COURSE GUIDE
ACADEMIC YEAR 2025-2026

UNIVERSITY OF WESTERN MACEDONIA
SCHOOL OF ENGINEERING

DEPARTMENT OF MECHANICAL ENGINEERING

http://www.mech.uowm.gr/

ΠΙΣΤΟΠΟΙΗΜΕΝΟ ΠΡΟΓΡΑΜΜΑ ΣΠΟΥΔΩΝ
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KOZANI
2026

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WELCOME

Dear members of our academic community,

As Head of the Mechanical Engineering Department, it is my great pleasure to offer a warm welcome to all of you.

The Department was originally founded in 1999 in Kozani as a branch of the Aristotle University of Thessaloniki under the name *Department of Engineering and Management of Energy Resources*. In 2004, it became part of the University of Western Macedonia, joining the newly established School of Engineering. In 2009, following curriculum revisions and laboratory restructuring to reflect the full scope of Mechanical Engineering, the Department adopted its current name. Although still relatively young, the Department has established a strong presence within the Greek academic landscape and earned well-deserved recognition. Looking ahead, our goal is to further enhance all departmental functions by fostering creativity, critical thinking, and a genuine passion for engineering.

Our primary mission is to deliver high-quality education and prepare our students to undertake complex engineering challenges. Mechanical engineering is a dynamic and continuously evolving field, shaped by emerging technologies and innovative methodologies. In response, we ensure that our curricula remain aligned with the latest industry and research developments, addressing advanced topics such as energy generation and transfer, renewable energy sources, environmental sustainability, cutting-edge mechanical engineering design methods, and industrial management.

Through a combination of lectures, laboratory work, and practical sessions, as well as through engagement in advanced research during diploma projects and thesis writing, we equip our students with the skills and expertise necessary to excel in their careers and beyond. As my predecessor aptly stated, *"Engineering courses open a wide window of prospects and opportunities for every engineer—not only for their professional development, but also by broadening their perspective on life's complexities and refining their approaches to problem-solving. Engineering education enables students to acquire the fundamentals of scientific principles and to develop a unique way of thinking, synthesising, analysing, and resolving issues."*

To all our students, I would like to emphasise that our academic and research staff are fully dedicated to teaching and research and are here to offer guidance and support and mentorship. They serve as your instructors, role models, and collaborators. I encourage you to engage actively with them, work collaboratively, ask questions, and make the most of the knowledge and experience they bring to lectures and lab sessions. Together, we will explore fundamental principles, address technological challenges, and discover the wide range of opportunities within Mechanical Engineering.

Whether your interests lie in vehicle design, space exploration, or other fields within mechanical engineering, you will have the opportunity to apply your knowledge by participating in international competitions. You may also pursue part of your studies abroad through mobility programmes such as Erasmus+ and student exchange initiatives (e.g., IAESTE)—opportunities that I strongly encourage you to take advantage of.

In addition to academic pursuits, we recognise the importance of students' overall well-being. Those interested in sports, volunteering, the arts, or other social activities will find many opportunities to participate outside the classroom. Our university offers a variety of activities, groups, and clubs for various interests and talents. Our Department is also committed to fostering an inclusive and supportive environment where every student feels valued and empowered to contribute positively.

To conclude, I would like to highlight the significance of hard work, determination, and a commitment to continuous growth. Success in your studies often requires persistence and the ability to view challenges as opportunities for personal development. Keep in mind that your time here is not just about gaining knowledge and skills; it's also about developing qualities such as patience and resilience to overcome difficulties. I encourage you to fully embrace this experience wholeheartedly, stay focused on your goals, and imagine a bright future ahead.

Welcome to the Department of Mechanical Engineering. I look forward to meeting each of you and seeing you grow, progress, and thrive throughout your studies with us.

The Department Head,

Konstantinidis E. Efstathios, Professor

1. INTRODUCTION

The Course Guide provides an overview of the Undergraduate Study Programme offered by the Department of Mechanical Engineering, School of Engineering, at the University of Western Macedonia (TMM-UoWM). It is designed to inform you about the structure and objectives of the programme and its curriculum, including detailed module descriptions, while also outlining the Department's academic and administrative framework.

The Department is committed to continuously improving the quality of education by regularly updating the curriculum, introducing new modules, revising existing content, and adjusting semester schedules. Should you identify any inaccuracies or omissions, please notify the Department so that they can be addressed promptly.

2. OBJECTIVES

The Department of Mechanical Engineering aims at fostering education, scientific research, and knowledge in key areas of Mechanical Engineering.

