semester
Lectures	65
Laboratory	25
writingProject	35
BibliographyAnalysis	61
Examinations	3
Total	**189**

STUDENT EVALUATION Description of the evaluation process Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others Please indicate all relevant information about the course assessment and how students are informed	• ProblemSolving (Summative)

5. SUGGESTED BIBLIOGRAPHY

EUDOXUS

1. "Physical Chemistry", Peter Atkins, Julio de Paula, James Keeler, Oxford University Press, 2023
2. "Physical Chemistry for the Chemical Sciences", Raymond Chang, Jr. Thoman John W., University Science Books, 2014
3. “Physical Chemistry”, David W. Ball, Cengage Learning, 2014

Additional bibliography for study

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LINEAR ALGEBRA AND ITS APPLICATIONS

1. GENERAL

FACULTY	Engineering		
SCHOOL	Bachelor of Science in Clean Energy Science and Engineering		
LEVEL OF STUDIES	ISCED level 6 – Bachelor's or equivalent level		
COURSE CODE	CESE07	SEMESTER	2nd Semester
COURSE TITLE	LINEAR ALGEBRA AND ITS APPLICATIONS		

TEACHING ACTIVITIES If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.	TEACHING HOURS PER WEEK	ECTS CREDITS
	4	6.0

COURSETYPE Background, General Knowledge, Scientific Area, Skill Development	General Background
PREREQUISITES	**PREREQUISITES** - **General prerequisites** -
TEACHING & EXAMINATION	English
COURSE OFFERED TO ERASMUS STUDENTS	NO
COURSE URL	https://elearning.auth.gr/course/index.php?categoryid=30

2. LEARNING OUTCOMES

Learning Outcomes
Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

By the end of this course, students will be able to:

- to understand the basics in matrix theory
- to solve systems of linear (differential) equations
- to analyse problems by suitable decomposition techniques, to program and perform fundamental numerical tasks

General Skills Name the desirable general skills upon successful completion of the module	
Search, analysis and synthesis of data and information, ICT Use,Adaptation to new situations, Decision making, Autonomous work, Teamwork, Working in an international environment, Working in an interdisciplinary environment, Production of new research ideas	Project design and management Equity and Inclusion Respect for the natural environment Sustainability Demonstration of social, professional and moral responsibility and sensitivity to gender issues Critical thinking Promoting free, creative and inductive reasoning

Practical application of knowledge
Search, analysis and synthesis of data and information, ICT Use
Adaptation to new situations
Decision making
Working in an interdisciplinary environment
Promoting free, creative and inductive reasoning

3. COURSE CONTENT

- Elementary Matrix Theory
- Systems of simultaneous equations – Reduced row echelon form – Numerical implementation in MATLAB and python
- Linear algebra in n-dimensions – Vector spaces – bases – column and row space – null and range space – representation of lines and planes – Numerical implementation in MATLAB and python
- Orthogonality and its consequences – Orthogonal and orthonormal bases – projection to spaces – Numerical implementation in MATLAB and python
- Eigenvalue – eigenvector problem – Numerical implementation in MATLAB and python
- Quadratic forms
- Linear regression, simulation and optimization Applications in Clean Energy Systems in MATLAB and python

4. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD Face to face, Distance learning, etc.	Face to face
USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) Use of ICT in Teaching, in Laboratory Education, in Communication with students	**USE OF ICT** • Use of ICT in Teaching • Use of ICT in Laboratory Education • Use of ICT in Communication with students • Use of ICT in Evaluation of students **Description** Use of ICT in Course Teaching, Use of ICT in Laboratory Teaching, Use of ICT in Communication with Students Description: Use of Information and Communication Technologies (ICT) in teaching the course with tools of modern distance learning (ZOOM) and asynchronous education (eclass). Use of learning aids based on ICT: Excel

Use of ICT in student assessment: Electronic grading (eclass, universis).
Use of ICT in communication with students: eclass, email, ZOOM.

TEACHING ORGANIZATION

The ways and methods of teaching are described in detail. Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research& analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc.

The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards

Activity	Workload/semester
Lectures	52
InteractiveLearning	36
writingProject	36
BibliographyAnalysis	35
Examinations	3
Total	**162**

STUDENT EVALUATION

Description of the evaluation process

Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others

Please indicate all relevant information about the course assessment and how students are informed

Description

Written and Computer Assignment (Summative) 50%, , Written Exam with Multiple Choice Questions 25%, Written Exam with Problem Solving (Summative) 25%

Student Evaluation Languages

English

Student evaluation methods

- MultipleChoice (Summative)
- ComputerExamination (Summative)
- ProblemSolving (Summative)

5. SUGGESTED BIBLIOGRAPHY

EUDOXUS

1. J. L. Goldberg, Matrix Theory with Applications, McGraw Hill.

Additional bibliography for study

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ENERGY RESOURCES

1. GENERAL

FACULTY	Engineering		
SCHOOL	Bachelor of Science in Clean Energy Science and Engineering		
LEVEL OF STUDIES	ISCED level 6 – Bachelor's or equivalent level		
COURSE CODE	CESE08	SEMESTER	2nd Semester
COURSE TITLE	ENERGY RESOURCES		

TEACHING ACTIVITIES If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.	TEACHING HOURS PER WEEK	ECTS CREDITS
	4	5.0

COURSETYPE Background, General Knowledge, Scientific Area, Skill Development	General Background
PREREQUISITES	**PREREQUISITES** - **General prerequisites** -
TEACHING & EXAMINATION	English
COURSE OFFERED TO ERASMUS STUDENTS	NO
COURSE URL	https://elearning.auth.gr/course/index.php?categoryid=30

2. LEARNING OUTCOMES

Learning Outcomes
Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

By the end of this course, students will be able to:

- Explain the fundamental concepts of energy resources, including availability, conversion, and sustainability.
- Describe the characteristics, advantages, and limitations of conventional (fossil, nuclear) and renewable (solar, wind, hydro, biomass, geothermal, marine) energy sources.
- Understand the role of energy storage and integration in clean energy systems.
- Calculate and compare key performance metrics such as EROI (Energy Return on Investment), efficiency, and lifecycle emissions for different energy resources.

- Apply resource assessment tools and simulation methods to evaluate renewable projects.
- Analyze trade-offs between energy resource choices in terms of economics, environmental impact, and social acceptance.
- Propose strategies for integrating multiple energy resources into sustainable energy systems.
- Present technical findings clearly through written reports and oral presentations.
- Collaborate effectively in group projects

General Skills

Name the desirable general skills upon successful completion of the module

Search, analysis and synthesis of data and information,
ICT Use,Adaptation to new situations,
Decision making,
Autonomous work,
Teamwork,
Working in an international environment,
Working in an interdisciplinary environment, Production of new research ideas

Project design and management
Equity and Inclusion
Respect for the natural environment
Sustainability
Demonstration of social, professional and moral responsibility and sensitivity to gender issues
Critical thinking
Promoting free, creative and inductive reasoning

Practical application of knowledge
Search, analysis and synthesis of data and information, ICT Use
Decision making
Autonomous work
Working in an interdisciplinary environment
Production of new research ideas
Promoting free, creative and inductive reasoning

3. COURSE CONTENT

Introduction to Energy Resources: Global energy demand, energy units, Energy Return On Investment, sustainability concepts, Fossil Fuels: Coal, oil, natural gas – reserves, imports/exports, extraction, oil refineries, natural gas processing, uses, environmental impacts, Nuclear Energy: Fission, fusion prospects, safety, waste management, Hydropower: Large-scale dams, small hydro, hydro pumped storage, Solar Energy: Photovoltaics, solar thermal, Concentrated Solar Power, Wind Energy: Wind turbines, onshore, offshore, resource assessment, Biomass & Bioenergy: Biomass types and characteristics, thermochemical conversion (combustion, gasification, pyrolysis), biochemical processes (fermentation, aerobic and anaerobic digestion, biofuels, biomass/waste-to-energy technologies, Geothermal Energy: Resource types, technologies, limitations, Marine Energy: Tidal, wave, ocean thermal, Energy Storage: Mechanical and thermal storage methods, Electrochemical storage, batteries, hydrogen technologies (production, storage, transportation and repower), P2X technologies, alternative fuels (ammonia, methanol, synthetic fuels), Energy Systems Integration: Smart grids, hybrid systems, Energy Economics & Policy: Cost analysis, subsidies, carbon pricing, Future Outlook & Review: Global energy transition scenarios

4. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD Face to face, Distance learning, etc.	Face to face
USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) Use of ICT in Teaching, in Laboratory Education, in Communication with students	**USE OF ICT** • Use of ICT in Teaching • Use of ICT in Laboratory Education • Use of ICT in Communication with students

	• Use of ICT in Evaluation of students **Description** Use of Information and Communication Technologies (ICT) in course teaching with asynchronous education tools (e-learning) and in the communication with the students (e-learning, e-mails, telcos).
TEACHING ORGANIZATION The ways and methods of teaching are described in detail. Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research& analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc. The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards	
STUDENT EVALUATION Description of the evaluation process Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others Please indicate all relevant information about the course assessment and how students are informed	**Description** Group Project (15%) – Weeks 5–12, report and presentation Final Exam (85%) – Week 13, evaluation of all topics **Student Evaluation Languages** English **Student evaluation methods** • WrittenAssignment (Summative) • EssayDevelopmentQuestions (Summative)

Activity	Workload/semester
Lectures	52
Seminars	38
writingProject	20
BibliographyAnalysis	22
Examinations	3
Total	**135**

5. SUGGESTED BIBLIOGRAPHY

EUDOXUS

1. Introduction to Energy: Resources, Technology, and Society by Edward S. Cassedy, Peter Z. Grossman
2. Introduction to Energy Systems by Ibrahim Dincer, Dogan Erdemir
3. Science of Energy : Resources and Power Explained by Michael E. Wysession

Additional bibliography for study

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ΜΟΝΑΔΑ ΔΙΑΣΦΑΛΙΣΗΣ ΠΟΙΟΤΗΤΑΣ Α.Π.Θ.

STATISTICS

1. GENERAL

FACULTY	Engineering		
SCHOOL	Bachelor of Science in Clean Energy Science and Engineering		
LEVEL OF STUDIES	ISCED level 6 – Bachelor's or equivalent level		
COURSE CODE	CESE09	SEMESTER	2nd Semester
COURSE TITLE	STATISTICS		

TEACHING ACTIVITIES If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.	TEACHING HOURS PER WEEK	ECTS CREDITS
	4	6.0

COURSETYPE Background, General Knowledge, Scientific Area, Skill Development	General Background
PREREQUISITES	**PREREQUISITES** - **General prerequisites** -
TEACHING & EXAMINATION	English
COURSE OFFERED TO ERASMUS STUDENTS	NO
COURSE URL	https://elearning.auth.gr/course/index.php?categoryid=30

2. LEARNING OUTCOMES

Learning Outcomes
Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

Upon successful completion of the course, the student will be able to:

- Summarize and visualize data using descriptive statistics, frequency distributions, and graphical techniques such as histograms.
- Apply fundamental probability concepts—including conditional probability and Bayes' theorem—to quantify uncertainty in real-world scenarios.
- Describe and work with major probability distributions, both discrete and continuous, and compute key measures such as expected value and variance.
- Use the central limit theorem to justify inference procedures and understand the behavior of sampling distributions.

- Construct and interpret point estimates and confidence intervals, and determine the sample size required for desired precision.
- Formulate and test statistical hypotheses, evaluate Type I and Type II errors, and perform goodness-of-fit tests.
- Build and interpret simple linear regression models to analyze relationships between variables.
- Use statistical reasoning and software tools to analyze data, interpret results, and communicate findings effectively.

General Skills

Name the desirable general skills upon successful completion of the module

Search, analysis and synthesis of data and information,
ICT Use,Adaptation to new situations,
Decision making,
Autonomous work,
Teamwork,
Working in an international environment,
Working in an interdisciplinary environment, Production of new research ideas

Project design and management
Equity and Inclusion
Respect for the natural environment
Sustainability
Demonstration of social, professional and moral responsibility and sensitivity to gender issues
Critical thinking
Promoting free, creative and inductive reasoning

Practical application of knowledge
Search, analysis and synthesis of data and information, ICT Use
Adaptation to new situations
Decision making
Autonomous work
Promoting free, creative and inductive reasoning

3. COURSE CONTENT

This course introduces the fundamental concepts of probability and statistics used for data analysis and inference. Students learn to summarize and visualize data using descriptive statistics, frequency distributions, and histograms, and to quantify key characteristics such as central tendency and variability. The course covers core probability principles, including random variables, expected values, and major discrete and continuous probability distributions, along with the central limit theorem. Students then explore statistical estimation through sampling distributions, point estimators, confidence intervals, and sample-size determination. Building on these foundations, the course addresses hypothesis testing for parameters and goodness-of-fit, before concluding with an introduction to simple linear regression for modeling relationships in data.

4. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD Face to face, Distance learning, etc.	Face to face
USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) Use of ICT in Teaching, in Laboratory Education, in Communication with students	**USE OF ICT** • Use of ICT in Teaching • Use of ICT in Laboratory Education • Use of ICT in Communication with students • Use of ICT in Evaluation of students **Description** • Use of ICT in Course Teaching e-learning, zoom, programm • Use of ICT in Communication with Students, e-learning, e-mails • Use of ICT in Student Assessment, e-mails, programm

presentations, zoom teams

TEACHING ORGANIZATION

The ways and methods of teaching are described in detail. Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research& analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc.

The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards

Activity	Workload/semester
Lectures	52
BibliographyAnalysis	77
writingProject	30
Examinations	3
Total	**162**

STUDENT EVALUATION

Description of the evaluation process

Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others

Please indicate all relevant information about the course assessment and how students are informed

Description

• Written Exam with Multiple Choice Questions (Summative) • Written Exam with Short Answer Questions (Summative) • Written Exam with Extended Answer Questions (Summative) • Written Assignment (Summative) • Written Exam with Problem Solving (Summative) • Homework (Summative)

Student Evaluation Languages

English

Student evaluation methods

• MultipleChoice (Summative)

• ShortAnswerQuestions (Summative)

• EssayDevelopmentQuestions (Summative)

• WrittenAssignment (Summative)

• ProblemSolving (Summative)

• EssayReport (Summative)

5. SUGGESTED BIBLIOGRAPHY

EUDOXUS

1. Montgomery, D.C., Runger, G.C., Applied Statistics and Probability for Engineers, Wiley, 2006.
2. Montgomery, D.C., Runger, G.C., Hubele, N.F., Engineering Statistics, Wiley, 2007

Additional bibliography for study

3rd Semester

DATA ANALYSIS AND MODELLING

1. GENERAL

FACULTY	Engineering		
SCHOOL	Bachelor of Science in Clean Energy Science and Engineering		
LEVEL OF STUDIES	ISCED level 6 – Bachelor's or equivalent level		
COURSE CODE	CESE10	SEMESTER	3rd Semester
COURSE TITLE	DATA ANALYSIS AND MODELLING		

TEACHING ACTIVITIES If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.	TEACHING HOURS PER WEEK	ECTS CREDITS
	5	8.0

COURSETYPE Background, General Knowledge, Scientific Area, Skill Development	General Background
PREREQUISITES	**PREREQUISITES** - **General prerequisites** -
TEACHING & EXAMINATION	English
COURSE OFFERED TO ERASMUS STUDENTS	NO
COURSE URL	https://elearning.auth.gr/course/index.php?categoryid=30

2. LEARNING OUTCOMES

Learning Outcomes
Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

By the end of this course, students will be able to:

1. Clean and visualize energy and environmental datasets
2. Apply basic regression and classification to real problems
3. Understand when to use different analytical methods
4. Build simple forecasting models for energy applications

5. Complete an independent data analysis project
6. Communicate findings through clear visualizations and presentations

General Skills

Name the desirable general skills upon successful completion of the module

Search, analysis and synthesis of data and information,
ICT Use,Adaptation to new situations,
Decision making,
Autonomous work,
Teamwork,
Working in an international environment,
Working in an interdisciplinary environment, Production of new research ideas

Project design and management
Equity and Inclusion
Respect for the natural environment
Sustainability
Demonstration of social, professional and moral responsibility and sensitivity to gender issues
Critical thinking
Promoting free, creative and inductive reasoning

Practical application of knowledge
Search, analysis and synthesis of data and information, ICT Use
Adaptation to new situations
Decision making
Autonomous work
Teamwork
Working in an interdisciplinary environment
Production of new research ideas
Promoting free, creative and inductive reasoning

3. COURSE CONTENT

Indicative Course Structure (13-week semester)
Module 1: Foundations of Energy & Environment data analysis
Week 1: Introduction to Energy and Environmental Data

- Types of data: energy consumption, renewable generation, air quality, weather
- Reading datasets (CSV, Excel) and basic data structures and formats (JSON, time series)
- Simple visualization: line plots, bar charts, scatter plots
- Exploratory data analysis (EDA) fundamentals
- Practical exercise: Exploring a solar generation dataset

Week 2: Data Cleaning and Basic Statistics

- Handling missing values, outliers, duplicates
- Descriptive & explanatory statistics: mean, median, standard deviation, skewness, kurtosis
- Data transformation and normalization
- Data quality checks
- Hands-on: Cleaning an energy consumption dataset

Week 3: Patterns and Trends identification & visualization

- Time series basics: trends and seasonality in energy data
- Correlation: how variables relate (temperature vs. energy use)
- Creating effective visualizations
- Advanced plotting: histograms, box plots, heatmaps, pair plots
- Time series visualization techniques
- Exercise: Analyzing monthly energy consumption patterns

Module 2: Basic Predictive Modelling

Week 4: Introduction to Regression
- Regression: predicting continuous values
- Feature selection
- Applications: Building energy demand, solar output prediction
- Model evaluation basics (R-squared, error metrics)
- Exercise: Predicting heating demand from temperature

Week 5: Classification Methods
- Introduction to classification: categorizing data
- Decision trees
- Handling imbalance datasets
- Applications: Building efficiency ratings, air quality categories
- Hands-on: Classifying air quality levels

Week 6: Forecasting
- Forecasting basics for renewable energy
- Simple methods: moving averages, trend analysis
- Understanding forecast accuracy

Exercise: Forecasting next-day solar generation

Week 7: Mid-term Review and Practical Exam
- Review of Weeks 1-6 concepts
- Practical exam: complete a data analysis task
- Q&A session

Module 3: Machine Learning Essentials

Week 8: Pattern Recognition - Clustering and PCA
- Clustering basics: grouping similar data points
- Principal Component Analysis (PCA): simplifying complex datasets
- Applications: Consumer types, wind turbine performance groups
- Demo: Identifying building consumption patterns

Week 9: Neural Networks Introduction
- Introduction to ANNs
- When to use neural networks vs. traditional methods
- Applications: Energy forecasting, environmental prediction

Week 10: Comparing Methods and Model Selection
- Decision trees vs. regression vs. neural networks
- Choosing the right method for your problem
- Real-world examples from energy and environment

Module 4: Integration and Project Work

Week 11: Basics in information service design
- Energy and environment data as “raw material” for electronic information services
- Basic components of data workflows: data visualization and processing technologies
- Dataset exploration

Week 12: Project Work Session
- Apply learned methods to a chosen topic
- Options: energy forecasting, consumption analysis, environmental prediction

Week 13: Project Presentations and Wrap-up
- Student presentations (10 min each
- Key takeaways

4. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD Face to face, Distance learning, etc.	Face to face

USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) Use of ICT in Teaching, in Laboratory Education, in Communication with students	**USE OF ICT** • Use of ICT in Teaching • Use of ICT in Laboratory Education • Use of ICT in Communication with students • Use of ICT in Evaluation of students **Description** Use of ICT in Course Teaching, Use of ICT in Laboratory Teaching, Use of ICT in Communication with Students Description: • Excel/Google spreadsheets • Python/Matlab programming language • Free visualization tools
TEACHING ORGANIZATION The ways and methods of teaching are described in detail. Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research& analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc. The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards	
STUDENT EVALUATION Description of the evaluation process Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others Please indicate all relevant information about the course assessment and how students are informed	**Description** • Weekly and exercises: 25% • Mid-term exam (Week 7): 25% • Final project and presentation: 40% • Participation: 10% **Student Evaluation Languages** English **Student evaluation methods** • WrittenAssignment (Formative) • Proodos (Formative, Summative) • Presentation (Formative, Summative) • ContinuousEvaluation (Formative, Summative)

Activity	Workload/semester
Lectures	65
InteractiveLearning	26
Laboratory	85
Seminars	11
BibliographyAnalysis	26
Examinations	3
Total	**216**

5. SUGGESTED BIBLIOGRAPHY

EUDOXUS

1. Karatzas K. (2012). Environmental Informatics Lecture Notes (100 pages)

Additional bibliography for study

1. McKinney W. (2023). Python for Data Analysis, 3rd Edition

2. Géron A. (2022). Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow" (3rd Edition)

ΜΟΝΑΔΑ ΔΙΑΣΦΑΛΙΣΗΣ ΠΟΙΟΤΗΤΑΣ Α.Π.Θ.

THERMOFLUIDS

1. GENERAL

FACULTY	Engineering		
SCHOOL	Bachelor of Science in Clean Energy Science and Engineering		
LEVEL OF STUDIES	ISCED level 6 – Bachelor's or equivalent level		
COURSE CODE	CESE11	SEMESTER	3rd Semester
COURSE TITLE	THERMOFLUIDS		

TEACHING ACTIVITIES If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.	TEACHING HOURS PER WEEK	ECTS CREDITS
	4	7.0

COURSETYPE Background, General Knowledge, Scientific Area, Skill Development	Specific Background
PREREQUISITES	**PREREQUISITES** - **General prerequisites** -
TEACHING & EXAMINATION	English
COURSE OFFERED TO ERASMUS STUDENTS	NO
COURSE URL	https://elearning.auth.gr/course/index.php?categoryid=30

2. LEARNING OUTCOMES

Learning Outcomes
Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

By the end of this course, students will be able to:

- Understand the basic principles of thermofluids engineering.
- Understand the basics principles of Thermodynamics.
- Understand the basics principles of Fluid Mechanics.
- Understand the basics principles of Heat Transfer.
- Comprehend the importance of the relevant applications in Thermofluids.
- Have the opportunity to practice the operational procedures of themofluid systems.

General Skills Name the desirable general skills upon successful completion of the module	
Search, analysis and synthesis of data and information, ICT Use,Adaptation to new situations, Decision making, Autonomous work, Teamwork, Working in an international environment, Working in an interdisciplinary environment, Production of new research ideas	Project design and management Equity and Inclusion Respect for the natural environment Sustainability Demonstration of social, professional and moral responsibility and sensitivity to gender issues Critical thinking Promoting free, creative and inductive reasoning

Practical application of knowledge
Search, analysis and synthesis of data and information, ICT Use
Adaptation to new situations
Decision making
Autonomous work
Teamwork
Working in an interdisciplinary environment
Production of new research ideas
Promoting free, creative and inductive reasoning

3. COURSE CONTENT

This course presents a holistic approach in the main principles of energy technology.
In particular, the main principles of Thermodynamis, Fluidd Mechanics and Heat Transfer are presented in this course.
1. Thermodynamics
The first principles of Thermodynamics including the First and Second Law of Thermodynamics are presented. The application of the related technologies are introced using the worked out examples.
2. Fluid Mechanics
The first principles of Fluid Mechanics are introduced in this course. The conservation of mass, energy and momentum are presented in 0D, namely the Continuity Equation, the Bernoulli Equation and the Force-Momentum Equation.
3. Heat Transfer
The first principles of Heat Transfer are introduced in this course. The main concepts of heat transfer by convection, conduction and radiation are presented.

4. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD Face to face, Distance learning, etc.	Face to face
USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) Use of ICT in Teaching, in Laboratory Education, in Communication with students	**USE OF ICT** • Use of ICT in Teaching • Use of ICT in Laboratory Education • Use of ICT in Communication with students • Use of ICT in Evaluation of students **Description** Use of ICT in Course Teaching, Use of ICT in Laboratory Teaching, Use of

	ICT in Communication with Students Description: Use of Information and Communication Technologies (ICT) in teaching the course with tools of modern distance learning (ZOOM) and asynchronous education (eclass). Use of learning aids based on ICT: Excel Use of ICT in student assessment: Electronic grading (eclass, universis). Use of ICT in communication with students: e-learning, email, ZOOM.
TEACHING ORGANIZATION The ways and methods of teaching are described in detail. Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research& analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc. The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards	

Activity	Workload/semester
Lectures	52
writingProject	60
BibliographyAnalysis	74
Examinations	3
Total	**189**

STUDENT EVALUATION Description of the evaluation process Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others Please indicate all relevant information about the course assessment and how students are informed	**Description** Written Assignment (Summative), Written Exam with Problem Solving (Summative) **Student Evaluation Languages** English **Student evaluation methods** • WrittenAssignment (Summative) • ProblemSolving ()

5. SUGGESTED BIBLIOGRAPHY

EUDOXUS

1. Fluid Mechanics, Frank M. White and Henry Xue. ISBN10: 1260446557. ISBN13: 9781260446555. 9th Edition, McGraw Hill.
2. Thermodynamics: An Engineering Approach, Yunus A. Cengel and Michael A. Boles, ISBN10: 1265903697 | ISBN13: 97812659036910th Edition, Mc Graw Hill.
3. Fundamentals of Heat and Mass Transfer (6th Edition) 2006, Frank P. Incropera, David P. Dewitt, Theodore L. Bergman, Adrienne S. Lavine

Additional bibliography for study

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MATERIALS SCIENCE AND ENGINEERING

1. GENERAL

FACULTY	Engineering		
SCHOOL	Bachelor of Science in Clean Energy Science and Engineering		
LEVEL OF STUDIES	ISCED level 6 – Bachelor's or equivalent level		
COURSE CODE	CESE12	SEMESTER	3rd Semester
COURSE TITLE	MATERIALS SCIENCE AND ENGINEERING		

TEACHING ACTIVITIES If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.	TEACHING HOURS PER WEEK	ECTS CREDITS
	5	8.0

COURSETYPE Background, General Knowledge, Scientific Area, Skill Development	Specific Background
PREREQUISITES	**PREREQUISITES** - **General prerequisites** -
TEACHING & EXAMINATION	English
COURSE OFFERED TO ERASMUS STUDENTS	NO
COURSE URL	https://elearning.auth.gr/course/index.php?categoryid=30

2. LEARNING OUTCOMES

Learning Outcomes
Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

By the end of this course, students will be able to:

- Explain the structure-processing-properties-performance paradigm in Materials Science and Engineering.
- Describe bonding, crystal structures, and common defects, and relate them to macroscopic properties.
- Interpret basic phase diagrams and use them to rationalize microstructure evolution.
- Compare metals, ceramics, polymers, semiconductors, and composites in terms of key properties and applications.
- Select simple characterization and testing methods appropriate for a given materials problem.
- Communicate materials-related technical information using correct terminology and clear engineering reasoning..

General Skills Name the desirable general skills upon successful completion of the module	
Search, analysis and synthesis of data and information, ICT Use,Adaptation to new situations, Decision making, Autonomous work, Teamwork, Working in an international environment, Working in an interdisciplinary environment, Production of new research ideas	Project design and management Equity and Inclusion Respect for the natural environment Sustainability Demonstration of social, professional and moral responsibility and sensitivity to gender issues Critical thinking Promoting free, creative and inductive reasoning

Practical application of knowledge
Search, analysis and synthesis of data and information, ICT Use
Adaptation to new situations
Decision making
Autonomous work
Teamwork
Respect for the natural environment
Promoting free, creative and inductive reasoning

3. COURSE CONTENT

Materials Science and Engineering examines how a material's internal structure determines its properties and, ultimately, its performance in real applications, emphasizing design trade-offs and the "materials paradigm" linking processing, structure, properties, and function. The course surveys the main classes of materials and their typical uses, introducing microstructure as a key descriptor of material behavior. Fundamental topics include atomic bonding, crystal structures, and amorphous solids, followed by crystal defects (vacancies, dislocations, and grain boundaries) and the basics of diffusion. Students learn to interpret phase diagrams (phases, lever rule, eutectic reactions) and gain an introductory understanding of phase transformations. Mechanical behavior is covered through elastic and plastic deformation, strengthening mechanisms, and fracture fundamentals. An overview of functional properties (electrical, thermal, magnetic, and optical) along with corrosion basics, highlights performance beyond mechanics. The course concludes with an introduction to major processing routes (casting, deformation processing, heat treatment, polymer processing, sintering, and additive manufacturing) and key concepts in materials selection with sustainability considerations.

4. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD Face to face, Distance learning, etc.	Face to face
USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) Use of ICT in Teaching, in Laboratory Education, in Communication with students	**USE OF ICT** • Use of ICT in Teaching • Use of ICT in Laboratory Education • Use of ICT in Communication with students • Use of ICT in Evaluation of students **Description** Learning management system (e-learning platform) for notes, quizzes and announcements; spreadsheets for simple property charts; basic use of materials databases for information retrieval.

TEACHING ORGANIZATION

The ways and methods of teaching are described in detail. Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research& analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc.

The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards

Activity	Workload/semester
Lectures	65
Laboratory	30
writingProject	25
BibliographyAnalysis	60
Other	33
Examinations	3
Total	**216**

STUDENT EVALUATION

Description of the evaluation process

Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others

Please indicate all relevant information about the course assessment and how students are informed

Description

Assessment language: English. Methods: written final exam (60%), homework/problem sets and short quizzes (25%), mini-case study/report (15%). Students are informed via the course guide and e-learning announcements.

Student Evaluation Languages

English

Student evaluation methods

- WrittenAssignment (Formative, Summative)
- LaboratoryReport (Formative, Summative)
- ProblemSolving (Summative)

5. SUGGESTED BIBLIOGRAPHY

EUDOXUS

1. W.D. Callister & D.G. Rethwisch, Materials Science and Engineering: An Introduction.
2. M.F. Ashby & D.R.H. Jones, Engineering Materials 1–2.
3. J.F. Shackelford, Introduction to Materials Science for Engineers.

Additional bibliography for study

1. Selected open courseware notes (indicative): MIT OCW / UC Berkeley MSE course materials.

ENERGY SYSTEMS

1. GENERAL

FACULTY	Engineering		
SCHOOL	Bachelor of Science in Clean Energy Science and Engineering		
LEVEL OF STUDIES	ISCED level 6 – Bachelor's or equivalent level		
COURSE CODE	CESE13	SEMESTER	3rd Semester
COURSE TITLE	ENERGY SYSTEMS		

TEACHING ACTIVITIES If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.	TEACHING HOURS PER WEEK	ECTS CREDITS
	4	7.0

COURSETYPE Background, General Knowledge, Scientific Area, Skill Development	Specific Background
PREREQUISITES	**PREREQUISITES** - **General prerequisites** Calculus, Linear Algebra, Physics, Chemistry
TEACHING & EXAMINATION	English
COURSE OFFERED TO ERASMUS STUDENTS	NO
COURSE URL	https://elearning.auth.gr/course/index.php?categoryid=30

2. LEARNING OUTCOMES

Learning Outcomes
Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

By the end of this course, students will be able to:

- calculate the basic thermodynamic properties
- formulate the material and energy balances
- model basic processes and networks
- design heat exchanger networks
- simulate the behavior of energy systems

General Skills Name the desirable general skills upon successful completion of the module	
Search, analysis and synthesis of data and information, ICT Use,Adaptation to new situations, Decision making, Autonomous work, Teamwork, Working in an international environment, Working in an interdisciplinary environment, Production of new research ideas	Project design and management Equity and Inclusion Respect for the natural environment Sustainability Demonstration of social, professional and moral responsibility and sensitivity to gender issues Critical thinking Promoting free, creative and inductive reasoning
Practical application of knowledge Search, analysis and synthesis of data and information, ICT Use Adaptation to new situations Decision making Teamwork Working in an interdisciplinary environment Respect for the natural environment Promoting free, creative and inductive reasoning	

3. COURSE CONTENT

- Thermodynamic Properties and phase equilibrium
- Material and Energy Balances – Basic Principles
- Unit operations – Modeling
- Separation, reaction processes
- Heat exchangers
- Heat exchangers networks – pinch analysis
- Pumps, Compressors and Expanders
- Steam systems and evaporators
- Principles of energy systems simulation
- Simulation of energy process systems (ASPEN Plus)
- Optimization of energy process systems (GAMS)

4. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD Face to face, Distance learning, etc.	Face to face
USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) Use of ICT in Teaching, in Laboratory Education, in Communication with students	**USE OF ICT** • Use of ICT in Teaching • Use of ICT in Laboratory Education • Use of ICT in Communication with students • Use of ICT in Evaluation of students **Description** Use of ICT in Course Teaching, Use of ICT in Laboratory Teaching, Use of ICT in Communication with Students

	Description: Use of Information and Communication Technologies (ICT) in teaching the course with tools of modern distance learning (ZOOM) and asynchronous education (eclass). Use of learning aids based on ICT: Excel Use of ICT in student assessment: Electronic grading (eclass, universis). Use of ICT in communication with students: eclass, email, ZOOM.
TEACHING ORGANIZATION The ways and methods of teaching are described in detail. Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research& analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc. The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards	<table><tr><th>Activity</th><th>Workload/semester</th></tr><tr><td>Lectures</td><td>52</td></tr><tr><td>InteractiveLearning</td><td>50</td></tr><tr><td>writingProject</td><td>42</td></tr><tr><td>BibliographyAnalysis</td><td>42</td></tr><tr><td>Examinations</td><td>3</td></tr><tr><td>Total</td><td>189</td></tr></table>
STUDENT EVALUATION Description of the evaluation process Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others Please indicate all relevant information about the course assessment and how students are informed	**Description** Written Assignment (Summative) 25%, , Computer assignments 25%, Written Exam with Problem Solving (Summative) 50% **Student Evaluation Languages** English **Student evaluation methods** • ComputerExamination (Summative) • WrittenAssignment (Summative) • ProblemSolving (Summative)

5. SUGGESTED BIBLIOGRAPHY

EUDOXUS

1. Biegler LT, Grossmann IE, Westerberg AW, “Systematic Methods of Chemical Process Design”, Prentice Hall.
2. Smith R. “Chemical Process Design and Integration”, Wiley.

Additional bibliography for study

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4th Semester

ENGINEERING DESIGN AND ANALYSIS

1. GENERAL

FACULTY	Engineering		
SCHOOL	Bachelor of Science in Clean Energy Science and Engineering		
LEVEL OF STUDIES	ISCED level 6 – Bachelor's or equivalent level		
COURSE CODE	CESE14	SEMESTER	4th Semester
COURSE TITLE	ENGINEERING DESIGN AND ANALYSIS		

TEACHING ACTIVITIES If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.	TEACHING HOURS PER WEEK	ECTS CREDITS
	4	5.0

COURSETYPE Background, General Knowledge, Scientific Area, Skill Development	Specific Background
PREREQUISITES	**PREREQUISITES** - **General prerequisites** Technical Mechanics
TEACHING & EXAMINATION	English
COURSE OFFERED TO ERASMUS STUDENTS	NO
COURSE URL	https://elearning.auth.gr/course/index.php?categoryid=30

2. LEARNING OUTCOMES

Learning Outcomes
Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

By the end of this course, students will be able to:

- Apply Systematic Design Methodologies.
- Develop and Optimize Conceptual Designs.
- Communicate and Justify Design Decisions
- Design operational energy systems with modern Computer Aided Design tools

General Skills Name the desirable general skills upon successful completion of the module	
Search, analysis and synthesis of data and information, ICT Use,Adaptation to new situations, Decision making, Autonomous work, Teamwork, Working in an international environment, Working in an interdisciplinary environment, Production of new research ideas	Project design and management Equity and Inclusion Respect for the natural environment Sustainability Demonstration of social, professional and moral responsibility and sensitivity to gender issues Critical thinking Promoting free, creative and inductive reasoning

Practical application of knowledge
Search, analysis and synthesis of data and information, ICT Use
Adaptation to new situations
Decision making
Autonomous work
Teamwork
Working in an interdisciplinary environment
Production of new research ideas
Project design and management
Promoting free, creative and inductive reasoning

3. COURSE CONTENT

This course focuses on integrating design principles with practical engineering examples. Students learn systematic methodologies (e. g. approaches for safety and durability) for the design process, emphasizing problem definition, concept generation, and optimization. The course applies these principles directly to energy conversion systems, for example piping systems and pressure vessels, wind turbines, solar panels etc. Key topics include understanding system components, performance evaluation, material selection, and economic and sustainability considerations in the context of advanced engineering projects.
Key topics:

- Systematic Design Methodology: Applying structured phases (e.g., conceptual design, embodiment design, detail design) to solve complex engineering problems.
- Analysis of Energy Conversion Systems: Detailed study of how systems (like heat engines, turbines, or photovoltaic arrays) transform one form of energy into another, focusing on efficiency and performance.
- Sustainable Engineering Principles: Incorporating environmental impact, life-cycle assessment, and material selection to ensure designs are effective
- Optimization and Modeling: Using analytical and computational tools to refine design parameters and achieve maximum performance or cost-effectiveness.

4. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD Face to face, Distance learning, etc.	Face to face

USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) Use of ICT in Teaching, in Laboratory Education, in Communication with students	**USE OF ICT** • Use of ICT in Teaching • Use of ICT in Laboratory Education • Use of ICT in Communication with students • Use of ICT in Evaluation of students **Description** Use of ICT in Course Teaching, Use of ICT in Communication with Students Description: Use of Information and Communication Technologies (ICT) in teaching the course with tools of modern distance learning (MS-Teams) and asynchronous education (e-learning). Use of learning aids based on ICT: Excel Use of ICT in Laboratory Teaching: Autodesk Inventor, Solidworks Use of ICT in student assessment: Electronic grading (e-learning). Use of ICT in communication with students: e-leaning, email, MS-Teams.
TEACHING ORGANIZATION The ways and methods of teaching are described in detail. Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research& analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc. The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards	
STUDENT EVALUATION Description of the evaluation process Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others Please indicate all relevant information about the course assessment and how students are informed	**Description** Assignment Report Written Exams with Problem Solving (Summative) **Student Evaluation Languages** English **Student evaluation methods** • EssayReport (Summative) • ProblemSolving (Summative)

Activity	Workload/semester
Lectures	52
InteractiveLearning	28
writingProject	26
BibliographyAnalysis	26
Examinations	3
Total	**135**

5. SUGGESTED BIBLIOGRAPHY

EUDOXUS

1. Pahl, G., Beitz, W., Feldhusen, J., & Grote, K. H. (2007). Engineering design: A systematic approach (3rd ed.). Springer-Verlag.
2. Buede, D. M. (2016). The engineering design of systems: Models and methods (3rd ed.). John Wiley & Sons, Inc..

Additional bibliography for study

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ELECTROCHEMICAL ENERGY STORAGE

1. GENERAL

FACULTY	Engineering		
SCHOOL	Bachelor of Science in Clean Energy Science and Engineering		
LEVEL OF STUDIES	ISCED level 6 – Bachelor's or equivalent level		
COURSE CODE	CESE15	SEMESTER	4th Semester
COURSE TITLE	ELECTROCHEMICAL ENERGY STORAGE		

TEACHING ACTIVITIES If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.	TEACHING HOURS PER WEEK	ECTS CREDITS
	5	7.0

COURSETYPE Background, General Knowledge, Scientific Area, Skill Development	Specific Background
PREREQUISITES	**PREREQUISITES** - **General prerequisites** -
TEACHING & EXAMINATION	English
COURSE OFFERED TO ERASMUS STUDENTS	NO
COURSE URL	https://elearning.auth.gr/course/index.php?categoryid=30

2. LEARNING OUTCOMES

Learning Outcomes
Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

Knowledge
After successfully completing the course, students will be able to:

- Explain the fundamental electrochemical principles governing charge storage, electrode reactions, ion transport and interfacial phenomena in rechargeable systems.
- Describe the operating mechanisms, performance characteristics and limitations of major battery chemistries including lithium-ion, sodium-ion, flow batteries, metal-air systems and solid-state architectures.
- Understand electric double-layer and pseudocapacitive charge-storage mechanisms in electrochemical supercapacitors and their implications for power-energy trade-offs.

- Identify the key processes determining performance and degradation in batteries, supercapacitors and fuel cells.
- Explain the basic operating principles of fuel cells and their role within broader clean-energy systems.

Skills
Upon completion, students will be able to:
- Perform experimental characterisation of electrochemical devices, including charge-discharge cycling, open-circuit voltage measurements and Coulombic efficiency analysis.
- Use basic electrochemical diagnostic tools such as cyclic voltammetry to assess electrode behaviour and reaction kinetics.
- Interpret performance metrics such as capacity, rate capability, power density, energy density and efficiency.
- Evaluate the effects of materials selection, electrolyte composition and electrode architecture on device performance.

Abilities / Competences
Students will develop the ability to:
- Integrate electrochemical, kinetic and transport concepts to analyse the performance and limitations of energy-storage devices.
- Assess the suitability of different electrochemical technologies for specific clean-energy applications.
- Identify degradation mechanisms and factors influencing long-term stability and safety.
- Communicate laboratory findings, performance analyses and design considerations clearly in written and oral form.
- Connect foundational electrochemical principles with advanced courses on hydrogen technologies, fuel cells and energy systems engineering.

General Skills

Name the desirable general skills upon successful completion of the module

Search, analysis and synthesis of data and information,
ICT Use,Adaptation to new situations,
Decision making,
Autonomous work,
Teamwork,
Working in an international environment,
Working in an interdisciplinary environment, Production of new research ideas

Project design and management
Equity and Inclusion
Respect for the natural environment
Sustainability
Demonstration of social, professional and moral responsibility and sensitivity to gender issues
Critical thinking
Promoting free, creative and inductive reasoning

Practical application of knowledge
Search, analysis and synthesis of data and information, ICT Use
Autonomous work
Teamwork
Working in an interdisciplinary environment

3. COURSE CONTENT

This course introduces the principles and technologies of electrochemical energy storage, focusing on rechargeable batteries, electrochemical supercapacitors and introductory fuel cell concepts. Students explore electrode reactions, ion transport, electrolyte properties and the role of interfaces in determining device performance and degradation. Major rechargeable battery chemistries are discussed, including lithium-ion, sodium-ion, flow batteries, metal-air systems, and emerging solid-state architectures. The course also examines electrochemical supercapacitors, covering electric double-layer and pseudocapacitive mechanisms, materials selection and power-energy trade-offs. Fuel cells are presented at an introductory level, emphasizing their operating principles, efficiency, and their broader role within integrated clean-energy systems. Laboratory demonstrations emphasize hands-on characterization of electrochemical devices, including charge-discharge cycling of battery cells, measurement of specific capacity and Coulombic efficiency, open-circuit voltage analysis, and basic electrochemical diagnostics such as cyclic voltammetry. By the end of the course,

students will understand the scientific foundations, performance metrics, and challenges of electrochemical devices used in modern sustainable energy applications.

4. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD Face to face, Distance learning, etc.	Face to face
USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) Use of ICT in Teaching, in Laboratory Education, in Communication with students	**USE OF ICT** • Use of ICT in Teaching • Use of ICT in Laboratory Education • Use of ICT in Communication with students • Use of ICT in Evaluation of students **Description** Use of ICT • Use of ICT in Teaching • Use of ICT in Communication with students Use of ICT – Description • elearning.auth.gr: educational materials available to students along with exercises • Teaching with electronic presentations (slides, video, etc.) • Communication via elearning.aut.gr and emails
TEACHING ORGANIZATION The ways and methods of teaching are described in detail. Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research& analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc. The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards	
STUDENT EVALUATION Description of the evaluation process Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others Please indicate all relevant information about the course assessment and how students are informed	**Description** Written Assignment (Summative), Performance / Staging (Summative), Written Exam with Problem Solving (Summative) **Student Evaluation Languages** English **Student evaluation methods** • WrittenAssignment (Summative) • ContinuousEvaluation (Summative) • ProblemSolving (Summative)

Activity	Workload/semester
Lectures	65
writingProject	35
Laboratory	25
BibliographyAnalysis	61
Examinations	3
Total	**189**

5. SUGGESTED BIBLIOGRAPHY

EUDOXUS

1. "Ηλεκτροχημικές πηγές ενέργειας: μπαταρίες, κυψέλες καυσίμου και υπερπυκνωτές ", V.S. Bagotsky, A.M. Skundin, Y.M. Volfkovich, John Wiley & Sons (2015)
2. «Ηλεκτροχημική αποθήκευση ενέργειας», Reinhart Job, De Gruyter (2025)
3. «Ηλεκτροχημικά Ενεργειακά Συστήματα», Artur Braun, De Gruyter (2018)
4. «Υδρογόνο, μπαταρίες και κυψέλες καυσίμου», Bengt Sundén, Academic Press (2019)
5. "Βασικές αρχές κυψελών καυσίμου", Ryan O'Hayre, Suk-Won Cha, Whitney Colella και Fritz B. Prinz, John Wiley & Sons (2016)

Additional bibliography for study

-

COMPUTATIONAL METHODS FOR SIMULATING ENERGY MATERIALS

1. GENERAL

FACULTY	Engineering		
SCHOOL	Bachelor of Science in Clean Energy Science and Engineering		
LEVEL OF STUDIES	ISCED level 6 – Bachelor's or equivalent level		
COURSE CODE	CESE16	SEMESTER	4th Semester
COURSE TITLE	COMPUTATIONAL METHODS FOR SIMULATING ENERGY MATERIALS		

TEACHING ACTIVITIES If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.	TEACHING HOURS PER WEEK	ECTS CREDITS
	5	7.0

COURSETYPE Background, General Knowledge, Scientific Area, Skill Development	Specific Background
PREREQUISITES	**PREREQUISITES** - **General prerequisites** • Calculus • Introduction to Programming • General Physics for Energy Material Engineers
TEACHING & EXAMINATION	English
COURSE OFFERED TO ERASMUS STUDENTS	NO
COURSE URL	https://elearning.auth.gr/course/index.php?categoryid=30

2. LEARNING OUTCOMES

Learning Outcomes
Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

Upon successful completion of the course, students will:

- Build atomistic models of energy materials and prepare simulation input files using Python and free/open source software (e. g., ASE, LAMMPS).
- Apply Molecular Dynamics (MD) and Monte Carlo (MC) methods to study adsorption, diffusion, phase stability, and thermal transport in clean energy systems.
- Automate workflows and perform post processing and data analysis of simulation results with Python, ensuring reproducibility and efficiency.
- Interpret simulation outcomes in the context of practical energy applications such as hydrogen storage, CO_2 reduction,

nanoporous materials, and battery alloys.
- Integrate computational insights with experimental data to support the design and optimization of energy materials.
- Demonstrate awareness of the theoretical background that connects microscopic interactions with macroscopic material properties, while focusing on engineering-oriented applications

General Skills

Name the desirable general skills upon successful completion of the module

Search, analysis and synthesis of data and information,
ICT Use,Adaptation to new situations,
Decision making,
Autonomous work,
Teamwork,
Working in an international environment,
Working in an interdisciplinary environment, Production of new research ideas

Project design and management
Equity and Inclusion
Respect for the natural environment
Sustainability
Demonstration of social, professional and moral responsibility and sensitivity to gender issues
Critical thinking
Promoting free, creative and inductive reasoning

Practical application of knowledge
Search, analysis and synthesis of data and information, ICT Use
Autonomous work
Teamwork
Working in an interdisciplinary environment
Promoting free, creative and inductive reasoning

3. COURSE CONTENT

This course trains students in the computational design and simulation of energy materials, focusing on practical workflows and applications rather than abstract theory. Students learn how to set up atomistic models, prepare input files, and run simulations using free/open source software such as LAMMPS and ASE. A strong emphasis is placed on Python programming, both for automating simulation tasks and for post processing and analyzing results.
Through lectures and laboratory exercises, students gain hands on experience in Molecular Dynamics (MD) and Monte Carlo (MC) methods, applying them to real energy challenges. Case studies include:
- Hydrogen and methane uptake in nanoporous materials (e.g. Metal Organic Frameworks – MOFs) for clean energy storage.
- Phase stability in alloy systems relevant to batteries.
- Thermal conductivity at the nanoscale for thermoelectric materials.

By the end of the course, students will be able to design, simulate, and analyze energy materials using modern computational tools, bridging the gap between engineering practice and scientific insight.
Weekly Program
- Weeks 1–2: Introduction to simulation workflows; building atomistic models with ASE. A short theoretical background is provided to connect microscopic interactions with macroscopic material properties.
- Weeks 3–4: Ensembles and input preparation; adsorption and chemical potential applications.
- Weeks 5–6: Molecular Dynamics labs; diffusion and thermal conductivity in solids.
- Weeks 7–8: Monte Carlo methods; alloy ordering and adsorption simulations.
- Weeks 9–10: Advanced topics: free energy calculations, ensemble switching; hydrogen storage in MOFs.
- Weeks 11–13: Student projects using MD/MC with Python workflows; final presentations.

4. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD Face to face, Distance learning, etc.	Face to face
USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) Use of ICT in Teaching, in Laboratory Education, in Communication with students	**USE OF ICT** • Use of ICT in Teaching • Use of ICT in Laboratory Education • Use of ICT in Communication with students • Use of ICT in Evaluation of students **Description** ICT is integrated into all teaching activities. ZOOM supports live classes, while eClass provides asynchronous materials. Tools such as Excel, Python programming, Jupyter notebooks, online databases, and visualization software are used for demonstrations, numerical examples, and student exercises. Student assessment is managed through electronic submission, digital grading, and platforms like eClass and Universis. Communication with students takes place via eClass announcements, institutional email, and ZOOM meetings.
TEACHING ORGANIZATION The ways and methods of teaching are described in detail. Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research& analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc. The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards	
STUDENT EVALUATION Description of the evaluation process Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others Please indicate all relevant information about the course assessment and how students are informed	**Description** Assessment Language: English Assessment Methods: • Written exam (40%) • Laboratory assignments (30%) • Final project report and presentation (30%) **Student Evaluation Languages** English **Student evaluation methods** • LaboratoryAssignment (Summative) • Presentation (Summative) • ProblemSolving (Summative)

Activity	Workload/semester
Lectures	65
Laboratory	40
writingProject	40
BibliographyAnalysis	41
Examinations	3
Total	**189**

5. SUGGESTED BIBLIOGRAPHY

EUDOXUS

1. Frenkel, D. & Smit, B. Understanding Molecular Simulation (Academic Press)
2. McQuarrie, D. A. Statistical Mechanics (University Science Books)
3. Rapaport, D. C. The Art of Molecular Dynamics Simulation (Cambridge University Press)
4. Allen, M. P. & Tildesley, D. J. Computer Simulation of Liquids (Oxford Science)

Additional bibliography for study

1. Online resources: ASE, Materials Project, lammps

ΜΟΝΑΔΑ ΔΙΑΣΦΑΛΙΣΗΣ ΠΟΙΟΤΗΤΑΣ Α.Π.Θ.

CIRCUITRY AND ELECTRONICS

1. GENERAL

FACULTY	Engineering		
SCHOOL	Bachelor of Science in Clean Energy Science and Engineering		
LEVEL OF STUDIES	ISCED level 6 – Bachelor's or equivalent level		
COURSE CODE	CESE17	SEMESTER	4th Semester
COURSE TITLE	CIRCUITRY AND ELECTRONICS		

TEACHING ACTIVITIES If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.	TEACHING HOURS PER WEEK	ECTS CREDITS
	5	6.0

COURSETYPE Background, General Knowledge, Scientific Area, Skill Development	Specific Background
PREREQUISITES	**PREREQUISITES** - **General prerequisites** -
TEACHING & EXAMINATION	English
COURSE OFFERED TO ERASMUS STUDENTS	NO
COURSE URL	https://elearning.auth.gr/course/index.php?categoryid=30

2. LEARNING OUTCOMES

Learning Outcomes
Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

By the end of this course, students will be able to:

- Analyze DC and AC electric circuits using fundamental laws and network theorems.
- Understand the physics and operation of fundamental electronic components (diodes, transistors, operational amplifiers).
- Design and simulate basic analog circuits and filters relevant to energy monitoring.
- Interpret datasheets and perform laboratory measurements using oscilloscopes, multimeters, and function generators

General Skills Name the desirable general skills upon successful completion of the module	
Search, analysis and synthesis of data and information, ICT Use,Adaptation to new situations, Decision making, Autonomous work, Teamwork, Working in an international environment, Working in an interdisciplinary environment, Production of new research ideas	Project design and management Equity and Inclusion Respect for the natural environment Sustainability Demonstration of social, professional and moral responsibility and sensitivity to gender issues Critical thinking Promoting free, creative and inductive reasoning

Practical application of knowledge
Search, analysis and synthesis of data and information, ICT Use
Adaptation to new situations
Decision making
Autonomous work
Teamwork
Promoting free, creative and inductive reasoning

3. COURSE CONTENT

The course begins with the fundamental principles of electric circuit analysis, establishing the necessary background for understanding complex energy systems. Students will master DC and AC circuit theory, including Ohm's Law, Kirchhoff's laws, nodal and mesh analysis, and network theorems such as Thevenin and Norton equivalencies. Special emphasis is placed on AC power analysis, impedance, phasors, and the concept of Power Factor, which is critical for efficient energy transmission and grid stability.

Subsequently, the course introduces semiconductor physics and the operation of non-linear electronic devices. This includes the study of PN junctions and diodes, focusing on their application in rectification (AC to DC conversion) and voltage regulation. Students will also examine Bipolar Junction Transistors (BJTs) and Field Effect Transistors (MOSFETs), specifically analyzing their behavior as electronic switches—a concept that forms the foundation of modern power management systems.

The curriculum then transitions to analog signal processing and operational amplifiers (Op-Amps). Students will learn to design and analyze inverting and non-inverting amplifiers, integrators, and differentiators. This section highlights the application of Op-Amps in sensor interfacing and signal conditioning, which are essential for monitoring performance metrics in renewable energy technologies.

4. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD Face to face, Distance learning, etc.	Face to face
USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) Use of ICT in Teaching, in Laboratory Education, in Communication with students	**USE OF ICT** • Use of ICT in Teaching • Use of ICT in Laboratory Education • Use of ICT in Communication with students • Use of ICT in Evaluation of students **Description** Use of ICT in Course Teaching, Use of ICT in Laboratory Teaching, Use of

	ICT in Communication with Students Description: Use of Information and Communication Technologies (ICT) in teaching the course with tools of modern distance learning (ZOOM) and asynchronous education (eclass). Use of learning aids based on ICT: Excel, Matlab/SIMULINK, LTSpice Use of ICT in student assessment: Electronic grading (e-learning, universis). Use of ICT in communication with students: eclass, email, ZOOM.
TEACHING ORGANIZATION The ways and methods of teaching are described in detail. Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research& analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc. The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards	<table><tr><th>Activity</th><th>Workload/semester</th></tr><tr><td>Lectures</td><td>65</td></tr><tr><td>writingProject</td><td>47</td></tr><tr><td>BibliographyAnalysis</td><td>47</td></tr><tr><td>Examinations</td><td>3</td></tr><tr><td>Total</td><td>162</td></tr></table>
STUDENT EVALUATION Description of the evaluation process Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others Please indicate all relevant information about the course assessment and how students are informed	**Description** Written Exam with Problem Solving (Summative). Semester project. Laboratory reports. **Student Evaluation Languages** English **Student evaluation methods** • WrittenAssignment (Summative) • LaboratoryReport (Summative) • ProblemSolving (Summative)

5. SUGGESTED BIBLIOGRAPHY

EUDOXUS

1. Agarwal, Anant, and Jeffrey H. Lang. Foundations of Analog and Digital Electronic Circuits. San Mateo, CA: Morgan Kaufmann Publishers, Elsevier, July 2005. ISBN: 9781558607354.
2. Alexander, C. K., & Sadiku, M. N. O. (2020). Fundamentals of Electric Circuits. McGraw-Hill Education. (Standard text for circuit theory).
3. Sedra, A. S., & Smith, K. C. (2020). Microelectronic Circuits. Oxford University Press. (Standard text for electronics).

Additional bibliography for study

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BIOENGINEERING AND BIOTECHNOLOGY

1. GENERAL

FACULTY	Engineering		
SCHOOL	Bachelor of Science in Clean Energy Science and Engineering		
LEVEL OF STUDIES	ISCED level 6 – Bachelor's or equivalent level		
COURSE CODE	CESE18	SEMESTER	4th Semester
COURSE TITLE	BIOENGINEERING AND BIOTECHNOLOGY		

TEACHING ACTIVITIES If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.	TEACHING HOURS PER WEEK	ECTS CREDITS
	4	5.0

COURSETYPE Background, General Knowledge, Scientific Area, Skill Development	Specific Background
PREREQUISITES	**PREREQUISITES** - **General prerequisites** -
TEACHING & EXAMINATION	English
COURSE OFFERED TO ERASMUS STUDENTS	NO
COURSE URL	https://elearning.auth.gr/course/index.php?categoryid=30

2. LEARNING OUTCOMES

Learning Outcomes
Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

By the end of this course, students will be able to:

- Understand cellular structures and their functional roles in bioprocesses.
- Explain major biological macromolecules and their relevance to biotechnology.
- Describe metabolic pathways and their applications in bioprocess engineering.
- Analyse enzyme kinetics and mechanisms for industrial and research applications.
- Evaluate microbial and cell growth dynamics in bioprocess systems.
- Assess biotechnological applications across microbial, plant, animal, aquatic, and environmental sectors.

General Skills

Name the desirable general skills upon successful completion of the module

Search, analysis and synthesis of data and information,
ICT Use,Adaptation to new situations,
Decision making,
Autonomous work,
Teamwork,
Working in an international environment,
Working in an interdisciplinary environment, Production of new research ideas
Project design and management
Equity and Inclusion
Respect for the natural environment
Sustainability
Demonstration of social, professional and moral responsibility and sensitivity to gender issues
Critical thinking
Promoting free, creative and inductive reasoning

Practical application of knowledge
Search, analysis and synthesis of data and information, ICT Use
Adaptation to new situations
Decision making
Teamwork
Working in an interdisciplinary environment
Critical thinking
Promoting free, creative and inductive reasoning

3. COURSE CONTENT

1. Cell structure and function (overview of prokaryotic and eukaryotic cells, organelles, membranes, functional roles in biological and industrial systems).
2. Macromolecules (structure and function of proteins, nucleic acids, carbohydrates, lipids relevant to bioprocess and biotechnology applications).
3. Cell metabolism (metabolic pathways, energy production, catabolism, anabolism, metabolic regulation in engineered biological systems.
4. Enzymes (enzyme structure, catalytic mechanisms, kinetics, inhibition, industrial enzyme applications).
5. Cell growth (microbial and cell culture growth phases, models, kinetics, nutrient requirements, environmental influences).
6. Genetics, DNA structure, replication, transcription and translation (genetic organization, DNA replication mechanisms, gene expression processes, regulation of protein synthesis).
7. PCR, DNA sequencing, sequence analysis, Real-time PCR (principles of PCR, sequencing technologies, data analysis, quantitative PCR applications in biotechnology).
8. Microbial biotechnology (microbial strain engineering, fermentation processes, metabolite production, industrial microbial applications).
9. Plant biotechnology (plant tissue culture, genetic modification, crop improvement, production of plant-derived bioproducts).
10. Animal biotechnology (animal cell culture, transgenic animals, biopharmaceutical production, ethical considerations).
11. Aquatic biotechnology (applications in aquaculture, marine bioresources, aquatic species improvement, environmental monitoring).
12. Bioremediation (microbial and plant-based systems for pollutant degradation, environmental detoxification, engineered remediation strategies).
13. Waste biotechnology (biological waste treatment, valorisation of waste streams, microbial processes for sustainable resource recovery).

4. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD Face to face, Distance learning, etc.	Face to face
USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) Use of ICT in Teaching, in Laboratory Education, in Communication with students	**USE OF ICT** • Use of ICT in Teaching • Use of ICT in Laboratory Education • Use of ICT in Communication with students • Use of ICT in Evaluation of students **Description** • Use of ICT in Course Teaching e-learning, ZOOM • Use of ICT in Laboratory Teaching Zoom • Use of ICT in student assessment: Electronic grading (e-learning, universis). • Use of ICT in communication with students: e-learning, email, ZOOM.
TEACHING ORGANIZATION The ways and methods of teaching are described in detail. Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research& analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc. The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards	
STUDENT EVALUATION Description of the evaluation process Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others Please indicate all relevant information about the course assessment and how students are informed	**Description** Description of the procedure: • Final written exam – 70% • Participation and assignments – 30% Assessment methods: • Assignments (Formative) • Written Exam with Multiple Choice Questions (Concluding) • Written Exam with Short Answer Questions (Concluding) **Student Evaluation Languages** English **Student evaluation methods** • WrittenAssignment (Formative, Summative) • ShortAnswerQuestions (Summative)

Activity	Workload/semester
Lectures	52
writingProject	26
BibliographyAnalysis	27
Laboratory	27
Examinations	3
Total	**135**

5. SUGGESTED BIBLIOGRAPHY

EUDOXUS

1. Michael L. Shuler, Fikret Kargi (2001). Bioprocess Engineering Basic Concepts. Prentice Hall PTR, Upper Saddle River, NJ 07458. ISBN 0_13_081908_5
2. Matthew DeLisa, Michael L. Shuler, Fikret Kargi (2017). Bioprocess Engineering: Basic Concepts, 3rd Edition. Pearson. ISBN-13 978-0-13-706270-6
3. Ross Carlson, Kate Morrissey, Pauline M. Doran (2025). Bioprocess Engineering Principles. 3rd Edition. Academic Press. ISBN

9780128221914, https://doi.org/10.1016/C2017-0-01824-4
4. William J. Thieman, Michael Angelo Palladino (2014). Introduction To Biotechnology, 3rd edition. Pearson/Benjamin Cummings. ISBN 9781292027616

Additional bibliography for study

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5th Semester

SUSTAINABILITY ENGINEERIGN AND CIRCULAR ECONOMY

1. GENERAL

FACULTY	Engineering		
SCHOOL	Bachelor of Science in Clean Energy Science and Engineering		
LEVEL OF STUDIES	ISCED level 6 – Bachelor's or equivalent level		
COURSE CODE	CESE19	SEMESTER	5th Semester
COURSE TITLE	SUSTAINABILITY ENGINEERIGN AND CIRCULAR ECONOMY		

TEACHING ACTIVITIES If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.	TEACHING HOURS PER WEEK	ECTS CREDITS
	4	5.0

COURSETYPE Background, General Knowledge, Scientific Area, Skill Development	Specific Background
PREREQUISITES	**PREREQUISITES** - **General prerequisites** -
TEACHING & EXAMINATION	English
COURSE OFFERED TO ERASMUS STUDENTS	NO
COURSE URL	https://elearning.auth.gr/course/index.php?categoryid=30

2. LEARNING OUTCOMES

Learning Outcomes
Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

By the end of this course, students will be able to:

- Explain the core concepts of environmental economics and the circular economy.
- Understand market failures, externalities, and environmental valuation.
- Compare linear and circular economic models.
- Analyze circular strategies such as reuse, repair, recycling, and product-life extension.

- Evaluate policies and economic tools supporting circular transitions.
- Apply circular economy principles to real-world sectors and case studies.

General Skills

Name the desirable general skills upon successful completion of the module

Search, analysis and synthesis of data and information,
ICT Use,Adaptation to new situations,
Decision making,
Autonomous work,
Teamwork,
Working in an international environment,
Working in an interdisciplinary environment, Production of new research ideas
Project design and management
Equity and Inclusion
Respect for the natural environment
Sustainability
Demonstration of social, professional and moral responsibility and sensitivity to gender issues
Critical thinking
Promoting free, creative and inductive reasoning

Practical application of knowledge
Search, analysis and synthesis of data and information, ICT Use
Adaptation to new situations
Decision making
Teamwork
Working in an interdisciplinary environment
Production of new research ideas
Respect for the natural environment
Promoting free, creative and inductive reasoning

3. COURSE CONTENT

This course provides an interdisciplinary introduction to the principles of the circular economy and environmental economics. Students will explore how economic systems impact the environment, how circular strategies can reduce waste and resource use, and what policy and business models support sustainability transitions. After analyzing the basic background in the aforementioned concepts, the principles of Sustainable Development Goals (SDGs) of United Nations and the ESG (Environmental, Social, and Governance) criteria, students will have the opportunity to delve into indicative legislative milestones with an emphasis on the CSRD Directive - Corporate Sustainability Reporting Directive for sustainability reports, as well as the SEVESO Directive. Particular emphasis is placed on the management of critical/specific waste streams and by-products to support circular economy business models. The course also includes the demonstration of sustainability management tools, emphasizing on Life Cycle Assessment (LCA). The aim to highlight case studies of sustainable production and services design. Case studies are expected to be examined for a better understanding of the theory and preparation of students on issues related to the promotion of green technologies and environmental responsibility strategies for businesses.
The course combines economic theory, policy analysis, calculation of economic indicators and real-world case studies to build practical understanding for the circular economy model approach.

4. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD Face to face, Distance learning, etc.	Face to face

USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) Use of ICT in Teaching, in Laboratory Education, in Communication with students	**USE OF ICT** • Use of ICT in Teaching • Use of ICT in Laboratory Education • Use of ICT in Communication with students • Use of ICT in Evaluation of students **Description** Use of ICT in Course Teaching, Use of ICT in Laboratory Teaching, Use of ICT in Communication with Students Description: Use of Information and Communication Technologies (ICT) in teaching the course with tools of modern distance learning (ZOOM) and asynchronous education (e-learning). Use of learning aids based on ICT: Excel Use of ICT in student assessment: Electronic grading (e-learning, universis). Use of ICT in communication with students: e-learning, email, ZOOM.
TEACHING ORGANIZATION The ways and methods of teaching are described in detail. Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research& analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc. The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards	
STUDENT EVALUATION Description of the evaluation process Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others Please indicate all relevant information about the course assessment and how students are informed	**Description** Written Assignment (Summative), Performance / Staging (Summative), Written Exam with Problem Solving (Summative) **Student Evaluation Languages** English **Student evaluation methods** • WrittenAssignment (Summative) • Proodos (Summative) • ProblemSolving (Summative)

Activity	Workload/semester
Lectures	52
writingProject	40
BibliographyAnalysis	40
Examinations	3
Total	**135**

5. SUGGESTED BIBLIOGRAPHY

EUDOXUS

1. SUSTAINABILITY MANAGEMENT AND CIRCULAR ECONOMY, VLACHOKOSTAS CHRISTOS, YACHOUDI PUBLICATIONS ISBN: 9786185393250 1st Edition/2022
2. INDUSTRIAL ECOLOGY, T. E. GRAEDEL, B. R. ALLENBY, KLEIDARITHMOS PUBLICATIONS LTD, ISBN: 9789604612024, 2nd Edition/2009
3. SOLID WASTE MANAGEMENT AND ENGINEERING, KOMILIS DIMITRIOS, A. PUBLICATIONS TZIOLA & SONS S.A., ISBN: 9786182210239, 3rd Edition/2023

4. ENVIRONMENTAL IMPACT STUDIES, VAGIONA DIMITRA, DISIGMA PUBLICATIONS IKE, ISBN: 9786182020654, 2nd Edition/2021
5. SUSTAINABLE DEVELOPMENT AND THE ECONOMICS OF CLIMATE CHANGE, TSOUTSOS THEOCHARIS, A. PAPASOTIRIOU & SIA IKE, ISBN: 9789604911608, 1st Edition /2022

Additional bibliography for study

1. Ellen MacArthur Foundation. (2013–2022). Towards the circular economy (multiple volumes). Ellen MacArthur Foundation.
2. European Commission. (2020). A new circular economy action plan. Publications Office of the European Union.
3. OECD. (2019). Circular economy: Principles and policy approaches. OECD Publishing.
4. UNEP. (2021). Global resources outlook 2021. United Nations Environment Programme.

- Related academic journals:

1. Sustainability
2. Waste Management
3. Journal of Cleaner Production
4. Recycling
5. Environment International

ELECTRICAL MACHINES

1. GENERAL

FACULTY	Engineering		
SCHOOL	Bachelor of Science in Clean Energy Science and Engineering		
LEVEL OF STUDIES	ISCED level 6 – Bachelor's or equivalent level		
COURSE CODE	CESE20	SEMESTER	5th Semester
COURSE TITLE	ELECTRICAL MACHINES		

TEACHING ACTIVITIES If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.	TEACHING HOURS PER WEEK	ECTS CREDITS
	5	5.0

COURSETYPE Background, General Knowledge, Scientific Area, Skill Development	Specific Background
PREREQUISITES	**PREREQUISITES** - **General prerequisites** -
TEACHING & EXAMINATION	English
COURSE OFFERED TO ERASMUS STUDENTS	NO
COURSE URL	https://elearning.auth.gr/course/index.php?categoryid=30

2. LEARNING OUTCOMES

Learning Outcomes
Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

By the end of this course, students will be able to know and understand:

- Basic theory of magnetic circuits, induced voltage and electromechanical energy conversion.
- Transformers, DC motors and generators (construction, equivalent circuit, operation).
- Induction motors (construction, equivalent circuit, operation).
- Synchronous generators (construction, equivalent circuit, operation).
- Permanent magnet motor and generator drives (control methods, topology, operation)

General Skills

Name the desirable general skills upon successful completion of the module

Search, analysis and synthesis of data and information,
ICT Use,Adaptation to new situations,
Decision making,
Autonomous work,
Teamwork,
Working in an international environment,
Working in an interdisciplinary environment, Production of new research ideas
Project design and management
Equity and Inclusion
Respect for the natural environment
Sustainability
Demonstration of social, professional and moral responsibility and sensitivity to gender issues
Critical thinking
Promoting free, creative and inductive reasoning

Practical application of knowledge
Search, analysis and synthesis of data and information, ICT Use
Adaptation to new situations
Decision making
Autonomous work
Teamwork
Project design and management
Promoting free, creative and inductive reasoning

3. COURSE CONTENT

The course begins with the introduction to machinery principles (production of a magnetic field in the electrical machines, magnetic circuits, core losses (hysteresis and eddy current losses), Faraday's law, electromagnetic and magnetomotive forces, force and torque production).

Transformers (theory and operation of the single and three-phase transformers, construction, equivalent circuit, phasor diagram, transformer power losses and efficiency, voltage and current relationships, three-phase transformer connections, ratings and autotransformer).

DC machinery fundamentals and DC motors and generators (construction, production of voltage and torque, equivalent circuit, analysis of dc motors and generators, connections, speed and voltage control, speed and torque characteristics).

Three phase and single-phase induction motors and generators (construction. voltage and torque relationships, equivalent circuit, speed and torque characteristics, speed control, theory and operation of single-phase induction motors).

Synchronous generators (construction, equivalent circuit, phasor diagrams, power and torque characteristics, operation of synchronous generators in parallel with the grid, transient operation).

Permanent magnet motor drives (theory of permanent magnets, construction, speed and position control of motor and generator drives, close loop control system, power converters, topologies).

4. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD Face to face, Distance learning, etc.	Face to face

USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) Use of ICT in Teaching, in Laboratory Education, in Communication with students	**USE OF ICT** • Use of ICT in Teaching • Use of ICT in Laboratory Education • Use of ICT in Communication with students • Use of ICT in Evaluation of students **Description** Use of ICT in Course Teaching, Use of ICT in Laboratory Teaching, Use of ICT in Communication with Students Description: Use of Information and Communication Technologies (ICT) in teaching the course with tools of modern distance learning (ZOOM) and asynchronous education (e-learning,). Use of learning aids based on ICT: Matlab/SIMULINK Use of ICT in student assessment: Electronic grading (e-learning,, universis). Use of ICT in communication with students: e-learning, email, ZOOM.
TEACHING ORGANIZATION The ways and methods of teaching are described in detail. Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research& analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc. The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards	
STUDENT EVALUATION Description of the evaluation process Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others Please indicate all relevant information about the course assessment and how students are informed	**Description** Written Exam with Problem Solving (Summative). Semester project. Laboratory reports. **Student Evaluation Languages** English **Student evaluation methods** • WrittenAssignment (Summative) • ProblemSolving (Summative)

Activity	Workload/semester
Lectures	65
writingProject	35
BibliographyAnalysis	32
Examinations	3
Total	**135**

5. SUGGESTED BIBLIOGRAPHY

EUDOXUS

1. B.K. Bose, “Power Electronics and AC Drives”, Prentice-Hall, Englewood Cliffs, New Jersey:1986
2. P.C. Krause, “Analysis of Electric Machinery”, Mc Graw Hill, New York:1987.
3. S. J. Chapman, “Electric Machinery Fundamentals”, McGraw Hill Higher Education, Boston: 2005.
4. D.P. Kothari and I.J. Nagrath, “Electric Machines”, Tata Mc. Graw Hill Education Private Limited, New Delhi: 2010.

Additional bibliography for study

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CLEAN COMBUSTION

1. GENERAL

FACULTY	Engineering		
SCHOOL	Bachelor of Science in Clean Energy Science and Engineering		
LEVEL OF STUDIES	ISCED level 6 – Bachelor's or equivalent level		
COURSE CODE	CESE21	SEMESTER	5th Semester
COURSE TITLE	CLEAN COMBUSTION		

TEACHING ACTIVITIES If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.	TEACHING HOURS PER WEEK	ECTS CREDITS
	4	6.0

COURSETYPE Background, General Knowledge, Scientific Area, Skill Development	Specific Background
PREREQUISITES	**PREREQUISITES** - **General prerequisites** -
TEACHING & EXAMINATION	English
COURSE OFFERED TO ERASMUS STUDENTS	NO
COURSE URL	https://elearning.auth.gr/course/index.php?categoryid=30

2. LEARNING OUTCOMES

Learning Outcomes
Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

By the end of this course, students will be able to:
- Setup and solve chemical kinetics problems
- Design and solve problems of reacting systems
- Study combustion reactors
- Calculate the development of combustion with the help of computer software (Senkin)
- Recognize main pollutants and understand pollution control options

General Skills Name the desirable general skills upon successful completion of the module	
Search, analysis and synthesis of data and information, ICT Use,Adaptation to new situations, Decision making, Autonomous work, Teamwork, Working in an international environment, Working in an interdisciplinary environment, Production of new research ideas	Project design and management Equity and Inclusion Respect for the natural environment Sustainability Demonstration of social, professional and moral responsibility and sensitivity to gender issues Critical thinking Promoting free, creative and inductive reasoning
Practical application of knowledge Search, analysis and synthesis of data and information, ICT Use Decision making Teamwork	

3. COURSE CONTENT

Chemical thermodynamics: Mass conservation and mixture stoichiometry, lambda value and equivalence ratio, energy conservation in chemical reactions, Gibbs free energy, chemical equilibrium, combustion temperature, equilibrium products. Chemical kinetics: Elementary reactions, propagation and branching, reaction rate, reaction rate constant, partial equilibrium and steady state approximations, reversible reactions, chain reactions, explosion limits, some important combustion mechanisms, pollutant formation kinetics, chemical time scales. Combustion Reactors: constant volume, constant pressure, well-stirred reactor, plug-flow reactor, dimensioning, stability, power considerations. Structure of laminar flame, theory of Mallard, flame thickness, flame speed. Conventional fuels and alternative fuels, including combustion of biofuels, biomethane, larger hydrocarbons, H2, NH3 and bio-alcohols. Main fuel properties of interest. Greenhouse gas and air pollutants formation and principles of pollution control (catalytic, non-catalytic, filtering, precipitators, scrubbers).

4. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD Face to face, Distance learning, etc.	Face to face
USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) Use of ICT in Teaching, in Laboratory Education, in Communication with students	**USE OF ICT** • Use of ICT in Teaching • Use of ICT in Laboratory Education • Use of ICT in Communication with students • Use of ICT in Evaluation of students **Description** • Use of ICT in Course Teaching (e-learning, zoom) • Use of ICT in Communication with Students (e-learning, e-mails, zoom) • Powerpoint presentations on a beamer • Video presentations on a beamer • Simulation software on computers, using specialized software (Senkin)

TEACHING ORGANIZATION
The ways and methods of teaching are described in detail. Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research& analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc.

The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards

Activity	Workload/semester
Lectures	48
InteractiveLearning	4
Laboratory	36
writingProject	36
BibliographyAnalysis	35
Examinations	3
Total	**162**

STUDENT EVALUATION
Description of the evaluation process

Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others

Please indicate all relevant information about the course assessment and how students are informed

Description
Description of the procedure: The final score is composited by the scores in one project during the semester that is examined orally, and the score of the final written exams. The final score weighing is: - 20% score in project report - 20% score in oral examination - 60% final written exam Assessment methods: - Written Exam with Multiple Choice Questions (Summative) - Written Exam with Short Answer Questions (Summative) - Written Exam with Problem Solving (Summative) - Written Assignment (Summative) - Oral Exams (Summative)

Student Evaluation Languages
English

Student evaluation methods

- EssayReport (Summative)
- OralExam (Summative)
- ProblemSolving (Summative)

5. SUGGESTED BIBLIOGRAPHY

EUDOXUS

1) Turns, SR; Haworth, DC. Introduction to Combustion Concepts, 4th Edition, McGraw Hill, 2020.
2) Warnatz, J; Maas, U; Dibble, RW. Combustion, 4th Edition, Springer, 2006.
3) Glassman, I; Yetter, RA; Glumac, NG. Combustion, 5th Edition, Academic Press, 2014

Additional bibliography for study

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BIOPROCESSING FOR CLEAN ENERGY PRODUCTION

1. GENERAL

FACULTY	Engineering		
SCHOOL	Bachelor of Science in Clean Energy Science and Engineering		
LEVEL OF STUDIES	ISCED level 6 – Bachelor's or equivalent level		
COURSE CODE	CESE22	SEMESTER	5th Semester
COURSE TITLE	BIOPROCESSING FOR CLEAN ENERGY PRODUCTION		

TEACHING ACTIVITIES If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.	TEACHING HOURS PER WEEK	ECTS CREDITS
	5	7.0

COURSETYPE Background, General Knowledge, Scientific Area, Skill Development	Specific Background
PREREQUISITES	**PREREQUISITES** - **General prerequisites** -
TEACHING & EXAMINATION	English
COURSE OFFERED TO ERASMUS STUDENTS	NO
COURSE URL	https://elearning.auth.gr/course/index.php?categoryid=30

2. LEARNING OUTCOMES

Learning Outcomes
Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

By the end of this course, students will be able to:

- Explain the principles of microbial metabolism and bioprocess engineering relevant to clean-energy production.
- Compare various bioenergy pathways (bioethanol, biogas, biodiesel, biohydrogen, microbial fuel cells) and evaluate their technical and environmental advantages.
- Analyse bioreactor systems for sustainable energy production, including key parameters such as kinetics, mass transfer, and process optimization.
- Assess biomass feedstocks and pretreatment methods for efficient conversion into biofuels and bioenergy.
- Familiarize with biorefinery concepts and their role in sustainable energy production.

- Design and optimize bioprocesses for specific clean energy outputs, such as biogas, biomethane, biohydrogen bioethanol, etc.

General Skills

Name the desirable general skills upon successful completion of the module

Search, analysis and synthesis of data and information,
ICT Use,Adaptation to new situations,
Decision making,
Autonomous work,
Teamwork,
Working in an international environment,
Working in an interdisciplinary environment, Production of new research ideas

Project design and management
Equity and Inclusion
Respect for the natural environment
Sustainability
Demonstration of social, professional and moral responsibility and sensitivity to gender issues
Critical thinking
Promoting free, creative and inductive reasoning

Practical application of knowledge
Search, analysis and synthesis of data and information, ICT Use
Adaptation to new situations
Decision making
Teamwork
Working in an interdisciplinary environment
Critical thinking

3. COURSE CONTENT

1. Introduction to clean energy and the role of bioprocessing (global energy demands, sustainability challenges, transition toward renewable systems, biological processes in clean-energy production, carbon neutrality, resource circularity, integration with waste-management infrastructures).
2. Biomass feedstocks and pretreatment technologies (agricultural waste, algae, physical, chemical, and biological pretreatment strategies).
3. Bioreactor design and operation (batch, fed-batch, continuous systems, mass transfer, agitation, sensors).
4. Fundamentals of anaerobic digestion (methanogenesis, anaerobic microbiology, biomethanation, reactor types, waste-to-energy concepts).
5. Anaerobic digestion process optimisation (ADM1 model for performance prediction and optimization, kinetic modelling (Monod, first-order), physicochemical dynamics, digester design strategies, and scale-up considerations).
6. AI and machine learning for anaerobic digestion optimization (enhance digester operation through feedstock optimization, early detection of process imbalances, real-time predictive control, and data-driven methane-yield improvement).
7. CO2-to-CH4 technologies (biological and power-to-gas pathways, emerging technologies biological methanation and integrated power-to-gas systems, microbial CO2 reduction pathways, hydrogenotrophic methanation, renewable hydrogen closing the carbon loop).
8. Biohydrogen production and Microbial Fuel Cells (dark fermentation, photo-fermentation, microbial electrolysis, electrogenic bacteria, bioelectrochemical systems hydrogen generation, direct electricity production).
9. Bioethanol, biobutanol and longer-chain alcohols (fermentation pathways for liquid biofuels, saccharification, yeast and bacterial metabolic engineering, and advanced syngas or waste-gas fermentation)
10. Biodiesel production (oleaginous microbes, enzyme-based processes, waste oil conversion, downstream purification, sustainability, scalability, quality specifications).
11. Biorefineries and waste-to-bioproduct systems (integrated biorefineries that transform diverse waste streams into energy, fuels, bioplastics, and value-added chemicals, circular-economy frameworks, process integration, and examples of industrial multiproduct bioprocessing systems)

12. Future trends in bioprocessing for clean energy (next-generation innovations, synthetic biology, metabolic engineering, advanced reactor systems, industrial biorefineries).
13. Course review and project presentations (students present group projects synthesizing course concepts, discussion of emerging research directions, and preparation for final exams).

4. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD Face to face, Distance learning, etc.	Face to face
USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) Use of ICT in Teaching, in Laboratory Education, in Communication with students	**USE OF ICT** • Use of ICT in Teaching • Use of ICT in Laboratory Education • Use of ICT in Communication with students • Use of ICT in Evaluation of students **Description** • Use of ICT in Course Teaching • Use of ICT in Laboratory Teaching • Use of ICT in Communication with Students • Use of ICT in student assessment: Electronic grading (e-learning, universis). • Use of ICT in communication with students: e-learning, email, ZOOM.
TEACHING ORGANIZATION The ways and methods of teaching are described in detail. Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research& analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc. The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards	
STUDENT EVALUATION Description of the evaluation process Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others Please indicate all relevant information about the course assessment and how students are informed	**Description** Description of the procedure: • Final written exam – 60% • Project / Laboratory work – 30% • Participation and assignments – 10% Assessment methods: • Report (Formative) • Project / Laboratory work (Formative) • Written Exam with Multiple Choice Questions (Concluding) • Written Exam with Short Answer Questions (Concluding) **Student Evaluation Languages** English **Student evaluation methods** • LaboratoryReport

Activity	Workload/semester
Lectures	65
Laboratory	22
BibliographyAnalysis	30
writingProject	30
StudyCreation	39
Examinations	3
Total	**189**

STUDENT EVALUATION Description of the evaluation process Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others Please indicate all relevant information about the course assessment and how students are informed	(Formative) • ContinuousEvaluation (Formative) • ProblemSolving (Summative)

5. SUGGESTED BIBLIOGRAPHY

EUDOXUS

1. Srivastava, N., Srivastava, M., Mishra, P., & Gupta, V. (2020). Bioprocessing for Biofuel Production. Springer. ISBN 978-981-15-7069-8, https://doi.org/10.1007/978-981-15-7070-4
2. Sahay, Sanjay (2021). Handbook of Biofuels. Academic Press. ISBN 9780128228104, https://doi.org/10.1016/C2019-0-04999-0
3. Jay Cheng (2017). Biomass to Renewable Energy Processes. CRC Press. eBook ISBN 9781315152868, https://doi.org/10.1201/9781315152868
4. Pradeep Verma (2020). Biorefineries: A Step Towards Renewable and Clean Energy. Springer Nature. ISBN 9811595933, https://doi.org/10.1007/978-981-15-9593-6

Additional bibliography for study

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COMPUTATIONAL APPROACHES FOR MATERIALS IN ENERGY SYSTEMS

1. GENERAL

FACULTY	Engineering		
SCHOOL	Bachelor of Science in Clean Energy Science and Engineering		
LEVEL OF STUDIES	ISCED level 6 – Bachelor's or equivalent level		
COURSE CODE	CESE23	SEMESTER	5th Semester
COURSE TITLE	COMPUTATIONAL APPROACHES FOR MATERIALS IN ENERGY SYSTEMS		

TEACHING ACTIVITIES If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.	TEACHING HOURS PER WEEK	ECTS CREDITS
	5	7.0

COURSETYPE Background, General Knowledge, Scientific Area, Skill Development	Specific Background
PREREQUISITES	**PREREQUISITES** - **General prerequisites** -
TEACHING & EXAMINATION	English
COURSE OFFERED TO ERASMUS STUDENTS	NO
COURSE URL	https://elearning.auth.gr/course/index.php?categoryid=30

2. LEARNING OUTCOMES

Learning Outcomes
Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

Upon successful completion of the course, students will be able to:

Knowledge and Understanding
- Describe fundamental concepts of electronic structure (orbitals, electron density, HOMO–LUMO, charge distribution).
- Recognize the principles and limitations of semiempirical and first-principles electronic-structure methods (HF, DFT).

Application of Knowledge
- Construct molecular, cluster, and simple surface models and perform basic electronic-structure calculations using WebMO.
- Compute and interpret properties such as energy levels, IR/UV–Vis spectra, partial charges, dipole moments, and simple

adsorption energies.
Analysis and Synthesis
- Relate electronic properties to the functional behavior of materials in energy applications (e.g., catalysis, electrodes, light absorption).
- Evaluate the reliability and limitations of computed results based on the chosen method and calculation settings.

Communication and Autonomy
- Present computational findings clearly using appropriate visualizations and technical terminology.
- Use correct electronic-structure vocabulary in scientific and engineering contexts.
- Design, execute, and document a small electronic-structure study of an energy-relevant system.

General Skills

Name the desirable general skills upon successful completion of the module

Search, analysis and synthesis of data and information,
ICT Use,Adaptation to new situations,
Decision making,
Autonomous work,
Teamwork,
Working in an international environment,
Working in an interdisciplinary environment, Production of new research ideas
Project design and management
Equity and Inclusion
Respect for the natural environment
Sustainability
Demonstration of social, professional and moral responsibility and sensitivity to gender issues
Critical thinking
Promoting free, creative and inductive reasoning

Practical application of knowledge
Search, analysis and synthesis of data and information, ICT Use
Adaptation to new situations
Decision making
Autonomous work
Production of new research ideas
Promoting free, creative and inductive reasoning

3. COURSE CONTENT

This course introduces students to computational techniques for analyzing the electronic structure, chemical behavior, and spectroscopic properties of molecules, solids, and interfaces relevant to modern energy systems. Emphasis is placed on practical electronic-structure approaches that reveal how bonding, charge distribution, electronic levels, and optical characteristics influence the functionality of materials used in batteries, catalysts, photovoltaics, and other clean energy technologies. Students learn to construct and evaluate molecular and materials models, perform molecular structure optimizations, interpret vibrational and optical spectra, and assess electronic descriptors connected to reactivity and performance.
Hands-on laboratory sessions use the WebMO platform on the university's HPC system, allowing students to run semiempirical and first-principles electronic-structure calculations through an accessible web interface. The course introduces cluster-based representations of solids and surfaces, and guides students in interpreting electronic features such as HOMO–LUMO gaps, localized electronic states, adsorption behavior, and charge redistribution. Through a final mini-project, students design and communicate a focused electronic-structure analysis of an energy-relevant system. The course equips students with applied computational literacy, interpretive skills, and the conceptual vocabulary needed to understand and articulate electronic-level processes in materials used across energy engineering.

Topic-based outline:
- Weeks 1–2: Foundations of Electronic-Structure Modeling
  - Role of electronic-structure analysis in clean energy materials and systems.

o	Atomic and molecular structure representations.
o	Introduction to orbitals, electron density, HOMO–LUMO concepts.
o	Charge distribution, electrostatic potential, and simple reactivity indicators.
o	Introduction to WebMO and basic computational workflows.
•	Weeks 2–3: Semiempirical Electronic-Structure Methods
o	Motivation and approximations in semiempirical approaches (AM1, PM6, ZINDO).
o	Molecular geometry optimization and stability.
o	Prediction and interpretation of IR and UV/Vis spectra.
o	Rapid screening of energy-relevant molecular systems.
•	Weeks 4–6: First-Principles Electronic-Structure Methods
o	Hartree–Fock as a mean-field electronic approach, basis sets
o	Density Functional Theory: density, exchange–correlation.
o	Electronic levels, orbital characteristics, dipole moments.
o	Vibrational analysis and spectral interpretation (IR, Raman, optical transitions).
o	TD-DFT concepts for light-absorbing molecules (introductory level).
•	Weeks 7–9: Electronic Structure of Solids, Surfaces, and Interfaces
o	From molecular orbitals to bands: qualitative understanding.
o	Electronic descriptors of crystalline materials (band gap, DOS – conceptual).
o	Cluster models for solids and surfaces.
o	Local electronic environments in catalysts, electrode materials, and interfaces.
o	Adsorption phenomena and charge redistribution.
•	Weeks 10–11: Electronic Structure in Energy Applications
o	Electronic factors governing performance in: battery electrode materials, catalytic sites, light-absorbing and photovoltaic materials.
o	Connecting computed electronic properties to material functionality.
•	Weeks 11–13: Mini-Project: Design, Execution, and Communication
o	Defining a focused computational question.
o	Running electronic-structure calculations for a chosen system.
o	Interpreting results in an engineering-relevant context.
o	Preparing plots, visualizations, and short technical reports.
•	Oral or poster presentation of project results.

4. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD Face to face, Distance learning, etc.	Face to face
USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) Use of ICT in Teaching, in Laboratory Education, in Communication with students	**USE OF ICT** • Use of ICT in Teaching • Use of ICT in Laboratory Education • Use of ICT in Communication with students • Use of ICT in Evaluation of students **Description** Information and Communication Technologies (ICT) are systematically integrated into all instructional activities. Synchronous online teaching is supported through the ZOOM platform, while asynchronous instruction and learning materials are delivered via the institutional e-learning platform. ICT-based educational tools (e.g., Excel) are employed to support demonstrations, numerical examples, and student exercises. ICT is also utilized in student assessment through electronic submission,

	automated or electronic grading, and the use of platforms such as e-learning and Universis. Communication with students is conducted through e-learning announcements, institutional email, and ZOOM for virtual meetings or consultations.
TEACHING ORGANIZATION The ways and methods of teaching are described in detail. Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research& analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc. The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards	<table><tr><th>Activity</th><th>Workload/semester</th></tr><tr><td>Lectures</td><td>65</td></tr><tr><td>Laboratory</td><td>41</td></tr><tr><td>BibliographyAnalysis</td><td>40</td></tr><tr><td>writingProject</td><td>40</td></tr><tr><td>Examinations</td><td>3</td></tr><tr><td>Total</td><td>189</td></tr></table>
STUDENT EVALUATION Description of the evaluation process Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others Please indicate all relevant information about the course assessment and how students are informed	**Description** Assessment Language: English Assessment Methods: Summative • Written exam (70%) • Essay (30%) **Student Evaluation Languages** English **Student evaluation methods** • EssayReport (Formative, Summative) • ProblemSolving (Summative)

5. SUGGESTED BIBLIOGRAPHY

EUDOXUS

1. Christopher J. Cramer, Essentials of Computational Chemistry: Theories and Models (2nd ed.), John Wiley & Sons (2004) ISBN: 0470091821
2. David S. Sholl, Janice A. Steckel, Density Functional Theory: A Practical Introduction, John Wiley & Sons (2009) ISBN: 0470392671
3. Wolfram Koch, Max C. Holthausen, A Chemist's Guide to Density Functional Theory (2nd ed.), Wiley-VCH (2001) ISBN: 3527303720
4. David C. Young, Computational Chemistry: A Practical Guide for Applying Techniques to Real-World Problems, John Wiley & Sons (2001) ISBN: 0471333680
5. June Gunn Lee, Computational Materials Science: An Introduction, CRC Press (2013) ISBN: 1439885306
6. Andrew R. Leach, Molecular Modelling: Principles and Applications (2nd ed.), Prentice Hall / Pearson (2001), ISBN: 0582382107

Additional bibliography for study

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6th Semester

ENGINEERING PROFESSIONALISM

1. GENERAL

FACULTY	Engineering		
SCHOOL	Bachelor of Science in Clean Energy Science and Engineering		
LEVEL OF STUDIES	ISCED level 6 – Bachelor's or equivalent level		
COURSE CODE	CESE24	SEMESTER	6th Semester
COURSE TITLE	ENGINEERING PROFESSIONALISM		

TEACHING ACTIVITIES If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.	TEACHING HOURS PER WEEK	ECTS CREDITS
	4	10.0

COURSETYPE Background, General Knowledge, Scientific Area, Skill Development	Skill Development
PREREQUISITES	**PREREQUISITES** - **General prerequisites** -
TEACHING & EXAMINATION	English
COURSE OFFERED TO ERASMUS STUDENTS	NO
COURSE URL	https://elearning.auth.gr/course/index.php?categoryid=30

2. LEARNING OUTCOMES

Learning Outcomes
Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

By the end of this course, students will be able to:
- Understand codes of contact for engineers in a professional environment
- Prepare clear and well organized technical reports
- Deliver clear messages in their oral presentations, using suitable software
- Prepare effective CVs

- Use their new knowledge in practice through actual training dry runs
General Skills Name the desirable general skills upon successful completion of the module Search, analysis and synthesis of data and information, ICT Use,Adaptation to new situations, Decision making, Autonomous work, Teamwork, Working in an international environment, Working in an interdisciplinary environment, Production of new research ideas Project design and management Equity and Inclusion Respect for the natural environment Sustainability Demonstration of social, professional and moral responsibility and sensitivity to gender issues Critical thinking Promoting free, creative and inductive reasoning
Practical application of knowledge Search, analysis and synthesis of data and information, ICT Use Adaptation to new situations Decision making Working in an interdisciplinary environment Project design and management Demonstration of social, professional and moral responsibility and sensitivity to gender issues Critical thinking Promoting free, creative and inductive reasoning

3. COURSE CONTENT

The course introduces students to the ethical, communicative, and professional standards expected in modern engineering practice. The course explores codes of conduct from engineering associations, emphasizing how regulations, standards, and ethical frameworks guide responsible decision making. Students examine accountability in contemporary engineering contexts, including the appropriate use of AI tools, ownership of technical work, proper attribution, and managing one's professional reputation. A strong focus is placed on professional communication: structuring and writing technical reports, preparing effective presentations, and using digital tools to support clear, persuasive oral communication. Students are also introduced to scientific and conference publication practices, including research methods, referencing conventions, and dissemination approaches. The course supports students' professional development through guidance on CV preparation, understanding employment expectations, and planning for lifelong learning. Throughout the semester, students collect, analyze, and synthesize data to produce a technical report and present their findings in a formal oral presentation.

4. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD Face to face, Distance learning, etc.	Face to face
USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) Use of ICT in Teaching, in Laboratory Education, in Communication with students	**USE OF ICT** • Use of ICT in Teaching • Use of ICT in Laboratory Education • Use of ICT in Communication with students • Use of ICT in Evaluation of students **Description** • Use of ICT in Course Teaching

- Use of ICT in Communication with Students
- Powerpoint presentations on a beamer
- Video presentations on a beamer

TEACHING ORGANIZATION

The ways and methods of teaching are described in detail. Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research& analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc.

The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards

Activity	Workload/semester
Lectures	24
Seminars	28
InteractiveLearning	48
writingProject	102
BibliographyAnalysis	60
Examinations	8
Total	**270**

STUDENT EVALUATION

Description of the evaluation process

Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others

Please indicate all relevant information about the course assessment and how students are informed

Description

Description of the procedure: The final score is composited by the scores in two presentations during the semester, discussion on a technical report and discussion on a mock-up of conference paper. The final score weighing is: - 15% score in presentation 1 - 25% score in presentation 2 - 30% score in technical report - 30% score in conference paper mock up Assessment methods: - Oral exams (Formative) - Oral exams (Summative) - Performance / Staging (Summative) - Written Assignment (Summative)

Student Evaluation Languages

English

Student evaluation methods

- EssayReport (Summative)
- Presentation (Summative)
- LaboratoryReport (Summative)
- WrittenAssignment (Summative)

5. SUGGESTED BIBLIOGRAPHY

EUDOXUS

1) Fleddermann, CB; Engineering Ethics, 4th Edition, Pearson, 2011.

Additional bibliography for study

- Class material

RENEWABLE ENERGY TECHNOLOGIES

1. GENERAL

FACULTY	Engineering		
SCHOOL	Bachelor of Science in Clean Energy Science and Engineering		
LEVEL OF STUDIES	ISCED level 6 – Bachelor's or equivalent level		
COURSE CODE	CESE25	SEMESTER	6th Semester
COURSE TITLE	RENEWABLE ENERGY TECHNOLOGIES		

TEACHING ACTIVITIES If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.	TEACHING HOURS PER WEEK	ECTS CREDITS
	4	6.0

COURSETYPE Background, General Knowledge, Scientific Area, Skill Development	Specific Background
PREREQUISITES	**PREREQUISITES** - **General prerequisites** -
TEACHING & EXAMINATION	English
COURSE OFFERED TO ERASMUS STUDENTS	NO
COURSE URL	https://elearning.auth.gr/course/index.php?categoryid=30

2. LEARNING OUTCOMES

Learning Outcomes
Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

By the end of this course, students will be able to:

- Understand the physical characteristics of the main renewable energy sources (solar, wind, hydro, geothermal, etc.) as well as the techniques for assessing their potential.
- Trace the historical development and the modern technologies for the utilization of renewable energy sources.
- Apply computational procedures for the sizing and design of renewable energy systems.
- Comprehend the basic principles for evaluating the techno-economic feasibility of renewable energy projects.
- At the same time, they practice the operational procedures of renewable energy systems.

General Skills Name the desirable general skills upon successful completion of the module	
Search, analysis and synthesis of data and information, ICT Use,Adaptation to new situations, Decision making, Autonomous work, Teamwork, Working in an international environment, Working in an interdisciplinary environment, Production of new research ideas	Project design and management Equity and Inclusion Respect for the natural environment Sustainability Demonstration of social, professional and moral responsibility and sensitivity to gender issues Critical thinking Promoting free, creative and inductive reasoning

Practical application of knowledge
Search, analysis and synthesis of data and information, ICT Use
Adaptation to new situations
Decision making
Teamwork
Working in an interdisciplinary environment
Production of new research ideas
Respect for the natural environment

3. COURSE CONTENT

This course examines the energy problem and renewable energy sources.
More specific the following renewable energy systems are examined
1. SOLAR ENERGY Thermal solar systems, photovoltaic systems, and concentrated solar power systems. Design and sizing of solar thermal systems for domestic hot water production and building heating. Design and sizing of photovoltaic systems.
2. WIND ENERGY Types of wind turbines and wind generators. Basic characteristics and properties. Methods and technologies of utilization. Estimation of the energy output of an individual wind turbine.
3. GEOTHERMAL ENERGY High-, medium-, and low-enthalpy applications for power generation and thermal uses. Basic characteristics and properties. Methods and technologies of utilization.
4. HYDROELECTRIC ENERGY Water turbines. Hydroelectric power plants. Pumped-storage power stations. Basic characteristics and properties. Methods and technologies of utilization.
5. OCEAN ENERGY Tidal and wave power plants for electricity generation. Basic characteristics and properties. Methods and technologies of utilization.
6. ENERGY STORAGE Thermal, electrochemical, and mechanical energy storage systems.
7. HEAT PUMPS Dimensioning, operation characteristics, correlation with the outdoor environment, efficiency.

4. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD Face to face, Distance learning, etc.	Face to face
USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) Use of ICT in Teaching, in Laboratory Education, in Communication with students	USE OF ICT • Use of ICT in Teaching • Use of ICT in Laboratory Education • Use of ICT in Communication with students

	• Use of ICT in Evaluation of students **Description** Use of ICT in Course Teaching, Use of ICT in Laboratory Teaching, Use of ICT in Communication with Students Description: Use of Information and Communication Technologies (ICT) in teaching the course with tools of modern distance learning (ZOOM) and asynchronous education (e-learning). Use of learning aids based on ICT: Excel Use of ICT in student assessment: Electronic grading (e-learning, universis). Use of ICT in communication with students: e-learning, email, ZOOM.
TEACHING ORGANIZATION The ways and methods of teaching are described in detail. Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research& analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc. The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards	
STUDENT EVALUATION Description of the evaluation process Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others Please indicate all relevant information about the course assessment and how students are informed	**Description** Written Assignment 20% (Summative), Written Exam with Problem Solving 80% (Summative) **Student Evaluation Languages** English **Student evaluation methods** • WrittenAssignment (Summative) • ProblemSolving (Summative)

Activity	Workload/semester
Lectures	52
writingProject	54
BibliographyAnalysis	53
Examinations	3
Total	**162**

5. SUGGESTED BIBLIOGRAPHY

EUDOXUS

1. EMBER, The Electrotech Revolution, 2025
2. RENEWABLE ENERGY RESOURCES, J. Twidell and T. Weir, 3η έκδοση 2015, ISBN-13: 978-0415584388

Additional bibliography for study

1. HAEE, Greek Energy Market Report, 2024
2. Lazard, Levelized Cost of Energy Report, 2025

CHEMICAL AND PHYSICAL PROCESSES FOR CLEAN ENERGY PRODUCTION

1. GENERAL

FACULTY	Engineering		
SCHOOL	Bachelor of Science in Clean Energy Science and Engineering		
LEVEL OF STUDIES	ISCED level 6 – Bachelor's or equivalent level		
COURSE CODE	CESE26	SEMESTER	6th Semester
COURSE TITLE	CHEMICAL AND PHYSICAL PROCESSES FOR CLEAN ENERGY PRODUCTION		

TEACHING ACTIVITIES If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.	TEACHING HOURS PER WEEK	ECTS CREDITS
	5	6.0

COURSETYPE Background, General Knowledge, Scientific Area, Skill Development	Specific Background
PREREQUISITES	**PREREQUISITES** - **General prerequisites** -
TEACHING & EXAMINATION	English
COURSE OFFERED TO ERASMUS STUDENTS	NO
COURSE URL	https://elearning.auth.gr/course/index.php?categoryid=30

2. LEARNING OUTCOMES

Learning Outcomes
Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

By the end of this course, students will be able to:

- Explain the fundamental principles of chemical reaction kinetics and describe how these govern the operation and design of chemical reactors used in clean energy production.
- Apply design equations and analytical methods to evaluate and size different types of chemical reactors, including systems involving multiple reactions, nonisothermal behavior, and catalytic processes.
- Analyze key physical separation processes—such as membrane-based, equilibrium-based, and affinity-based methods—in terms of their mechanisms, design parameters, and relevance to clean energy applications.

• Evaluate the performance and limitations of chemical and physical processes used in the production of renewable fuels, including biodiesel, bioethanol, biogas, and hydrogen. • Assess integrated process configurations in biorefineries, demonstrating understanding of how biomass can be converted into fuels, chemicals, and value-added products within a circular, low-carbon energy system.
General Skills Name the desirable general skills upon successful completion of the module
Search, analysis and synthesis of data and information, ICT Use,Adaptation to new situations, Decision making, Autonomous work, Teamwork, Working in an international environment, Working in an interdisciplinary environment, Production of new research ideas Project design and management Equity and Inclusion Respect for the natural environment Sustainability Demonstration of social, professional and moral responsibility and sensitivity to gender issues Critical thinking Promoting free, creative and inductive reasoning
Practical application of knowledge Search, analysis and synthesis of data and information, ICT Use Adaptation to new situations Decision making Teamwork Working in an interdisciplinary environment Project design and management Respect for the natural environment Promoting free, creative and inductive reasoning

3. COURSE CONTENT

Part I, Introduction to reaction kinetics: fundamentals and practical guides. Principles of chemical processes, types of chemical reactors, design equations, simple and multiple reactions, combination of reactors, nonisothermal reactors, catalytic reactions & reactors. Elements of theory of mixing and non-ideal reactors. Part II, Physical processes relevant to clean energy, basic principles and techniques: membrane-based methods (microfiltration, ultrafiltration), equilibrium-based processes (distillation, liquid-liquid extraction), and affinity-based separations (adsorption, ion exchange). Particulate processes (size reduction, crystallization). Part III, Applications of Chemical and Physical processes to production of clean energy: renewable biofuels, including biodiesel from microalgae, bioethanol, biogas, and hydrogen. Introduction to the biorefinery concept, highlighting integrated processes that convert biomass into fuels, chemicals, and value-added products for a circular, low-carbon energy future.

4. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD Face to face, Distance learning, etc.	Face to face
USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) Use of ICT in Teaching, in Laboratory Education, in Communication with students	**USE OF ICT** • Use of ICT in Teaching • Use of ICT in Laboratory Education • Use of ICT in Communication with students • Use of ICT in Evaluation of students **Description**

	Use of ICT in Course Teaching, Use of ICT in Laboratory Teaching, Use of ICT in Communication with Students Description: Use of Information and Communication Technologies (ICT) in teaching the course with tools of modern distance learning (ZOOM) and asynchronous education (e-learning). Use of learning aids based on ICT: Excel Use of ICT in student assessment: Electronic grading (e-learning, universis). Use of ICT in communication with students: e-learning, email, ZOOM.
TEACHING ORGANIZATION The ways and methods of teaching are described in detail. Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research& analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc. The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards	
STUDENT EVALUATION Description of the evaluation process Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others Please indicate all relevant information about the course assessment and how students are informed	**Description** Written Assignment 10% (Summative), Performance / Staging 10% (Summative), Written Exam with Problem Solving 80% (Summative) **Student Evaluation Languages** English **Student evaluation methods** • WrittenAssignment (Summative) • ContinuousEvaluation (Summative) • ProblemSolving (Summative)

Activity	Workload/semester
Lectures	65
Laboratory	13
writingProject	34
BibliographyAnalysis	47
Examinations	3
Total	**162**

5. SUGGESTED BIBLIOGRAPHY

EUDOXUS

1. W.L. McCabe, Julian C. Smith, P. Harriott, Unit Operations of Chemical Engineering, Mc Graw-Hill, New York 1993
2. J.M. Smith, Chemical Engineering kinetics, Mc Graw Hill, New York 1970

Additional bibliography for study

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LIFE CYCLE SUSTAINABILITY ASSESSMENT(LCSA)

1. GENERAL

FACULTY	Engineering		
SCHOOL	Bachelor of Science in Clean Energy Science and Engineering		
LEVEL OF STUDIES	ISCED level 6 – Bachelor's or equivalent level		
COURSE CODE	CESE27	SEMESTER	6th Semester
COURSE TITLE	LIFE CYCLE SUSTAINABILITY ASSESSMENT(LCSA)		

TEACHING ACTIVITIES If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.	TEACHING HOURS PER WEEK	ECTS CREDITS
	5	8.0

COURSETYPE Background, General Knowledge, Scientific Area, Skill Development	Specific Background
PREREQUISITES	**PREREQUISITES** - **General prerequisites** -
TEACHING & EXAMINATION	English
COURSE OFFERED TO ERASMUS STUDENTS	NO
COURSE URL	https://elearning.auth.gr/course/index.php?categoryid=30

2. LEARNING OUTCOMES

Learning Outcomes
Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

By the end of this course, students will be able to:

- understand the basic dimensions of environmental impact assessment and the environmental terms of projects and activities.

Consequently, students will be able to:

- understand the relationship between project/activity and environmental impact assessment
- delve into legislative milestones regarding basic environmental/energy management systems
- learn from case studies of construction sites, environmental incidents in projects with the aim of better deepening basic concepts

General Skills Name the desirable general skills upon successful completion of the module	
Search, analysis and synthesis of data and information, ICT Use,Adaptation to new situations, Decision making, Autonomous work, Teamwork, Working in an international environment, Working in an interdisciplinary environment, Production of new research ideas	Project design and management Equity and Inclusion Respect for the natural environment Sustainability Demonstration of social, professional and moral responsibility and sensitivity to gender issues Critical thinking Promoting free, creative and inductive reasoning

Practical application of knowledge
Search, analysis and synthesis of data and information, ICT Use
Adaptation to new situations
Decision making
Teamwork
Working in an interdisciplinary environment
Production of new research ideas
Project design and management
Respect for the natural environment

3. COURSE CONTENT

The course introduces the basic knowledge of Environmental Impact Assessment (EIA) and the respective compliance with environmental conditions within the framework of sustainable resources' management and relevant environmental legislation. The key points of Environmental Impact Studies and the relevant application of environmental legislation to projects and activities are analyzed. After analyzing the basic background and knowledge, the key points of Environmental Management Systems (EMS) and the monitoring of relevant environmental performance (mainly ISO 14001 and 50001 for energy issues) are analyzed. Students of this class will have the opportunity to delve into issues related to the management of construction site pollutants, waste and environmental risks with the ultimate aim of preserving the natural environment and minimizing social impacts. The course also focuses on the interactions between Energy and Environment by highlighting case studies from construction sites, environmental incidents in projects and techniques for optimal energy utilization and monitoring of environmental performance.

4. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD Face to face, Distance learning, etc.	Face to face
USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) Use of ICT in Teaching, in Laboratory Education, in Communication with students	**USE OF ICT** • Use of ICT in Teaching • Use of ICT in Laboratory Education • Use of ICT in Communication with students • Use of ICT in Evaluation of students **Description** Use of ICT in Course Teaching, Use of ICT in Laboratory Teaching, Use of ICT in Communication with Students Description: Use of Information and Communication Technologies (ICT) in teaching the course with tools of modern distance learning (ZOOM) and

asynchronous education (e-learning).
Use of learning aids based on ICT: Excel
Use of ICT in student assessment: Electronic grading (e-learning, universis).
Use of ICT in communication with students: e-learning, email, ZOOM.

TEACHING ORGANIZATION

The ways and methods of teaching are described in detail. Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research& analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc.

The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards

Activity	Workload/semester
Lectures	65
writingProject	75
BibliographyAnalysis	73
Examinations	3
Total	**216**

STUDENT EVALUATION

Description of the evaluation process

Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others

Please indicate all relevant information about the course assessment and how students are informed

Description

Summative Written exam at the end of the semester Intermediate assignment Homework Weekly homework exercises Use of Multiple Bibliography Monitoring students during the execution of laboratory or practical exercises Receiving systematic comments from students in the middle of the semester Ensuring transparency in the evaluation of student performance through correction of all written assignments exclusively by the course instructor. There are always hours of cooperation after the exams during which each student has the right to see his/her written assignment. Only after this procedure are the final grades sent to the secretariat and entered in their card.

Student Evaluation Languages

English

Student evaluation methods

- ContinuousEvaluation (Summative)
- WrittenAssignment (Summative)
- ProblemSolving (Summative)

5. SUGGESTED BIBLIOGRAPHY

EUDOXUS

1. Rosenzweig, Cynthia, et al., editors. Climate Change and Cities: Second Assessment Report of the Urban Climate Change Research Network (ARC3.2). Cambridge UP, 2018.
2. ENVIRONMENTAL IMPACT STUDIES, VAGIONA DIMITRA, DISIGMA PUBLICATIONS IKE, ISBN: 9786182020654, 2nd Edition/2021
3. SOLID WASTE MANAGEMENT AND ENGINEERING, KOMILIS DIMITRIOS, A. PUBLICATIONS TZIOLA & SONS S.A., ISBN: 9786182210239, 3rd Edition/2023

Additional bibliography for study

1. International Energy Agency. World Energy Outlook 2023. OECD/IEA, 2023.
2. International Renewable Energy Agency. Global Renewables Outlook: Energy Transformation 2050. IRENA, 2020.

7th Semester

ENERGY SYSTEMS IN THE BUILD ENVIRONMENT

1. GENERAL

FACULTY	Engineering		
SCHOOL	Bachelor of Science in Clean Energy Science and Engineering		
LEVEL OF STUDIES	ISCED level 6 – Bachelor's or equivalent level		
COURSE CODE	CESE01EL	SEMESTER	7th Semester
COURSE TITLE	ENERGY SYSTEMS IN THE BUILD ENVIRONMENT		

TEACHING ACTIVITIES If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.	TEACHING HOURS PER WEEK	ECTS CREDITS
	4	6.0

COURSETYPE Background, General Knowledge, Scientific Area, Skill Development	Specialty / Orientation
PREREQUISITES	**PREREQUISITES** - **General prerequisites** -
TEACHING & EXAMINATION	English
COURSE OFFERED TO ERASMUS STUDENTS	NO
COURSE URL	https://elearning.auth.gr/course/index.php?categoryid=30

2. LEARNING OUTCOMES

Learning Outcomes
Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

By the end of this course, students will be able to:

- Calculate thermal – cooling loads in correlation to the building system examined
- Dimensioning energy systems relevant to urban environments.
- Introduce building automations control systems (BACS)
- Explain key concepts in urban sustainability and low-carbon development.

- Evaluate buildings adopting holistic approach based on LEED/ BREEAM certification schemes methodology.
- Interpret urban energy policies and planning frameworks.
- Propose integrated solutions for sustainable and resilient urban energy systems.

General Skills

Name the desirable general skills upon successful completion of the module

Search, analysis and synthesis of data and information,
ICT Use,Adaptation to new situations,
Decision making,
Autonomous work,
Teamwork,
Working in an international environment,
Working in an interdisciplinary environment, Production of new research ideas

Project design and management
Equity and Inclusion
Respect for the natural environment
Sustainability
Demonstration of social, professional and moral responsibility and sensitivity to gender issues
Critical thinking
Promoting free, creative and inductive reasoning

Practical application of knowledge
Search, analysis and synthesis of data and information, ICT Use
Adaptation to new situations
Decision making
Teamwork
Working in an interdisciplinary environment
Production of new research ideas
Respect for the natural environment

3. COURSE CONTENT

This course examines how buildings can transition toward sustainable, low-carbon futures through renewable energy systems (mainly solar technologies) focused on urban environment application covering heating- cooling needs on terms of thermal comfort. Energy systems planning and dimensioning in regard to energy efficiency, health and well-being of users and climate-resilient infrastructure is also a key issue of the course. Students will explore the interplay between urbanization, energy demand and consumption, automations (BACS - Building Automation Control Systems), smart systems, cost effectiveness and environmental impacts (oriented to carbon footprint). The course integrates sustainability science, urban policy, and engineering approaches to equip students with analytical and practical tools for energy efficient urban development, buildings certification (LEED and BREEAM) providing a holistic approach to the design of urban planning in compliance to energy and climate policy.

4. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD Face to face, Distance learning, etc.	Face to face
USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) Use of ICT in Teaching, in Laboratory Education, in Communication with students	**USE OF ICT** • Use of ICT in Teaching • Use of ICT in Laboratory Education • Use of ICT in Communication with students • Use of ICT in Evaluation of students **Description** Use of ICT in Course Teaching, Use of ICT in Laboratory Teaching, Use of ICT in Communication with Students

	Description: Use of Information and Communication Technologies (ICT) in teaching the course with tools of modern distance learning (ZOOM) and asynchronous education (e-learning). Use of learning aids based on ICT: Excel Use of ICT in student assessment: Electronic grading (e-learning, universis). Use of ICT in communication with students: e-learning, email, ZOOM.
TEACHING ORGANIZATION The ways and methods of teaching are described in detail. Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research& analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc. The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards	<table><tr><th>Activity</th><th>Workload/semester</th></tr><tr><td>Lectures</td><td>52</td></tr><tr><td>writingProject</td><td>54</td></tr><tr><td>BibliographyAnalysis</td><td>53</td></tr><tr><td>Examinations</td><td>3</td></tr><tr><td>Total</td><td>162</td></tr></table>
STUDENT EVALUATION Description of the evaluation process Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others Please indicate all relevant information about the course assessment and how students are informed	**Description** Written Assignment (Summative), Performance / Staging (Summative), Written Exam with Problem Solving (Summative) **Student Evaluation Languages** English **Student evaluation methods** • WrittenAssignment (Summative) • ProblemSolving (Summative)

5. SUGGESTED BIBLIOGRAPHY

EUDOXUS

1. International Energy Agency. World Energy Outlook 2023. OECD/IEA, 2023.
2. International Renewable Energy Agency. Global Renewables Outlook: Energy Transformation 2050. IRENA, 2020.
3. Rosenzweig, Cynthia, et al., editors. Climate Change and Cities: Second Assessment Report of the Urban Climate Change Research Network (ARC3.2). Cambridge UP, 2018.

Additional bibliography for study

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ENERGY AND ENVIRONMENT

1. GENERAL

FACULTY	Engineering		
SCHOOL	Bachelor of Science in Clean Energy Science and Engineering		
LEVEL OF STUDIES	ISCED level 6 – Bachelor's or equivalent level		
COURSE CODE	CESE02EL	SEMESTER	7th Semester
COURSE TITLE	ENERGY AND ENVIRONMENT		

TEACHING ACTIVITIES If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.	TEACHING HOURS PER WEEK	ECTS CREDITS
	4	6.0

COURSETYPE Background, General Knowledge, Scientific Area, Skill Development	Specialty / Orientation
PREREQUISITES	**PREREQUISITES** - **General prerequisites** -
TEACHING & EXAMINATION	English
COURSE OFFERED TO ERASMUS STUDENTS	NO
COURSE URL	https://elearning.auth.gr/course/index.php?categoryid=30

2. LEARNING OUTCOMES

Learning Outcomes
Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

By the end of this course, students will be able to:

- Understand the scientific principles linking energy systems with environmental impacts.
- Analyze the effects of different energy production and conversion technologies (fossil fuels, renewables, nuclear, biomass, etc.) on climate, air quality, natural resources, and ecosystems.
- Evaluate greenhouse gas emissions, pollutant formation, and other environmental indicators associated with energy systems.
- Apply lifecycle assessment and environmental footprint analysis to energy technologies.
- Assess environmental trade-offs and sustainability implications of various energy pathways.
- Critically interpret data and case studies on energy and environmental impacts.

- Propose strategies for the transition to low-carbon, resource-efficient, and environmentally responsible energy systems.
- Communicate scientific findings effectively through written reports and oral presentations.

General Skills

Name the desirable general skills upon successful completion of the module

Search, analysis and synthesis of data and information,
ICT Use,Adaptation to new situations,
Decision making,
Autonomous work,
Teamwork,
Working in an international environment,
Working in an interdisciplinary environment, Production of new research ideas

Project design and management
Equity and Inclusion
Respect for the natural environment
Sustainability
Demonstration of social, professional and moral responsibility and sensitivity to gender issues
Critical thinking
Promoting free, creative and inductive reasoning

Practical application of knowledge
Search, analysis and synthesis of data and information, ICT Use
Adaptation to new situations
Decision making
Teamwork
Working in an interdisciplinary environment
Production of new research ideas
Project design and management
Respect for the natural environment

3. COURSE CONTENT

The course introduces students to the scientific principles that govern the interaction between the energy systems and the environment, providing a foundation for understanding the environmental challenges and opportunities of the clean-energy transition. It examines how different forms of energy production, conversion, and use—including oil, coal, natural gas, nuclear energy, biomass, geothermal, hydroelectric, wind, solar, and other renewable sources—affect climate change, air quality, natural resources, and ecosystems. Students study the environmental impacts of fossil fuels and emerging clean-energy technologies, focusing on greenhouse gas emissions, pollutant formation, carbon and nutrient cycles, and ecosystem interactions. The course explores lifecycle assessment, environmental footprint analysis, and sustainability metrics to evaluate energy technologies and systems. Attention is given to both local and global environmental consequences of energy choices, as well as the trade-offs involved in adopting different energy pathways. Through case studies, quantitative analysis, and applied examples, students develop the skills to assess the environmental performance of energy systems and to propose strategies for low-carbon, resource-efficient, and ecologically responsible energy solutions. The course emphasizes the critical role of science-based decision-making in guiding the transition toward sustainable and clean energy future.

4. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD Face to face, Distance learning, etc.	Face to face
USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) Use of ICT in Teaching, in Laboratory Education, in Communication with students	**USE OF ICT** • Use of ICT in Teaching • Use of ICT in Laboratory Education • Use of ICT in Communication with students

	• Use of ICT in Evaluation of students **Description** • Use of Information and Communication Technologies (ICT) in teaching the course with tools of modern distance learning (ZOOM) and asynchronous education (e-learning). • Use of learning aids based on ICT: Excel • Use of ICT in student assessment: Electronic grading (e-learning, universis). • Use of ICT in communication with students: e-learning, email, ZOOM.
TEACHING ORGANIZATION The ways and methods of teaching are described in detail. Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research& analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc. The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards	
STUDENT EVALUATION Description of the evaluation process Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others Please indicate all relevant information about the course assessment and how students are informed	**Description** Written Assignment (Summative), Performance / Staging (Summative), Written Exam with Problem Solving (Summative) **Student Evaluation Languages** English **Student evaluation methods** • WrittenAssignment (Summative) • ProblemSolving (Summative)

Activity	Workload/semester
Lectures	52
writingProject	54
BibliographyAnalysis	53
Examinations	3
Total	**162**

5. SUGGESTED BIBLIOGRAPHY

EUDOXUS

1. Kaushika, N.D., Reddy, K.S., Kaushik, K., Sustainable Energy and the Environment: A Clean Technology Approach, Springer, 2016.
2. Radolph, J., Masters, G.M., Energy for Sustainability: Foundations for Technology, Planning, and Policy (2nd Edition), Island Press, 2018.
3. Wolfson, R., Energy, Environment, and Climate (4th Edition), W. W. Norton & Company, 2023.

Additional bibliography for study

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TURBOMACHINES

1. GENERAL

FACULTY	Engineering		
SCHOOL	Bachelor of Science in Clean Energy Science and Engineering		
LEVEL OF STUDIES	ISCED level 6 – Bachelor's or equivalent level		
COURSE CODE	CESE03EL	SEMESTER	7th Semester
COURSE TITLE	TURBOMACHINES		

TEACHING ACTIVITIES If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.	TEACHING HOURS PER WEEK	ECTS CREDITS
	4	6.0

COURSETYPE Background, General Knowledge, Scientific Area, Skill Development	Specialty / Orientation
PREREQUISITES	**PREREQUISITES** - **General prerequisites** -
TEACHING & EXAMINATION	English
COURSE OFFERED TO ERASMUS STUDENTS	NO
COURSE URL	https://elearning.auth.gr/course/index.php?categoryid=30

2. LEARNING OUTCOMES

Learning Outcomes
Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

By the end of this course, students will be able to:
- Understand the morphology and configuration,
- The flow path
- The operation characteristics and efficiency of Compressors, Turbines, Pumps and Water turbines, and to perform first level calculations on their operation

General Skills Name the desirable general skills upon successful completion of the module	
Search, analysis and synthesis of data and information, ICT Use,Adaptation to new situations, Decision making, Autonomous work, Teamwork, Working in an international environment, Working in an interdisciplinary environment, Production of new research ideas	Project design and management Equity and Inclusion Respect for the natural environment Sustainability Demonstration of social, professional and moral responsibility and sensitivity to gender issues Critical thinking Promoting free, creative and inductive reasoning
Practical application of knowledge Search, analysis and synthesis of data and information, ICT Use Adaptation to new situations Autonomous work Promoting free, creative and inductive reasoning	

3. COURSE CONTENT

Introduction to turbomachinery, general principles, typical configurations. The turbomachinery and the operation system. Typical characteristics of turbomachines, similarity laws, cooperation of several turbomachines, operation in series or in parallel. The fluid mechanics and thermodynamics of turbomachines, thermodynamic cycles of gas and steam turbines. The relative flow, velocity triangles, Euler's equation. Aerodynamics of turbomachinery, basic principles of operation, non dimensional numbers, efficiencies, reaction. Axial compressors: design, operation, limiting factors. Blade aerodynamics for axial compressors operating both in sub- and super-sonic regions. Flow phenomena, 3D effects, tip leakage flows. Radial turbomachinery: Description, velocity triangles, design and operation problems. Axial turbines: Blade design and construction characteristics, 3-D flows. Blade cooling methodology and construction problems. Pumps: Study of the phase change of water under extremely low pressures, cavitation. Operational characteristics analysis of 3-D flow effects, multistage pumps, technical and operational problems. Radial turbines. Theory of design and operation, study of the flow in radial turbine rotors. Water turbines: Fluid mechanics of Pelton, Francis and Caplan turbines. Design and construction, operational characteristics cavitation.

4. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD Face to face, Distance learning, etc.	Face to face
USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) Use of ICT in Teaching, in Laboratory Education, in Communication with students	**USE OF ICT** • Use of ICT in Teaching • Use of ICT in Laboratory Education • Use of ICT in Communication with students • Use of ICT in Evaluation of students **Description** • Use of ICT in Course Teaching • Use of ICT in Communication with Students • Powerpoint presentations on a beamer • Video presentations on a beamer • Simulation software on computers, using specialized software

- communication e-learning, e-mails, microsoft teams, unisis
- assessment e-learning, e-mails, microsoft teams, unisis

TEACHING ORGANIZATION

The ways and methods of teaching are described in detail. Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research& analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc.

The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards

Activity	Workload/semester
Lectures	48
InteractiveLearning	4
Laboratory	36
writingProject	36
BibliographyAnalysis	35
Examinations	3
Total	**162**

STUDENT EVALUATION

Description of the evaluation process

Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others

Please indicate all relevant information about the course assessment and how students are informed

Description

The final score is composited by the scores in one project during the semester that is examined orally, and the score of the final written exams. The final score weighing is: - 20% score in project report - 20% score in oral examination - 60% final written exam Assessment methods: - Written Exam with Multiple Choice Questions (Summative) - Written Exam with Short Answer Questions (Summative) - Written Exam with Problem Solving (Summative) - Written Assignment (Summative) - Oral Exams (Summative)

Student Evaluation Languages

English

Student evaluation methods

- EssayReport (Summative)
- OralExam (Summative)
- ProblemSolving (Summative)

5. SUGGESTED BIBLIOGRAPHY

EUDOXUS

1. Turbomachinery Flow Physics and Dynamic Performance [electronic resource], Schobeiri, Meinhard

Additional bibliography for study

-

Senior project

1. GENERAL

FACULTY	Engineering		
SCHOOL	Bachelor of Science in Clean Energy Science and Engineering		
LEVEL OF STUDIES	ISCED level 6 – Bachelor's or equivalent level		
COURSE CODE	CESE28	SEMESTER	7th Semester
COURSE TITLE	Senior project		

TEACHING ACTIVITIES If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.	TEACHING HOURS PER WEEK	ECTS CREDITS
	0	12.0

COURSETYPE Background, General Knowledge, Scientific Area, Skill Development	Deepening / Consolidation
PREREQUISITES	**PREREQUISITES** - **General prerequisites** The student who is in the 7th semester of studies and owes a total of up to eight (8) courses to receive the Degree has the right to start the preparation of the Senior Project.
TEACHING & EXAMINATION	English
COURSE OFFERED TO ERASMUS STUDENTS	NO
COURSE URL	cese.auth.gr

2. LEARNING OUTCOMES

Learning Outcomes
Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

Upon successful assignment preparation and review, students are expected to demonstrate proficiency in project planning, data collection, critical evaluation of sources, and integration of interdisciplinary knowledge. Senior Project - Thesis I is the first essential step towards professional-level problem-solving, preparing students for the increased demands of Thesis II. Successful completion ensures that students can work autonomously, communicate their progress effectively, and apply clean energy principles in a structured and evidence-based manner.

General Skills Name the desirable general skills upon successful completion of the module	
Search, analysis and synthesis of data and information, ICT Use,Adaptation to new situations, Decision making, Autonomous work, Teamwork, Working in an international environment, Working in an interdisciplinary environment, Production of new research ideas	Project design and management Equity and Inclusion Respect for the natural environment Sustainability Demonstration of social, professional and moral responsibility and sensitivity to gender issues Critical thinking Promoting free, creative and inductive reasoning
Search, analysis and synthesis of data and information, ICT Use Decision making Autonomous work Project design and management Critical thinking Promoting free, creative and inductive reasoning	

3. COURSE CONTENT

The Senior Project introduces students to the full cycle of independent, research-led work in the field of Clean Energy. Utilizing the theoretical and laboratory background of the first six semesters, students are asked to identify a technical, environmental or socio-economic issue and develop a structured plan to address it. The course emphasizes research design, literature review, methodology selection, and the production of initial analytical or experimental results. Students are guided to formulate clear objectives, document their approach and work systematically on a medium-scale engineering or applied research challenge.

4. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD Face to face, Distance learning, etc.	Face to face
USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) Use of ICT in Teaching, in Laboratory Education, in Communication with students	**USE OF ICT** • Use of ICT in Communication with students • Use of ICT in Evaluation of students **Description** Communication by emails and use of the elearning platform to support the preparation of the paper and guidance in the required bibliography.
TEACHING ORGANIZATION The ways and methods of teaching are described in detail. Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research& analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc. The supervised and unsupervised workload per activity is indicated here, so that total workload per semester	

Activity	Workload/semester
Tutoring	13
BibliographyAnalysis	80
StudyCreation	100
writingProject	130

complies to ECTS standards	

Activity	Workload/semester
Examinations	1
Total	**324**

STUDENT EVALUATION
Description of the evaluation process

Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others

Please indicate all relevant information about the course assessment and how students are informed

Description
The student is constantly evaluated in weekly meetings with the supervisor, depending on the degree of understanding of the subject, the quality of the progress of the work, the degree of initiative and the scientific accuracy in the analysis of the topics assigned to him/her. At the end of the semester, an oral examination is conducted for the final grading through the question-and-answer process and taking into account the quality of the oral presentation by the student.

Student Evaluation Languages
English

Student evaluation methods

- ContinuousEvaluation (Formative)
- OralExam (Summative)

5. SUGGESTED BIBLIOGRAPHY

EUDOXUS

The bibliography is developed on the initiative of the student in collaboration with the teacher.

Additional bibliography for study

The bibliography is developed on the initiative of the student in collaboration with the teacher.

HEAT DEVICES AND ENGINES

1. GENERAL

FACULTY	Engineering		
SCHOOL	Bachelor of Science in Clean Energy Science and Engineering		
LEVEL OF STUDIES	ISCED level 6 – Bachelor's or equivalent level		
COURSE CODE	CESECEA01	SEMESTER	7th Semester
COURSE TITLE	HEAT DEVICES AND ENGINES		

TEACHING ACTIVITIES If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.	TEACHING HOURS PER WEEK	ECTS CREDITS
	4	6.0

COURSETYPE Background, General Knowledge, Scientific Area, Skill Development	Specialty / Orientation
PREREQUISITES	**PREREQUISITES** - **General prerequisites** -
TEACHING & EXAMINATION	English
COURSE OFFERED TO ERASMUS STUDENTS	NO
COURSE URL	https://elearning.auth.gr/course/index.php?categoryid=30

2. LEARNING OUTCOMES

Learning Outcomes
Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

By the end of this course, students will be able to:
- have an overview of various technologies of heat and power generation
- understand production of hot water and steam in boilers
- understand the fundamentals of engines and the operation of their main components
- make calculations on applied energy balances and performance of boilers and engines
- understand pollutant formation by combustion and aftertreatment technologies

General Skills Name the desirable general skills upon successful completion of the module	
Search, analysis and synthesis of data and information, ICT Use,Adaptation to new situations, Decision making, Autonomous work, Teamwork, Working in an international environment, Working in an interdisciplinary environment, Production of new research ideas	Project design and management Equity and Inclusion Respect for the natural environment Sustainability Demonstration of social, professional and moral responsibility and sensitivity to gender issues Critical thinking Promoting free, creative and inductive reasoning

Practical application of knowledge
Search, analysis and synthesis of data and information, ICT Use
Adaptation to new situations
Decision making
Teamwork
Production of new research ideas
Promoting free, creative and inductive reasoning

3. COURSE CONTENT

By accomplishing this course, students will be able to understand energy balance and ways this its applied in technical applications. They will have obtained an insight into the fundamentals of issues addressed by the energy and manufacturing of energy use systems for heat and power production.
Introduction to heating systems and equipment: principles and systems of heating. Thermal load calculation. Boilers, heating elements, heat pumps dimensioning and operation. Piping calculations and design of the heating network.
Introduction to Internal Combustion Engines: IC engine classification, engine components and terminology, engine maps. Sizing and use of IC engines in conventional and hybrid propulsion systems. Engines Cycles: Introduction. Gas Cycles (Otto, Diesel, Miller). Combustion Thermodynamics. Fuel-air cycles. Calculation of engine cycles and gas composition. Measurement Techniques. Analysis of indicator diagrams. Friction and lubrication. Fluid Mechanics in 4-stroke and 2-stroke engines. Turbocharging and supercharging. Fuel injection systems. Heat Transfer and Engine Cooling. Combustion in Otto and Diesel engines. Calculation of combustion rate. Pollutant formation and after-treatment technology.

4. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD Face to face, Distance learning, etc.	Face to face
USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) Use of ICT in Teaching, in Laboratory Education, in Communication with students	**USE OF ICT** • Use of ICT in Teaching • Use of ICT in Laboratory Education • Use of ICT in Communication with students • Use of ICT in Evaluation of students **Description** • Use of ICT in Course Teaching • Use of ICT in Communication with Students • Powerpoint presentations on a beamer

	• Use of learning aids based on ICT: Excel, matlab • Use of ICT in student assessment: Electronic grading (e-learning, universis). • Use of ICT in communication with students: e-learning, email, ZOOM (if needed)
TEACHING ORGANIZATION The ways and methods of teaching are described in detail. Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research& analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc. The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards	

Activity	Workload/semester
Lectures	52
InteractiveLearning	24
writingProject	24
BibliographyAnalysis	59
Examinations	3
Total	**162**

STUDENT EVALUATION Description of the evaluation process Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others Please indicate all relevant information about the course assessment and how students are informed	**Description** Description of the procedure: The final score is composited by the scores in two projects during the semester that are examined orally, and the score of the final written exams. The final score weighing is: - 30% score in project report - 20% score in oral examination - 50% final written exam Assessment methods: - Written Exam with Multiple Choice Questions (Summative) - Written Exam with Short Answer Questions (Summative) - Written Exam with Problem Solving (Summative) - Written Assignment (Summative) - Oral Exams (Summative) **Student Evaluation Languages** English **Student evaluation methods** • EssayReport (Summative) • OralExam (Summative) • ProblemSolving (Summative)

5. SUGGESTED BIBLIOGRAPHY

EUDOXUS

1. ASHRAE Handbook-HVAC Systems and Equipment, American Society of Heating Refrigerating and Air-Conditioning Engineers, Inc., Atlanta, USA, 2024.
2. Internal Combustion Engine Fundamentals, Heywood John
3. Internal Combustion Engines: Applied Thermosciences, 4th Edition, C. FERGUSON - A. KIRKPATRICK

Additional bibliography for study

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ΜΟΝΑΔΑ ΔΙΑΣΦΑΛΙΣΗΣ ΠΟΙΟΤΗΤΑΣ Α.Π.Θ.

ENERGY SYSTEMS CONTROL

1. GENERAL

FACULTY	Engineering		
SCHOOL	Bachelor of Science in Clean Energy Science and Engineering		
LEVEL OF STUDIES	ISCED level 6 – Bachelor's or equivalent level		
COURSE CODE	CESECEA02	SEMESTER	7th Semester
COURSE TITLE	ENERGY SYSTEMS CONTROL		

TEACHING ACTIVITIES If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.	TEACHING HOURS PER WEEK	ECTS CREDITS
	4	6.0

COURSETYPE Background, General Knowledge, Scientific Area, Skill Development	Specialty / Orientation
PREREQUISITES	**PREREQUISITES** - **General prerequisites** Calculus, Linear Algebra, Physics, Chemistry
TEACHING & EXAMINATION	English
COURSE OFFERED TO ERASMUS STUDENTS	NO
COURSE URL	https://elearning.auth.gr/course/index.php?categoryid=30

2. LEARNING OUTCOMES

Learning Outcomes
Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

By the end of this course, students will be able to:

- Analyse the dynamic response of energy systems in the time and frequency domains
- Design of feedback control systems for desired dynamic performance

General Skills Name the desirable general skills upon successful completion of the module	
Search, analysis and synthesis of data and information, ICT Use,Adaptation to new situations, Decision making, Autonomous work, Teamwork, Working in an international environment, Working in an interdisciplinary environment, Production of new research ideas	Project design and management Equity and Inclusion Respect for the natural environment Sustainability Demonstration of social, professional and moral responsibility and sensitivity to gender issues Critical thinking Promoting free, creative and inductive reasoning
Practical application of knowledge Search, analysis and synthesis of data and information, ICT Use Adaptation to new situations Decision making Teamwork Working in an interdisciplinary environment Production of new research ideas Respect for the natural environment	

3. COURSE CONTENT

- Principles of Feedback Control – Elements of control
- Analysis of dynamic behavior (Stability, dynamic response)
- Single feedback control loop design (PID, controller tuning, cascade, feedforward, time delay systems)
- Multi-loop feedback control system design (interaction, decoupling)
- Frequency response control system design methods
- State-space model representation, state feedback control system design

4. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD Face to face, Distance learning, etc.	Face to face
USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) Use of ICT in Teaching, in Laboratory Education, in Communication with students	**USE OF ICT** • Use of ICT in Teaching • Use of ICT in Laboratory Education • Use of ICT in Communication with students • Use of ICT in Evaluation of students **Description** Use of ICT in Course Teaching, Use of ICT in Laboratory Teaching, Use of ICT in Communication with Students Description: Use of Information and Communication Technologies (ICT) in teaching the course with tools of modern distance learning (ZOOM) and asynchronous education (e-learning). Use of learning aids based on ICT: Excel Use of ICT in student assessment: Electronic grading (e-learning,

universis).
Use of ICT in communication with students: e-learning, email, ZOOM.

TEACHING ORGANIZATION

The ways and methods of teaching are described in detail. Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research& analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc.

The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards

Activity	Workload/semester
Lectures	52
InteractiveLearning	36
writingProject	36
BibliographyAnalysis	35
Examinations	3
Total	**162**

STUDENT EVALUATION

Description of the evaluation process

Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others

Please indicate all relevant information about the course assessment and how students are informed

Description

Written Assignment 25% (Summative) , Computer assignments 25%, Written Exam with Multiple Choice Questions 25%, Written Exam with Problem Solving 25% (Summative)

Student Evaluation Languages

English

Student evaluation methods

- WrittenAssignment (Summative)
- ComputerExamination (Summative)
- MultipleChoice (Summative)
- ProblemSolving (Summative)

5. SUGGESTED BIBLIOGRAPHY

EUDOXUS

1. Franklin G.F., J.D. Powell, A. Emami-Naeini. “Feedback Control of Dynamic Systems”, Prentice Hall, 2002.
2. Goodwin G.C., S.F. Graebe, M.E. Salgado. “Control System Design”, Prentice Hall, 2001.
3. Palm W. J. “Modeling, Analysis and Control of Dynamic Systems”, J. Wiley, 1999.
4. Ogata K. “Modern Control Engineering”, Prentice-Hall, 2001.
5. Marlin T.E. “Process Control”, McGraw-Hill, 1995.
6. Seborg D.E., T.F. Edgar, D.A. Mellichamp. “Process Dynamics and Control”, Wiley, 1989.
7. Smith C.A., and A.B. Corripio. “Principles and Practice of Automatic Process Control”, Wiley, 1997.

Additional bibliography for study

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ΜΟΝΑΔΑ ΔΙΑΣΦΑΛΙΣΗΣ ΠΟΙΟΤΗΤΑΣ Α.Π.Θ.

INDUSTRIAL PROCESS DESIGN

1. GENERAL

FACULTY	Engineering		
SCHOOL	Bachelor of Science in Clean Energy Science and Engineering		
LEVEL OF STUDIES	ISCED level 6 – Bachelor's or equivalent level		
COURSE CODE	CESEPD01	SEMESTER	7th Semester
COURSE TITLE	INDUSTRIAL PROCESS DESIGN		

TEACHING ACTIVITIES If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.	TEACHING HOURS PER WEEK	ECTS CREDITS
	4	6.0

COURSETYPE Background, General Knowledge, Scientific Area, Skill Development	Specialty / Orientation
PREREQUISITES	**PREREQUISITES** - **General prerequisites** -
TEACHING & EXAMINATION	English
COURSE OFFERED TO ERASMUS STUDENTS	NO
COURSE URL	https://elearning.auth.gr/course/index.php?categoryid=30

2. LEARNING OUTCOMES

Learning Outcomes
Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

By the end of this course, students will be able to:

- Conduct feasibility studies for industrial processes related to energy production.
- Employ specialized software tools for the design of an industrial process flow diagram.
- Develop and interpret methodological flow diagrams and apply mass and energy balance principles to process systems.
- Perform preliminary sizing and selection of major process equipment based on design requirements and operating conditions.
- Analyze process throughput, identify bottlenecks, and propose effective debottlenecking strategies.
- Optimize process operating conditions using operational criteria and apply scale-up principles to industrial systems.

• Determine and evaluate functional parameters in outlet streams to ensure regulatory compliance and sustainable operation.

General Skills

Name the desirable general skills upon successful completion of the module

Search, analysis and synthesis of data and information, ICT Use,Adaptation to new situations, Decision making, Autonomous work, Teamwork, Working in an international environment, Working in an interdisciplinary environment, Production of new research ideas	Project design and management Equity and Inclusion Respect for the natural environment Sustainability Demonstration of social, professional and moral responsibility and sensitivity to gender issues Critical thinking Promoting free, creative and inductive reasoning

Practical application of knowledge
Search, analysis and synthesis of data and information, ICT Use
Adaptation to new situations
Decision making
Teamwork
Working in an interdisciplinary environment
Production of new research ideas
Respect for the natural environment

3. COURSE CONTENT

The course introduces students to the application of feasibility studies in energy production industrial processes. It is based on a thorough feasibility study of a selected industrial plant, which varies each year, and the preparation of a detailed report that constitutes an important part of the overall course grade. The course covers the development and interpretation of methodological flow diagrams and the application of mass and energy balances for process analysis. Students learn the preliminary sizing and selection of key process equipment, as well as methods for estimation of project profitability. To support this, the course includes an extensive lab component where students use specialized software tools for industrial plant design. The course also addresses throughput analysis, identification of bottlenecks, and strategies for process optimization. Additionally, students explore the optimization of operating conditions using operational criteria and the principles of process scale-up. Finally, the course examines the determination and evaluation of quality parameters in outlet streams to ensure compliance with quality standards and sustainable operation.

4. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD Face to face, Distance learning, etc.	Face to face
USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) Use of ICT in Teaching, in Laboratory Education, in Communication with students	**USE OF ICT** • Use of ICT in Teaching • Use of ICT in Laboratory Education • Use of ICT in Communication with students • Use of ICT in Evaluation of students **Description** Use of ICT in Course Teaching, Use of ICT in Laboratory Teaching, Use of ICT in Communication with Students Description: Use of Information and Communication Technologies (ICT) in

	teaching the course with tools of modern distance learning (ZOOM) and asynchronous education (e-learning). Use of learning aids based on ICT: Excel Use of ICT in student assessment: Electronic grading (eclass, universis). Use of ICT in communication with students: e-learning, email, ZOOM.
TEACHING ORGANIZATION The ways and methods of teaching are described in detail. Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research& analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc. The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards	

Activity	Workload/semester
Lectures	52
InteractiveLearning	26
writingProject	35
BibliographyAnalysis	46
Examinations	3
Total	**162**

STUDENT EVALUATION Description of the evaluation process Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others Please indicate all relevant information about the course assessment and how students are informed	**Description** Written Assignment (Summative), Written Exam with Problem Solving (Summative) **Student Evaluation Languages** English **Student evaluation methods** • WrittenAssignment (Summative) • ProblemSolving (Summative)

5. SUGGESTED BIBLIOGRAPHY

EUDOXUS

1. Peters, M. S., Timmerhaus, K. D., & West, R. E. (2003). Plant design and economics for chemical engineers (5th ed.). McGraw-Hill.
2. Mizrahi, J. (2002). Developing An Industrial Chemical Process: An Integrated Approach. CRC Press.

Additional bibliography for study

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OPERATIONS RESEARCH AND OPTIMIZATION

1. GENERAL

FACULTY	Engineering		
SCHOOL	Bachelor of Science in Clean Energy Science and Engineering		
LEVEL OF STUDIES	ISCED level 6 – Bachelor's or equivalent level		
COURSE CODE	CESEPD02	SEMESTER	7th Semester
COURSE TITLE	OPERATIONS RESEARCH AND OPTIMIZATION		

TEACHING ACTIVITIES If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.	TEACHING HOURS PER WEEK	ECTS CREDITS
	4	6.0

COURSETYPE Background, General Knowledge, Scientific Area, Skill Development	Specialty / Orientation
PREREQUISITES	**PREREQUISITES** - **General prerequisites** -
TEACHING & EXAMINATION	English
COURSE OFFERED TO ERASMUS STUDENTS	NO
COURSE URL	https://elearning.auth.gr/course/index.php?categoryid=30

2. LEARNING OUTCOMES

Learning Outcomes
Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

By the end of this course, students will be able to:

- Know the basic mathematical programming (Linear and Non-linear) concepts and methods.
- model a real-world operational problem by the development of the appropriate mathematical programming model.
- solve mathematical programming models by employing the appropriate operations research methodologies and algorithms.
- handle data and solve mathematical programming models using computer software.
- perform sensitivity/"what-if" analyses on the results of operations research problems.
- interpret the results of an operations research problem's solution.

General Skills Name the desirable general skills upon successful completion of the module	
Search, analysis and synthesis of data and information, ICT Use,Adaptation to new situations, Decision making, Autonomous work, Teamwork, Working in an international environment, Working in an interdisciplinary environment, Production of new research ideas	Project design and management Equity and Inclusion Respect for the natural environment Sustainability Demonstration of social, professional and moral responsibility and sensitivity to gender issues Critical thinking Promoting free, creative and inductive reasoning
Practical application of knowledge Search, analysis and synthesis of data and information, ICT Use Adaptation to new situations Decision making Working in an interdisciplinary environment Production of new research ideas	

3. COURSE CONTENT

This course provides a comprehensive introduction to optimization and mathematical programming, covering the formulation of models through the definition of variables, objective functions, parameters, and constraints. Students will explore linear programming in depth, including its theoretical foundations, graphical solution techniques, the Simplex method, duality theory, and sensitivity analysis. The course also examines classical algorithms such as transportation, assignment, and transshipment methods, along with hands-on experience in solving linear programming problems using computer software. Further topics include integer programming and non-linear programming, with attention to classical solution methods for constrained and unconstrained models, including the Karush–Kuhn–Tucker (KKT) conditions and practical applications. The course concludes with multi-objective linear programming, goal programming, and broader decision-making methodologies.

4. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD Face to face, Distance learning, etc.	Face to face
USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) Use of ICT in Teaching, in Laboratory Education, in Communication with students	**USE OF ICT** • Use of ICT in Teaching • Use of ICT in Laboratory Education • Use of ICT in Communication with students • Use of ICT in Evaluation of students **Description** Use of ICT in Course Teaching, Use of ICT in Laboratory Teaching, Use of ICT in Communication with Students Description: Use of Information and Communication Technologies (ICT) in teaching the course with tools of modern distance learning (ZOOM) and asynchronous education (elearning). Use of learning aids based on ICT: Excel, GAMS/Lingo Use of ICT in student assessment: Electronic grading (e-learning,

universis).
Use of ICT in communication with students: e-learning, email, ZOOM.

TEACHING ORGANIZATION
The ways and methods of teaching are described in detail. Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research& analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc.

The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards

Activity	Workload/semester
Lectures	52
BibliographyAnalysis	70
writingProject	35
Examinations	5
Total	**162**

STUDENT EVALUATION
Description of the evaluation process

Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others

Please indicate all relevant information about the course assessment and how students are informed

Description
Written Assignment (Summative), Written Exam with Problem Solving (Summative)

Student Evaluation Languages
English

Student evaluation methods

- WrittenAssignment (Summative)
- ProblemSolving (Summative)

5. SUGGESTED BIBLIOGRAPHY

EUDOXUS

1. Hillier, F. S. and Lieberman, G. J., Introduction to Operations Research, McGraw-Hill, 11th ed., 2021.
2. Taha, H. A., Operations Research: An Introduction, Pearson Education, 11th ed., 2022.