Mechanical Engineering is focused on a wide range of topics, including energy, the environment, materials science and technology, engineering design, and technology systems control. It also encompasses research and development, design, testing, and manufacturing of products and systems, production planning and control, and business administration. The Department of Mechanical Engineering qualifies students to drive technological innovation and pursue successful careers both in Greece and abroad.

Its key objectives include:

- qualifying students with a thorough grounding in the basic principles of Mechanical Engineering
- offering comprehensive training and skills to enable students to implement acquired knowledge
- delivering exceptional education that prepares students to address the needs of industry and society
- delivering high-quality teaching and assessment for all taught courses
- encouraging students to make the most of their studies and prepare for a successful future career

- providing training in state-of-the-art facilities and laboratories
- promoting scientific collaboration among students and fostering independent learning

After a five-year course, ME students will be capable of:

- applying acquired knowledge to engage in various Engineering projects
- gaining knowledge of contemporary methods and techniques throughout the range of all applied technologies
- using up-to-date tools and processes for problem-solving in various areas, such as IT systems, computers, software packages, etc.
- achieving effective oral and written communication skills, work collaboratively within teams
- designing, undertaking, and running a wide variety of projects
- pursuing scientific advances and continuously expanding their knowledge
- providing expert services to both industry and society.

In addition to its educational mission, the Department of Mechanical Engineering hosts state-of-the-art research laboratories, participates in numerous national and international research projects, contributes to leading scientific journals, and presents its work at major conferences in Greece and abroad. The Department also emphasises the strong connection between academic research, industrial production, and research and development activities. Expertise in Mechanical Engineering provides valuable career opportunities across a wide range of sectors, including industrial production, technological development, scientific research, and academia. Furthermore, the Department aims to cultivate outstanding researchers among its students, who will go on to play significant roles in universities and research institutions.

3. COURSE OVERVIEW

3.1. Course Duration

Minimum course duration is 10 semesters (5 academic years). Each semester lasts 13 full teaching weeks. The maximum permitted duration is determined by current legislation and varies according to the student's year of admission. For students admitted from the academic year 2021–22 onwards, the maximum duration of studies is set at 8 academic years.

3.2. Majors and Specialisations

Course curricula for each academic year are approved by the Department General Assembly and take effect in the following academic year. They include both mandatory and elective courses, which students are required to register for each regular semester.

Courses in Mechanical Engineering at the University of Western Macedonia are organised into three Cycles:

The **First Course Cycle** lasts six semesters (1st to 6th) and includes core compulsory courses for all majors.

The **Second Course Cycle** spans two semesters (7th and 8th) and comprises Major Mandatory (MM), Major Elective (ME), and Elective Courses (E), in addition to an optional Student Project (or Mechanical Engineering Capstone Project), which accounts for 5 ECTS and can replace one elective course. During this cycle, students can choose one of the following Majors according to their interests:

1. Energy
2. Manufacturing
3. Industrial Management

Students register for their desired major courses by applying to the Department Administration Service at the start of the Second Cycle (7th semester).

The Third Course Cycle (9th and 10th semesters) includes Specialisation Mandatory (SM), Elective Specialisation (ES), and Elective Courses (E) for each course specialisation, as well as a compulsory Diploma Thesis. Within course majors, the following specialisations are offered:

1. **Energy**

   Environment and Energy Applications

2. **Manufacturing**

Manufacturing & Materials

3. **Industrial Management**

Industrial Management

Students apply for specialisations to the Department Administration Service at the start of the Third Cycle (9th semester).

3.3. Course Registration

All students (except those in the 1st semester) are required to register for courses at the beginning of each semester. To follow this process, which is necessary for participation in final examinations, students must apply online or in person to the Department Administration Service within the deadlines announced on the Department website. Deadlines are tight and no registrations or changes are allowed after that.

Once they have registered for courses, students are eligible to:

1. take final exams at the end of each semester and during the exam period of September,
2. receive available academic learning material (course books) via the **EUDOXUS** platform at the beginning of winter or spring terms.

Students must register for courses at the beginning of each term in order to attend lectures and laboratory sessions, access academic material, and participate in final examinations. Students admitted from the academic year 2020–2021 onward may apply for a course specialisation and register in the 2nd and 3rd study cycles once they have successfully completed at least 22 of the 32 required courses in the 1st Cycle (excluding the 1st-semester English course).