Additional bibliography for study

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DISTRIBUTED ENERGY PRODUCTION

1. GENERAL

FACULTY	Engineering		
SCHOOL	Bachelor of Science in Clean Energy Science and Engineering		
LEVEL OF STUDIES	ISCED level 6 – Bachelor's or equivalent level		
COURSE CODE	CESESS01	SEMESTER	7th Semester
COURSE TITLE	DISTRIBUTED ENERGY PRODUCTION		

TEACHING ACTIVITIES If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.	TEACHING HOURS PER WEEK	ECTS CREDITS
	4	6.0

COURSETYPE Background, General Knowledge, Scientific Area, Skill Development	Specialty / Orientation
PREREQUISITES	**PREREQUISITES** - **General prerequisites** -
TEACHING & EXAMINATION	English
COURSE OFFERED TO ERASMUS STUDENTS	NO
COURSE URL	https://elearning.auth.gr/course/index.php?categoryid=30

2. LEARNING OUTCOMES

Learning Outcomes
Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

By the end of this course, students will be able to:
- Analyze and model distributed energy resources (DERs)—including PV, wind, hydro, and storage—using power flow, time-series, and simulation tools.
- Evaluate the technical impacts of DG on distribution networks, such as voltage regulation, protection coordination, harmonics, and bi-directional power flow.
- Design and size distributed generation and microgrid systems, incorporating appropriate inverter technologies, control schemes, and interconnection requirements.
- Assess economic, regulatory, and policy factors affecting DG deployment, including CAPEX/OPEX, LCOE, incentives, interconnection

standards, and feasibility analysis.
- Develop integrated solutions for microgrid and smart-grid integration, addressing resilience, black-start capability, demand response, and optimal DER placement.

General Skills

Name the desirable general skills upon successful completion of the module

Search, analysis and synthesis of data and information,
ICT Use,Adaptation to new situations,
Decision making,
Autonomous work,
Teamwork,
Working in an international environment,
Working in an interdisciplinary environment, Production of new research ideas

Project design and management
Equity and Inclusion
Respect for the natural environment
Sustainability
Demonstration of social, professional and moral responsibility and sensitivity to gender issues
Critical thinking
Promoting free, creative and inductive reasoning

Practical application of knowledge
Search, analysis and synthesis of data and information, ICT Use
Adaptation to new situations
Decision making
Teamwork
Working in an interdisciplinary environment
Production of new research ideas
Promoting free, creative and inductive reasoning

3. COURSE CONTENT

Introduction (Definition, Centralized vs decentralized energy, Microgrids and prosumer models, DER classification)
Solar Photovoltaic (PV) Systems (PV cell physics, characteristics, temperature effects, Maximum power point tracking, Inverters, Grid integration)
Wind Energy Systems (Turbine types and power curves, induction generators, DFIGs, synchronous generators, PMSGs, Power Converters, Electrical behavior, Grid integration)
Small Hydro & Other Distributed Renewables (Hydro and micro-hydro electrical systems, Turbine-generator selection and control, CHP, biogas generators, electrical interconnection)
Power Electronics for Distributed Energy (Inverter topologies and modulation techniques, Harmonic generation and filtering, Anti-islanding and protection schemes, Grid-forming vs grid-following inverters)
Electrical Interconnection of DG Systems (Diagrams, Topology, Impact on distribution feeders, Voltage regulation and control strategies, Reactive power management, Protection issues)
System Modeling (Load and generation profiles, Time-series modeling of intermittency, Power flow studies, Sizing, DER placement)
Microgrids & Smart Grid Integration (Microgrid architectures, Control hierarchy, Demand response and intelligent loads)
Economics, Policy & Project Development (Cost analysis, Feed-in tariffs, Net metering, Regulatory frameworks, Project sizing, Feasibility studies, Reliability assessment and risk management, Environmental impact)

4. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD Face to face, Distance learning, etc.	Face to face

USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) Use of ICT in Teaching, in Laboratory Education, in Communication with students	**USE OF ICT** • Use of ICT in Teaching • Use of ICT in Laboratory Education • Use of ICT in Communication with students • Use of ICT in Evaluation of students **Description** ICT will support simulation-based learning, using tools like MATLAB, PSSE, Homer, DIgSILENT, or OpenDSS for DG and microgrid analysis. Online learning platforms (LMS) will be used to distribute lecture notes, readings, and multimedia content. Digital communication tools (e.g., forums) will enable continuous interaction between students and instructors. Data acquisition and visualization software will help students analyze load profiles, generation data, and performance metrics.
TEACHING ORGANIZATION The ways and methods of teaching are described in detail. Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research& analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc. The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards	
STUDENT EVALUATION Description of the evaluation process Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others Please indicate all relevant information about the course assessment and how students are informed	**Description** Summative : Written Exam including Theory and Problem Solving, project presentation (possible) **Student Evaluation Languages** English **Student evaluation methods** • ProblemSolving (Summative)

Activity	Workload/semester
Lectures	52
writingProject	54
BibliographyAnalysis	53
Examinations	3
Total	**162**

5. SUGGESTED BIBLIOGRAPHY

EUDOXUS

1. Masters, Gilbert M. Renewable and Efficient Electric Power Systems, 2nd Edition, Wiley, 2013.
2. Ackermann, Thomas (ed.) Wind Power in Power Systems, 2nd Edition, Wiley, 2012.
3. Bollen, Math H. J. & Hassan, Fainan A. Integration of Distributed Generation in the Power System, Wiley-IEEE Press, 2011.
4. Erdinc, Ozan & Uzunoglu, Mehmet. Distributed Generation Systems: Design, Operation and Grid Integration, Academic Press, 2019.

Additional bibliography for study

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ΜΟΝΑΔΑ ΔΙΑΣΦΑΛΙΣΗΣ ΠΟΙΟΤΗΤΑΣ Α.Π.Θ.

HYDROGEN AND FUEL CELLS

1. GENERAL

FACULTY	Engineering		
SCHOOL	Bachelor of Science in Clean Energy Science and Engineering		
LEVEL OF STUDIES	ISCED level 6 – Bachelor's or equivalent level		
COURSE CODE	CESESS02	SEMESTER	7th Semester
COURSE TITLE	HYDROGEN AND FUEL CELLS		

TEACHING ACTIVITIES If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.	TEACHING HOURS PER WEEK	ECTS CREDITS
	4	6.0

COURSETYPE Background, General Knowledge, Scientific Area, Skill Development	Specialty / Orientation
PREREQUISITES	**PREREQUISITES** - **General prerequisites** -
TEACHING & EXAMINATION	English
COURSE OFFERED TO ERASMUS STUDENTS	NO
COURSE URL	https://elearning.auth.gr/course/index.php?categoryid=30

2. LEARNING OUTCOMES

Learning Outcomes
Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

Knowledge
After successfully completing the course, students will be able to:

- Explain the fundamental physical and chemical properties of hydrogen that determine its use as an energy carrier.
- Describe the major hydrogen production pathways, including electrolysis, reforming, thermochemical and biological routes, and compare their efficiencies and environmental impacts.
- Understand hydrogen storage methods and associated safety considerations.
- Explain the operating principles, thermodynamics and performance characteristics of key fuel cell types (PEM, solid oxide, high-temperature proton-conducting).

- Identify the roles of electrode reactions, ion and gas transport, catalysts, and water/heat management in determining fuel cell performance and durability.
- Describe how hydrogen and fuel cells integrate into energy systems for mobility, industrial decarbonization and grid balancing.

Skills

Upon completion, students will be able to:

- Interpret polarization curves, efficiency plots and other diagnostic measurements to evaluate fuel cell behavior.
- Perform basic experimental or simulated assessments of fuel cell performance using impedance-based and electrochemical diagnostic techniques.
- Analyze the influence of operating conditions (temperature, humidity, gas composition, load) on fuel cell output and stability.
- Compare hydrogen production and storage options using quantitative metrics such as efficiency, energy density and cost.

Abilities / Competences

Students will develop the ability to:

- Integrate thermodynamic, electrochemical and transport concepts to evaluate the performance and limitations of hydrogen-based energy systems.
- Assess the viability of different fuel cell technologies for specific clean-energy applications.
- Identify degradation mechanisms and propose scientifically grounded explanations for performance losses.
- Communicate technical analyses of hydrogen and fuel cell systems clearly in written and oral formats.
- Connect foundational knowledge of hydrogen and fuel cells with advanced subjects such as electrolysis, energy systems engineering and clean-energy integration.

General Skills

Name the desirable general skills upon successful completion of the module

Search, analysis and synthesis of data and information,
ICT Use,Adaptation to new situations,
Decision making,
Autonomous work,
Teamwork,
Working in an international environment,
Working in an interdisciplinary environment, Production of new research ideas

Project design and management
Equity and Inclusion
Respect for the natural environment
Sustainability
Demonstration of social, professional and moral responsibility and sensitivity to gender issues
Critical thinking
Promoting free, creative and inductive reasoning

Practical application of knowledge
Search, analysis and synthesis of data and information, ICT Use
Autonomous work
Teamwork
Working in an interdisciplinary environment
Production of new research ideas
Respect for the natural environment

3. COURSE CONTENT

This course provides a comprehensive introduction to hydrogen as an energy carrier and to fuel cell technologies for clean power generation. Students explore the fundamental properties of hydrogen, its production routes (electrolysis, reforming, thermochemical and biological processes), storage methods and safety considerations. The course examines the operating principles, thermodynamics and performance characteristics of key fuel cell types, including PEM, solid oxide and high-temperature proton-conducting systems. Attention is given to electrode reactions, ion and gas transport, water and heat management, catalysts, and degradation mechanisms.

The role of hydrogen and fuel cells in energy systems integration, mobility, industrial decarbonization and grid balancing is analyzed using real-world case studies. Laboratory demonstrations introduce basic diagnostic tools, such as polarization curves, efficiency measurements and impedance-based performance assessment. By the end of the course, students will understand the scientific and engineering foundations that enable hydrogen and fuel cell technologies to contribute to a sustainable energy future.

4. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD Face to face, Distance learning, etc.	Face to face
USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) Use of ICT in Teaching, in Laboratory Education, in Communication with students	**USE OF ICT** • Use of ICT in Teaching • Use of ICT in Laboratory Education • Use of ICT in Communication with students • Use of ICT in Evaluation of students **Description** • Use of ICT in Teaching • Use of ICT in Communication with students Use of ICT – Description • elearning.auth.gr: educational materials available to students along with exercises • Teaching with electronic presentations (slides, video, etc.) • Communication via elearning.auth.gr and emails
TEACHING ORGANIZATION The ways and methods of teaching are described in detail. Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research& analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc. The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards	
STUDENT EVALUATION Description of the evaluation process Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others Please indicate all relevant information about the course assessment and how students are informed	**Description** Written Assignment (Summative), Performance / Staging (Summative), Written Exam with Problem Solving (Summative) **Student Evaluation Languages** English **Student evaluation methods** • ProblemSolving (Summative) • WrittenAssignment (Summative)

Activity	Workload/semester
Lectures	52
writingProject	36
Laboratory	35
BibliographyAnalysis	36
Examinations	3
Total	**162**

5. SUGGESTED BIBLIOGRAPHY

EUDOXUS

1. “Introduction to Hydrogen Technology”, K. S. V. Santhanam, Roman J. Press, Massoud J. Miri, Alla V. Bailey, Gerald A. Takacs, John Wiley & Sons (2017)
2. "Fuel Cell Fundamentals", Ryan O'Hayre, Suk-Won Cha, Whitney Colella and Fritz B. Prinz, John Wiley & Sons (2016)
3. “Fuel Cell Systems Explained", Andrew L. Dicks and David A. J. Rand, Wiley (2018)
4. “Fuel Cell Science and Engineering: Materials, Processes, Systems and Technology”, Detlef Stolten, Bernd Emonts, Wiley-VCH Verlag & Co. (2012)
5. "Fuel Cells: Problems and Solutions”, Vladimir S. Bagotsky John Wiley & Sons (2012)

Additional bibliography for study

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8th Semester

MODELING AND OPTIMIZATION OF ENERGY SYSTEMS

1. GENERAL

FACULTY	Engineering		
SCHOOL	Bachelor of Science in Clean Energy Science and Engineering		
LEVEL OF STUDIES	ISCED level 6 – Bachelor's or equivalent level		
COURSE CODE	CESE04EL	SEMESTER	8th Semester
COURSE TITLE	MODELING AND OPTIMIZATION OF ENERGY SYSTEMS		

TEACHING ACTIVITIES If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.	TEACHING HOURS PER WEEK	ECTS CREDITS
	4	6.0

COURSETYPE Background, General Knowledge, Scientific Area, Skill Development	Specialty / Orientation
PREREQUISITES	**PREREQUISITES** - **General prerequisites** -
TEACHING & EXAMINATION	English
COURSE OFFERED TO ERASMUS STUDENTS	NO
COURSE URL	https://elearning.auth.gr/course/index.php?categoryid=30

2. LEARNING OUTCOMES

Learning Outcomes
Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

- Describe mathematically and model a multi energy system using suitable constraints and variables
- Formulate optimization problems
- Use mathematical modelling and optimization tools to analyze and improve energy systems, both at the operation and overall system levels
- Propose potential optimal solutions to energy systems engineering problems

- Formulate an energy supply chain problem
- Design and Optimize a Heat Exchange Network for Energy savings in the industry
- Formulate and solve a long-term energy planning problem
- Understand the Fundamentals of modern energy markets
- Analyze and assess the economic and other benefits of optimizing energy systems and processes

General Skills

Name the desirable general skills upon successful completion of the module

Search, analysis and synthesis of data and information,
ICT Use,Adaptation to new situations,
Decision making,
Autonomous work,
Teamwork,
Working in an international environment,
Working in an interdisciplinary environment, Production of new research ideas

Project design and management
Equity and Inclusion
Respect for the natural environment
Sustainability
Demonstration of social, professional and moral responsibility and sensitivity to gender issues
Critical thinking
Promoting free, creative and inductive reasoning

Practical application of knowledge
Search, analysis and synthesis of data and information, ICT Use
Adaptation to new situations
Decision making
Working in an interdisciplinary environment
Production of new research ideas
Respect for the natural environment

3. COURSE CONTENT

The course introduces students to state-of-the-art topics for the modeling and optimization of energy systems, including modelling of hybrid feedstock energy systems, energy supply chain networks, polygeneration systems, combined heat and power systems, energy markets and energy planning.

In the first half of the semester computer-aided techniques for Energy Systems Modeling and Optimization will be introduced including: energy and material balances, introduction of variables for technology description and energy flows, definition of operating and design constraints. Modeling with 0-1 variables for technology selection in energy-related plants and flowsheets. Definition of objectives functions such as economic or environmental-related. Efficient Modeling of complex logic-based decisions and constraints. Illustrative examples considering multi-energy systems.
In the second half Multi-echelon energy and production supply chains will be described and quantified. Moreover, modeling and Optimization of long-term energy planning will be studied including introduction of energy generation technologies constraints, energy demands, availability of energy resources, modeling of environmental and energy policies. Development of an integrated Mixed-Integer Linear Programming Model (MILP). Finally, Fundamentals of energy markets modeling and Optimization will be described.

Applications/projects and laboratory training:

- Introduction to the GAMS modeling and optimization tool.
- Synthesis and Optimization of Heat Exchange Networks
- Modeling and Optimization of a Long-term planning problem (project in teams of 2-3 students)

4. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD Face to face, Distance learning, etc.	Face to face
USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) Use of ICT in Teaching, in Laboratory Education, in Communication with students	**USE OF ICT** • Use of ICT in Teaching • Use of ICT in Laboratory Education • Use of ICT in Communication with students • Use of ICT in Evaluation of students **Description** • Use of Information and Communication Technologies (ICT) in teaching the course with tools of modern distance learning (ZOOM) and asynchronous education (e-learning). • Use of learning aids based on ICT: GAMS modeling and optimization tool • Use of ICT in student assessment: Electronic grading (e-learning, universis). • Use of ICT in communication with students: e-learning, email, ZOOM.
TEACHING ORGANIZATION The ways and methods of teaching are described in detail. Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research& analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc. The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards	
STUDENT EVALUATION Description of the evaluation process Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others Please indicate all relevant information about the course assessment and how students are informed	**Description** Assessment Methods: Summative • Written Exam with Extended Answer Questions • Written assignments **Student Evaluation Languages** English **Student evaluation methods** • WrittenAssignment (Summative) • ProblemSolving (Summative)

Activity	Workload/semester
Lectures	52
writingProject	36
Laboratory	36
BibliographyAnalysis	35
Examinations	3
Total	**162**

5. SUGGESTED BIBLIOGRAPHY

EUDOXUS

1. M.C. Georgiadis, E.S. Kikkinides, E.N. Pistikopoulos. Energy Systems Engineering. • Publisher : Wiley-VCH, ISBN-10 : 9783527316946
2. C.A. Floudas. Nonlinear and Mixed-Integer Optimization: Fundamentals and Applications (Topics in Chemical Engineering) 1st Edition, Kindle Edition, Oxford University Press, ISBN-13 : 978-0195356557

Additional bibliography for study

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ΜΟΝΑΔΑ ΔΙΑΣΦΑΛΙΣΗΣ ΠΟΙΟΤΗΤΑΣ Α.Π.Θ.

BATTERY MANAGEMENT IN ELECTRIC VEHICLES

1. GENERAL

FACULTY	Engineering		
SCHOOL	Bachelor of Science in Clean Energy Science and Engineering		
LEVEL OF STUDIES	ISCED level 6 – Bachelor's or equivalent level		
COURSE CODE	CESE05EL	SEMESTER	8th Semester
COURSE TITLE	BATTERY MANAGEMENT IN ELECTRIC VEHICLES		

TEACHING ACTIVITIES If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.	TEACHING HOURS PER WEEK	ECTS CREDITS
	4	6.0

COURSETYPE Background, General Knowledge, Scientific Area, Skill Development	Specialty / Orientation
PREREQUISITES	**PREREQUISITES** - **General prerequisites** -
TEACHING & EXAMINATION	English
COURSE OFFERED TO ERASMUS STUDENTS	NO
COURSE URL	https://elearning.auth.gr/course/index.php?categoryid=30

2. LEARNING OUTCOMES

Learning Outcomes
Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

By the end of this course, students will be able to:

- Understand the architecture and drivetrain configurations of Electric Vehicles (BEV, HEV, PHEV).
- Analyze the electrical characteristics of Lithium-Ion cells and packs under dynamic load conditions.
- Design and simulate Battery Management System (BMS) architectures, including cell balancing, voltage monitoring, and protection circuits.
- Implement algorithms for estimating State of Charge (SOC), State of Health (SOH), and State of Power (SOP).
- Understand charging standards and the interaction between EVs and the Smart Grid (Vehicle-to-Grid/V2G concepts).

General Skills Name the desirable general skills upon successful completion of the module	
Search, analysis and synthesis of data and information, ICT Use,Adaptation to new situations, Decision making, Autonomous work, Teamwork, Working in an international environment, Working in an interdisciplinary environment, Production of new research ideas	Project design and management Equity and Inclusion Respect for the natural environment Sustainability Demonstration of social, professional and moral responsibility and sensitivity to gender issues Critical thinking Promoting free, creative and inductive reasoning
Practical application of knowledge Search, analysis and synthesis of data and information, ICT Use Adaptation to new situations Working in an interdisciplinary environment Production of new research ideas Project design and management Respect for the natural environment	

3. COURSE CONTENT

The course begins with a comprehensive overview of Electric Vehicle subsystems and powertrain configurations. Specific requirements for traction batteries compared to stationary storage, delving into the modeling of Lithium-Ion cells. Detailed study of equivalent circuit models used to predict battery behavior under the intense, dynamic current profiles typical of automotive drive cycles.

Hardware and software design of Battery Management Systems (BMS), Critical safety functions of a BMS (over-current/over-voltage, over-temperature protection, etc.). Topology design for cell monitoring and the various passive and active cell balancing techniques required to maximize the usable capacity and lifespan of a battery pack.

Algorithmic controls. Applying techniques (Coulomb Counting and Extended Kalman Filters), Estimation of the State of Charge and State of Health in real-time. Thermal management of battery packs (air, liquid, and phase-change cooling systems essential for maintaining optimal operating temperatures).

Application in EVs (on-board/off-board charging topologies, communication protocols, etc.). Emerging role of EVs in grid stability through Vehicle-to-Grid (V2G) technologies. Second-life battery applications and recycling challenges, trying back to the clean energy circular economy.

4. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD Face to face, Distance learning, etc.	Face to face
USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) Use of ICT in Teaching, in Laboratory Education, in Communication with students	USE OF ICT • Use of ICT in Teaching • Use of ICT in Laboratory Education • Use of ICT in Communication with students • Use of ICT in Evaluation of students

	Description Use of Information and Communication Technologies (ICT) in teaching the course with tools of modern distance learning (ZOOM) and asynchronous education (e-learning). Use of learning aids based on ICT: MATLAB/Simulink, LTSpice. Use of ICT in student assessment: Electronic grading (e-learning, universis). Use of ICT in communication with students: e-learning, email, ZOOM.
TEACHING ORGANIZATION The ways and methods of teaching are described in detail. Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research& analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc. The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards	<table><tr><th>Activity</th><th>Workload/semester</th></tr><tr><td>Lectures</td><td>52</td></tr><tr><td>writingProject</td><td>54</td></tr><tr><td>BibliographyAnalysis</td><td>53</td></tr><tr><td>Examinations</td><td>3</td></tr><tr><td>Total</td><td>162</td></tr></table>
STUDENT EVALUATION Description of the evaluation process Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others Please indicate all relevant information about the course assessment and how students are informed	**Description** Written Exam with Problem Solving (Summative). Semester project. Laboratory reports. **Student Evaluation Languages** English **Student evaluation methods** • WrittenAssignment (Summative) • ProblemSolving (Summative)

5. SUGGESTED BIBLIOGRAPHY

EUDOXUS

1. Plett, G. L. (2015). Battery Management Systems, Volume I: Battery Modeling and Volume II: Equivalent-Circuit Methods. Artech House.
2. Bergveld, H. J., Kruijt, W. S., & Notten, P. H. L. (2002). Battery Management Systems: Design by Modelling. Philips Research.
3. Husain, I. (2021). Electric and Hybrid Vehicles: Design Fundamentals. CRC Press.

Additional bibliography for study

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ENERGY FROM THE CHEMICAL RECYCLING OF WASTE PLASTICS

1. GENERAL

FACULTY	Engineering		
SCHOOL	Bachelor of Science in Clean Energy Science and Engineering		
LEVEL OF STUDIES	ISCED level 6 – Bachelor's or equivalent level		
COURSE CODE	CESE06EL	SEMESTER	8th Semester
COURSE TITLE	ENERGY FROM THE CHEMICAL RECYCLING OF WASTE PLASTICS		

TEACHING ACTIVITIES If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.	TEACHING HOURS PER WEEK	ECTS CREDITS
	4	6.0

COURSETYPE Background, General Knowledge, Scientific Area, Skill Development	Specialty / Orientation
PREREQUISITES	**PREREQUISITES** - **General prerequisites** -
TEACHING & EXAMINATION	English
COURSE OFFERED TO ERASMUS STUDENTS	NO
COURSE URL	https://elearning.auth.gr/course/index.php?categoryid=30

2. LEARNING OUTCOMES

Learning Outcomes
Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

Knowledge
After successfully completing the course, students will be able to:

- Describe the types, composition, and physico-chemical properties of major polymer classes used in consumer and industrial plastics.
- Explain the scientific principles behind (thermo)chemical recycling processes, including pyrolysis, gasification, depolymerization and solvolysis.
- Identify energy products derived from waste plastics (biofuels, syngas, hydrogen, monomers) and evaluate their properties.
- Understand the process of incineration of waste plastics for the production of energy and their limitations

- Describe main processes for the removal of hazardous compounds in plastics before their valorization for energy recovery

Skills

Upon completion, students will be able to:

- Perform mass and energy balances for thermochemical conversion systems.
- Evaluate process conditions (temperature, catalysts, residence time, reactor type) that affect conversion efficiency and product distribution.
- Analyze and interpret experimental data from chemical recycling or thermochemical kinetics.

General Skills

Name the desirable general skills upon successful completion of the module

Search, analysis and synthesis of data and information,
ICT Use,Adaptation to new situations,
Decision making,
Autonomous work,
Teamwork,
Working in an international environment,
Working in an interdisciplinary environment, Production of new research ideas

Project design and management
Equity and Inclusion
Respect for the natural environment
Sustainability
Demonstration of social, professional and moral responsibility and sensitivity to gender issues
Critical thinking
Promoting free, creative and inductive reasoning

Practical application of knowledge
Search, analysis and synthesis of data and information, ICT Use
Adaptation to new situations
Decision making
Autonomous work
Teamwork
Working in an interdisciplinary environment
Production of new research ideas
Project design and management
Respect for the natural environment
Promoting free, creative and inductive reasoning

3. COURSE CONTENT

This course examines the principles and technologies of polymer waste recycling, with a focus on energy recovery and/or the production of bio-fuels through circular economy strategies.

1. Fundamentals of Polymers, Plastics and Waste Streams
   - Global plastic production, use, and waste statistics
   - Introduction to the science and technology of polymers
   - Main reaction mechanisms for the production of polymers
2. Properties of polymers
   - Physical and chemical properties of polymers focusing on the commodity polymers LDPE, HDPE, PP, PET, PVC, PS.
   - Classification of polymers into plastics, elastomers, fibers.
3. Polymer recycling methods
   - Waste plastics sorting
   - Classification of recycling approaches: mechanical vs. chemical
   - Detailed description of each method focusing on the production of valuable products and/or energy
4. Thermo-Chemical Recycling Technologies

- Pyrolysis: Thermal vs. catalytic. Oil yield, wax production, and gas fractions. Optimization of the oil composition for the production of bio-fuels. Pyrolysis of polyolefins
- Gasification: Production of syngas, hydrogen-rich streams, tar reduction

5. Catalysis & Product Upgrading
- Heterogeneous catalysts (zeolites, metal oxides, alumina)
- Reaction pathways for aromatics and olefin production
- Fuel quality upgrading, Synthetic crude oil and diesel substitutes

6. Kinetics and Thermodynamics of polymer degradation
- Kinetics and mechanisms of polymer degradation
- Models for the simulation of the thermal cracking of plastics
- Basic reactor design: batch, fluidized bed, tubular,

7. Limitations in plastics recycling
- Hazardous substances in plastic waste,
- Heteroatoms in the polymer chains
- Existence of other-than-polymer substances

8. Direct energy production from waste plastics
- Incineration of mixed waste plastics for the production of energy

9. Environmental & Life-Cycle Analysis
- Greenhouse gas emissions vs. landfilling & incineration
- Microplastics, toxic elements (e.g., PVC chlorine content), and emissions control
- feedstock purity requirements
- Legislative and regulatory challenges

10. Future Directions & Innovation
- Artificial intelligence for waste sorting and process optimization
- Plastic-to-monomer technologies and chemical upcycling
- Industrial scale case studies and emerging startups

Laboratory demonstrations
- Polymer identification using FTIR spectroscopy and DSC calorimetry
- Thermal decomposition analysis using TGA
- Demonstration of Bench-scale pyrolysis of plastics combined with GC-MS analysis of the products

Mini Project Options
- Techno-economic evaluation of a plastic-to-fuel plant

4. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD Face to face, Distance learning, etc.	Face to face
USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) Use of ICT in Teaching, in Laboratory Education, in Communication with students	**USE OF ICT** • Use of ICT in Teaching • Use of ICT in Laboratory Education • Use of ICT in Communication with students • Use of ICT in Evaluation of students **Description** • elearning.auth.gr: educational materials available to students along with exercises • Teaching with electronic presentations (slides, video, etc.) • Communication via elearning.auth.gr and emails

TEACHING ORGANIZATION	
The ways and methods of teaching are described in detail. Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research& analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc. The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards	<table><tr><th>Activity</th><th>Workload/semester</th></tr><tr><td>Lectures</td><td>52</td></tr><tr><td>writingProject</td><td>43</td></tr><tr><td>Laboratory</td><td>12</td></tr><tr><td>BibliographyAnalysis</td><td>52</td></tr><tr><td>Examinations</td><td>3</td></tr><tr><td>Total</td><td>162</td></tr></table>
STUDENT EVALUATION Description of the evaluation process Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others Please indicate all relevant information about the course assessment and how students are informed	**Description** Written Assignment (Summative), Written Exam with Problem Solving (Summative) **Student Evaluation Languages** English **Student evaluation methods** • WrittenAssignment (Summative) • ProblemSolving (Summative)

5. SUGGESTED BIBLIOGRAPHY

EUDOXUS

1. Feedstock Recycling and Pyrolysis of Waste Plastics: Converting Waste Plastics into Diesel and Other Fuels. J. Scheirs, W. Kaminsky (Eds.) J. Wiley & Sons 2006
2. Plastics to Energy: Fuel, Chemicals, and Sustainability Implications. Sultan Al-Salem, Elsevier (2018)

Additional bibliography for study

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Capstone Project

1. GENERAL

FACULTY	Engineering		
SCHOOL	Bachelor of Science in Clean Energy Science and Engineering		
LEVEL OF STUDIES	ISCED level 6 – Bachelor's or equivalent level		
COURSE CODE	CESE29	SEMESTER	8th Semester
COURSE TITLE	Capstone Project		

TEACHING ACTIVITIES If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.	TEACHING HOURS PER WEEK	ECTS CREDITS
	-	18.0

COURSETYPE Background, General Knowledge, Scientific Area, Skill Development	Deepening / Consolidation
PREREQUISITES	**PREREQUISITES** - **General prerequisites** The right to start the preparation of the Bachelor's Thesis (Capstone Project) belongs to the student who is in the 8th semester of studies, owes a total of up to four (4) courses to obtain the Degree and has successfully completed and been examined in the Senior Project.
TEACHING & EXAMINATION	English
COURSE OFFERED TO ERASMUS STUDENTS	NO
COURSE URL	cese.auth.gr

2. LEARNING OUTCOMES

Learning Outcomes
Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

Students cultivate the ability to manage complex tasks, interpret and document results, and present their findings with professional quality, both in writing and orally, Throughout the semester. The development of the Thesis fosters a high level of autonomy, responsibility, and interdisciplinary synthesis, reflecting the expectations of industry, research institutions, and postgraduate studies. Its completion certifies that graduates are ready to contribute substantially to the clean energy sector as technical staff, analysts, or researchers

General Skills Name the desirable general skills upon successful completion of the module	
Search, analysis and synthesis of data and information, ICT Use,Adaptation to new situations, Decision making, Autonomous work, Teamwork, Working in an international environment, Working in an interdisciplinary environment, Production of new research ideas	Project design and management Equity and Inclusion Respect for the natural environment Sustainability Demonstration of social, professional and moral responsibility and sensitivity to gender issues Critical thinking Promoting free, creative and inductive reasoning
Practical application of knowledge Search, analysis and synthesis of data and information, ICT Use Decision making Autonomous work Project design and management Critical thinking Promoting free, creative and inductive reasoning	

3. COURSE CONTENT

The Bachelor's Thesis is the most complete academic experience of the Curriculum of Studies and a prerequisite for the award of the Degree. In this advanced semester, students undertake an extensive technical, research or innovative challenge that requires the comprehensive utilization of technical knowledge, analytical skills and creative problem-solving. The subject of the thesis may include experimental investigation, field research, systems design, techno-economic evaluation, computational modeling or the development of new solutions in the field of clean energy. Students are expected to produce original work that demonstrates methodological clarity, technical depth, and the ability to translate scientific knowledge into practical results.

4. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD Face to face, Distance learning, etc.	Face to face
USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) Use of ICT in Teaching, in Laboratory Education, in Communication with students	**USE OF ICT** • Use of ICT in Teaching • Use of ICT in Laboratory Education • Use of ICT in Communication with students **Description** Communication by emails and use of the elearning platform to support the preparation of the project and guidance in the required bibliography.

TEACHING ORGANIZATION
The ways and methods of teaching are described in detail. Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research& analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc.

The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards

Activity	Workload/semester
Laboratory	40
FieldExercise	40
BibliographyAnalysis	80
Tutoring	13
StudyCreation	182
writingProject	130
Examinations	1
Total	**486**

STUDENT EVALUATION
Description of the evaluation process

Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others

Please indicate all relevant information about the course assessment and how students are informed

Description
The student is constantly evaluated in weekly meetings with the supervisor, depending on the degree of understanding of the subject, the quality of the progress of the work, the degree of initiative and the scientific accuracy in the analysis of the topics assigned to him/her. At the end of the semester, an oral examination is conducted for the final grading through the question-and-answer process and taking into account the quality of the oral presentation by the student.

Student Evaluation Languages
English

Student evaluation methods

- ContinuousEvaluation (Formative)
- OralExam (Summative)

5. SUGGESTED BIBLIOGRAPHY

EUDOXUS

The bibliography is developed on the initiative of the student in collaboration with the teacher.

Additional bibliography for study

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ΜΟΝΑΔΑ ΔΙΑΣΦΑΛΙΣΗΣ ΠΟΙΟΤΗΤΑΣ Α.Π.Θ.

APPLICATIONS IN AGRICULTURE

1. GENERAL

FACULTY	Engineering		
SCHOOL	Bachelor of Science in Clean Energy Science and Engineering		
LEVEL OF STUDIES	ISCED level 6 – Bachelor's or equivalent level		
COURSE CODE	CESECEA03	SEMESTER	8th Semester
COURSE TITLE	APPLICATIONS IN AGRICULTURE		

TEACHING ACTIVITIES If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.	TEACHING HOURS PER WEEK	ECTS CREDITS
	4	6.0

COURSETYPE Background, General Knowledge, Scientific Area, Skill Development	Specialty / Orientation
PREREQUISITES	**PREREQUISITES** - **General prerequisites** -
TEACHING & EXAMINATION	English
COURSE OFFERED TO ERASMUS STUDENTS	NO
COURSE URL	https://elearning.auth.gr/course/index.php?categoryid=30

2. LEARNING OUTCOMES

Learning Outcomes
Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

By the end of this course, students will be able to:

- Explain the principles of major clean-energy technologies relevant to agriculture (solar, geothermal, biomass, biogas).
- Design and assess passive solar-energy solutions for heating, drying, and productivity enhancement on farms.
- Analyse geothermal energy options including heat-pump and non-heat-pump systems for agricultural buildings, greenhouses, and drying facilities.
- Describe and optimize biomass pelleting processes for converting agricultural residues into efficient, clean-burning fuels.
- Design and improve agricultural biogas systems for the effective valorisation of farm and agro-industrial organic wastes.
- Integrate multiple clean-energy technologies into resilient, cost-effective, and sustainable agricultural energy systems.

General Skills

Name the desirable general skills upon successful completion of the module

Search, analysis and synthesis of data and information,
ICT Use,Adaptation to new situations,
Decision making,
Autonomous work,
Teamwork,
Working in an international environment,
Working in an interdisciplinary environment, Production of new research ideas
Project design and management
Equity and Inclusion
Respect for the natural environment
Sustainability
Demonstration of social, professional and moral responsibility and sensitivity to gender issues
Critical thinking
Promoting free, creative and inductive reasoning

Practical application of knowledge
Search, analysis and synthesis of data and information, ICT Use
Adaptation to new situations
Decision making
Teamwork
Working in an interdisciplinary environment
Production of new research ideas
Critical thinking

3. COURSE CONTENT

1. Fundamentals of solar energy in agricultural systems (solar radiation and energy capture principles, insolation and thermal-mass utilization, optimal orientation strategies, contribution of solar technologies to sustainable agricultural operations).
2. Passive solar heating and cooling strategies (greenhouse architectural design, passive solar barns, solar chimney applications, natural ventilation enhancement, heat storage materials, low-cost passive performance improvements).
3. Solar thermal systems for water and air heating (flat plate and evacuated-tube collectors, solar water-heating systems for livestock facilities, solar air heaters for efficient crop drying and postharvest operations).
4. Solar powered agricultural technologies (solar pumping systems, photovoltaic irrigation, electric fencing, remote sensing and monitoring devices, precision-agriculture integrations, robust off-grid energy solutions).
5. Introduction to geothermal systems and energy principles (classification of geothermal resources, soil thermal properties, and agricultural suitability of low, medium, and high enthalpy geothermal fields).
6. Shallow geothermal energy (geoexchange systems and ground-source heat pumps, horizontal and vertical loop configurations, seasonal thermal-energy storage, applications in agricultural building climate control).
7. Geothermal applications without heat pumps (direct use geothermal heating for greenhouses, aquaculture systems, agricultural processing, practical approaches to thermal water utilization).
8. Geothermal assisted crop drying and greenhouse climate control (design principles for geothermal crop-drying systems, greenhouse heating and cooling integration, performance evaluation, efficiency metrics, cost-benefit considerations).
9. Agricultural biomass resources and energy potential (agricultural residues, animal manure, and organic-waste streams, resource characterization, sustainability indicators for biomass-based energy production).
10. Biomass pretreatment and size reduction for pelleting (moisture optimization, grinding and milling technologies, particle size refinement, material conditioning approaches for producing high-quality biomass pellets).
11. Biomass pelleting processes (pellet-mill operation fundamentals, die and roller mechanics, lignin plasticization and mechanical compression, pellet cooling and screening, quality-standard requirements, pellet combustion performance and thermal efficiency).
12. Anaerobic digester design (design characteristics of CSTR, plug-flow, and fixed-dome digesters, feedstock selection, critical operating parameters, hydraulic-retention-time design, temperature control strategies).

13. Design improvements and best practices for biogas systems (process-stability enhancement, pretreatment of agricultural wastes, digestate valorisation pathways, biogas upgrading techniques, safety considerations, integration of biogas into diversified farm energy systems).

4. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD Face to face, Distance learning, etc.	Face to face
USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) Use of ICT in Teaching, in Laboratory Education, in Communication with students	**USE OF ICT** • Use of ICT in Teaching • Use of ICT in Laboratory Education • Use of ICT in Communication with students • Use of ICT in Evaluation of students **Description** • Use of ICT in Course Teaching • Use of ICT in Laboratory Teaching • Use of ICT in Communication with Students • Use of ICT in student assessment: Electronic grading (e-learning, universis). • Use of ICT in communication with students: e-learning, email, ZOOM.
TEACHING ORGANIZATION The ways and methods of teaching are described in detail. Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research& analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc. The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards	
STUDENT EVALUATION Description of the evaluation process Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others Please indicate all relevant information about the course assessment and how students are informed	**Description** • Final written exam – 70% • Participation and assignments – 30% methods: • Assignments (Formative) • Written Exam with Multiple Choice Questions (Concluding) • Written Exam with Short Answer Questions (Concluding) **Student Evaluation Languages** English **Student evaluation methods** • WrittenAssignment (Summative) • ProblemSolving (Summative)

Activity	Workload/semester
Lectures	52
Laboratory	36
writingProject	36
BibliographyAnalysis	35
Examinations	3
Total	**162**

5. SUGGESTED BIBLIOGRAPHY

EUDOXUS

- Jochen Bundschuh, Guangnan Chen, D. Chandrasekharam, Janusz Piechocki (2017). Geothermal, Wind and Solar Energy Applications in Agriculture and Aquaculture. CRC Press. ISBN 9780367573317, https://doi.org/10.1201/9781315158969
- Sultan, Muhammad, Muhammad Hamid Mahmood, Md Shamim Ahamed, Redmond R. Shamshiri, and Muhammad Wakil Shahzad. "Energy systems and applications in agriculture." Energies 15, no. 23 (2022): 9132. ISBN 978-3-0365-5008-4, https://doi.org/10.3390/books978-3-0365-5007-7
- Martín, Mariano (2021). Sustainable Design for Renewable Processes: Principles and Case Studies. Elsevier. ISBN 9780128243244, https://doi.org/10.1016/C2020-0-01111-4
- Van Nguyen, M., Arason, S., Gissurarson M. and Pálsson, P.G. (2015). Uses of geothermal energy in food and agriculture - Opportunities for developing countries. Rome, FAO. ISBN 978-92-5-108656-8.
- Santra, Priyabatra, Ranjay Kumar Singh, Surendra Poonia, Dilip Jain (2019). Solar energy in agriculture: principles and applications. New India Publishing Agency. ISBN 9780367726591.

Additional bibliography for study

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ENERGY FINANCE

1. GENERAL

FACULTY	Engineering		
SCHOOL	Bachelor of Science in Clean Energy Science and Engineering		
LEVEL OF STUDIES	ISCED level 6 – Bachelor's or equivalent level		
COURSE CODE	CESEPD03	SEMESTER	8th Semester
COURSE TITLE	ENERGY FINANCE		

TEACHING ACTIVITIES If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.	TEACHING HOURS PER WEEK	ECTS CREDITS
	4	6.0

COURSETYPE Background, General Knowledge, Scientific Area, Skill Development	Specialty / Orientation
PREREQUISITES	**PREREQUISITES** - **General prerequisites** -
TEACHING & EXAMINATION	English
COURSE OFFERED TO ERASMUS STUDENTS	NO
COURSE URL	https://elearning.auth.gr/course/index.php?categoryid=30

2. LEARNING OUTCOMES

Learning Outcomes
Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

By the end of this course, students will be able to:

- Understand energy markets – Explain the structure and functioning of global energy markets, including oil, gas, electricity, and renewable energy sectors.
- Apply financial principles to energy projects – Use core finance concepts such as time value of money, risk–return trade-offs, and capital budgeting in the context of energy investments.
- Evaluate energy project economics – Analyze the costs, revenues, and profitability of energy projects using tools such as NPV, IRR, payback period, and sensitivity analysis.
- Assess risk and uncertainty – Identify and quantify market, operational, regulatory, and environmental risks affecting energy

investments, and evaluate risk mitigation strategies.
- Analyze energy pricing and hedging – Understand energy price formation, volatility, and the use of derivatives and hedging instruments in energy markets.
- Compare conventional and renewable energy finance – Distinguish between financing structures for fossil fuel–based and renewable energy projects, including project finance and public–private partnerships.
- Communicate financial analyses effectively – Present energy finance analyses clearly and professionally through written reports and oral presentations.

General Skills

Name the desirable general skills upon successful completion of the module

Search, analysis and synthesis of data and information,
ICT Use,Adaptation to new situations,
Decision making,
Autonomous work,
Teamwork,
Working in an international environment,
Working in an interdisciplinary environment, Production of new research ideas

Project design and management
Equity and Inclusion
Respect for the natural environment
Sustainability
Demonstration of social, professional and moral responsibility and sensitivity to gender issues
Critical thinking
Promoting free, creative and inductive reasoning

Practical application of knowledge
Search, analysis and synthesis of data and information, ICT Use
Adaptation to new situations
Decision making
Teamwork
Working in an interdisciplinary environment
Production of new research ideas

3. COURSE CONTENT

By accomplishing this course, students will be able to understand how financial principles operate within the energy sector and how energy commodities are produced, traded, priced, and financed across global and regional markets. The course introduces the functioning of the Energy Exchange, including spot and futures markets, trading mechanisms, and the role of market participants such as producers, utilities, traders, and financial institutions. Students will gain insight into energy trading strategies, price discovery, volatility, and the use of financial instruments to manage risk. The content also explores investment decision-making in conventional and renewable energy projects, the impact of regulation and energy policy on financial performance, and the growing importance of sustainability and carbon markets. Emphasis is placed on linking market dynamics with financial analysis to support informed decisions in energy investment, trading, and risk management.

4. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD Face to face, Distance learning, etc.	Face to face
USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) Use of ICT in Teaching, in Laboratory Education, in Communication with students	**USE OF ICT** • Use of ICT in Teaching • Use of ICT in Laboratory Education • Use of ICT in Communication with students • Use of ICT in Evaluation of students

	Description Use of ICT in Course Teaching, Use of ICT in Communication with Students Description: Use of Information and Communication Technologies (ICT) in teaching the course with tools of modern distance learning (ZOOM) and asynchronous education (e-learning). Use of learning aids based on ICT: Excel Use of ICT in student assessment: Electronic grading (e-learning, universis). Use of ICT in communication with students: e-learning, email, ZOOM.
TEACHING ORGANIZATION The ways and methods of teaching are described in detail. Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research& analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc. The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards	<table><tr><th>Activity</th><th>Workload/semester</th></tr><tr><td>Lectures</td><td>52</td></tr><tr><td>Laboratory</td><td>36</td></tr><tr><td>writingProject</td><td>36</td></tr><tr><td>BibliographyAnalysis</td><td>35</td></tr><tr><td>Examinations</td><td>3</td></tr><tr><td>Total</td><td>162</td></tr></table>
STUDENT EVALUATION Description of the evaluation process Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others Please indicate all relevant information about the course assessment and how students are informed	**Description** Final score is determined as 30% semester project, 70% final exam. Written Assignment (Summative), Performance / Staging (Summative), Written Exam with Problem Solving (Summative) **Student Evaluation Languages** English **Student evaluation methods** • WrittenAssignment (Summative) • ProblemSolving (Summative)

5. SUGGESTED BIBLIOGRAPHY

EUDOXUS

1. Simkins, B.J., & Simkins, R. (Eds.). (2013). Energy finance and economics: Analysis and valuation, risk management, and the future of energy. John Wiley & Sons. ISBN978 1 118 01712 8.
2. Bhattacharyya, S.C. (2019). Energy economics: Concepts, issues, markets and governance (2nd ed.). Springer Nature. ISBN978 1 4471 468
3. Raikar, S., & Adamson, S. (2024). Renewable energy finance: Theory and practice (2nd ed.). Academic Press. ISBN978 0 443 15955 8.
4. Papavasiliou, A. (2024). Optimization models in electricity markets. Cambridge University Press. ISBN978 1 009 41661 0.

Additional bibliography for study

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SMART GRIDS

1. GENERAL

FACULTY	Engineering		
SCHOOL	Bachelor of Science in Clean Energy Science and Engineering		
LEVEL OF STUDIES	ISCED level 6 – Bachelor's or equivalent level		
COURSE CODE	CESESS03	SEMESTER	8th Semester
COURSE TITLE	SMART GRIDS		

TEACHING ACTIVITIES If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.	TEACHING HOURS PER WEEK	ECTS CREDITS
	4	6.0

COURSETYPE Background, General Knowledge, Scientific Area, Skill Development	Specialty / Orientation
PREREQUISITES	**PREREQUISITES** - **General prerequisites** -
TEACHING & EXAMINATION	English
COURSE OFFERED TO ERASMUS STUDENTS	NO
COURSE URL	https://elearning.auth.gr/course/index.php?categoryid=30

2. LEARNING OUTCOMES

Learning Outcomes
Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

- Introduction to smart grid
- Knowledge on the operation of smart grid technologies, advanced metering infrastructure, power quality management and smart grid applications

General Skills Name the desirable general skills upon successful completion of the module	
Search, analysis and synthesis of data and information, ICT Use,Adaptation to new situations, Decision making, Autonomous work, Teamwork, Working in an international environment, Working in an interdisciplinary environment, Production of new research ideas	Project design and management Equity and Inclusion Respect for the natural environment Sustainability Demonstration of social, professional and moral responsibility and sensitivity to gender issues Critical thinking Promoting free, creative and inductive reasoning
Practical application of knowledge Search, analysis and synthesis of data and information, ICT Use Decision making Autonomous work Teamwork Promoting free, creative and inductive reasoning	

3. COURSE CONTENT

Introduction. The course begins with the introduction to smart grid, concept, smart grid drivers, evolution of electric grid, definitions and equipment needs, functions and opportunities, challenges and benefits, Difference between conventional and smart grid.

Analysis of smart grid technologies, i.e. Smart energy resources, Feeder automation, Substations and Automation, Transmission systems (EMS, FACTS, HVDC), Monitoring, Protection and control, Energy management, Distribution systems (Volt/Var management, isolation, fault detection, service restoration), Auxiliary services, Distribution transformers, Phase shifting transformers, Electric vehicles (plugin and hybrid).

Smart meters and advanced metering infrastructure. Introduction to smart meters, protocols, Standard and initiatives, Advanced metering infrastructure, Power quality management and EMC in Smart Grids, Grid connected renewable energy sources, Power quality conditioners and monitoring, Power quality audit.

Computing for smart grid applications. Local area network, House area network, IP protocols, Cloud computing and cyber security for smart grids, Broadband over Power Lines (BPL), Energy management and specific applications.

4. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD Face to face, Distance learning, etc.	Face to face
USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) Use of ICT in Teaching, in Laboratory Education, in Communication with students	**USE OF ICT** • Use of ICT in Teaching • Use of ICT in Laboratory Education • Use of ICT in Communication with students • Use of ICT in Evaluation of students **Description** Use of Information and Communication Technologies (ICT) in teaching

	the course with tools of modern distance learning (ZOOM) and asynchronous education (e-learning). Use of learning aids based on ICT: Matlab/SIMULINK, NEPLAN Use of ICT in student assessment: Electronic grading (e-learning, universis). Use of ICT in communication with students: e-learning, email, ZOOM.
TEACHING ORGANIZATION The ways and methods of teaching are described in detail. Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research& analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc. The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards	<table><tr><th>Activity</th><th>Workload/semester</th></tr><tr><td>Lectures</td><td>52</td></tr><tr><td>writingProject</td><td>54</td></tr><tr><td>BibliographyAnalysis</td><td>53</td></tr><tr><td>Examinations</td><td>3</td></tr><tr><td>Total</td><td>162</td></tr></table>
STUDENT EVALUATION Description of the evaluation process Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others Please indicate all relevant information about the course assessment and how students are informed	**Description** Written Exam with Problem Solving (Summative). Semester project. Laboratory reports. **Student Evaluation Languages** English **Student evaluation methods** • WrittenAssignment (Summative) • ProblemSolving (Summative)

5. SUGGESTED BIBLIOGRAPHY

EUDOXUS

1. B. M. Buchholz and Z. A. Styczynski, “Smart Grids Fundamentals and Technologies in Electric Power Systems of the future” Springer, 2020.
2. A. Chakrabortty and M. D. Ilić, “Control and Optimization Methods for Electric Smart Grids”, Springer, 2012.
3. K. C. Budka , J. G. Deshpande and M. Thottan, “Communication Networks for Smart Grids
4. Making Smart Grid Real”, Springer, 2014.
5. James Momoh, “Smart Grid: Fundamentals of Design and Analysis”, John Wiley, 2012.

Additional bibliography for study

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