For students admitted from the academic year 2017–2018 onward, course registration must follow these limits: (a) up to **N+3** courses per semester, where **N** corresponds to the number of courses assigned to each of the first eight semesters; (b) up to **eight (8)** courses per semester during the 9th and 10th semesters; and (c) up to **twelve (12)** courses per semester from the 11th semester onward.

For previous applicants (admissions up to 2016-17), there are no restrictions on the number of courses they can register for.

Students may choose to skip courses from the current semester and instead register for courses from previous years. During the winter and spring terms, they may only register for courses taught in the corresponding winter (1st, 3rd, 5th, 7th, and 9th) or spring (2nd, 4th, 6th, 8th, and 10th) semesters. Winter term courses are not offered in the spring term, and vice versa.

3.4. Assessment - Exams

Assessment takes place throughout the academic year, and the final grades for each course are determined by a) student performance during the semester through assigned coursework, exercises, or one or more midterm exams as specified by instructors, and b) the final exams.

Each semester includes **two (2) examination periods** for taught courses, one at the end of the term (winter or spring), and a second in September before the start of the next academic semester.

Students may **take exams only in the courses they registered for at the beginning of each semester.** The winter (January-February) and spring (June) exam periods typically last three weeks, while the September exam period extends to four weeks. Under special circumstances, exam periods may be extended.

If students miss or fail the final exams (pass mark is 5) even after the second final examination in September:

a. for **Mandatory or Major Mandatory courses**, they are **required to register again in a future semester**. Upon re-applying, they may repeat coursework and re-sit the final exams.

b. for **Elective or Major Elective** courses, students can **register again in a future semester** to repeat the coursework and re-sit the final exams. Alternatively, **they may opt to register for a different Elective or Major Elective course available within their chosen major in a subsequent semester**.

3.5. Course Requirements

To complete the undergraduate study program and receive a diploma, students must accumulate 300 ECTS credits, which reflects the workload under the European Credit Transfer System (ECTS). ECTS credits are earned by passing course exams and completing the required diploma thesis (30 ECTS). Credits can also be obtained through internships (see below).

The table below demonstrates the required number of courses for a degree in

Mechanical Engineering, depending on the year of admission.

ADMISSIONS	NUMBER of 1st CYCLE COURSES (1st-2nd - 3rd YEAR)	NUMBER of 2nd CYCLE COURSES (4th YEAR)	NUMBER of 3rd CYCLE COURSES (5th YEAR)	TOTAL NUMBER OF COURSES	TOTAL
2025	33 MANDATORY (M)	6 MAJOR MANDATORY (MM) and 6 MAJOR ELECTIVE (ME) and GENERAL-ELECTIVE (GE) courses, of which at least two (2) must be MAJOR ELECTIVE (ME)	2 MAJOR MANDATORY (MM) and 4 MAJOR ELECTIVE (ME) and GENERAL-ELECTIVE (GE) courses in total, of which at least two (2) must be GE, plus the Diploma Thesis.	51 + DIPLOMA THESIS	33 M, 8 MM 10 ME and GE courses in total , of which at least four (4) must be ME
2020-2024	33 MANDATORY (M)	6 MAJOR MANDATORY (MM) 2 MAJOR ELECTIVE (ME) 4 ELECTIVE (E)	2 MAJOR MANDATORY (MM) 2 MAJOR ELECTIVE (ME) 2 ELECTIVE (E) + DIPLOMA THESIS	51 + DIPLOMA THESIS	33 M, 8 MM 4 ME, 6 E, DTH
2012-2019	34 MANDATORY (M) + Mechanical Engineering Capstone Project	6 MAJOR MANDATORY (MM) 2 MAJOR ELECTIVE (ME) 4 ELECTIVE (E)	3 MAJOR ELECTIVE (ME) 5 MAJOR ELECTIVE (ME) + DIPLOMA THESIS	54+ DIPLOMA THESIS	34 M, 9 MM 7 ME, 4 E DTH
2010-2012	37 MANDATORY (M) + Mechanical Engineering Capstone Project	6 MAJOR MANDATORY (MM) 2 MAJOR ELECTIVE (ME) 4 ELECTIVE (E)	3 MAJOR MANDATORY (MM) 5 MAJOR ELECTIVE (ME) + DIPLOMA THESIS	57 + DIPLOMA THESIS	37 M, 9 MM 7 ME, 4 E DTH
2005-2009	37 MANDATORY (M) + Mechanical Engineering Capstone Project	6 MAJOR MANDATORY (MM) 4 MAJOR ELECTIVE (ME) 2 ELECTIVE (E)	8 MAJOR MANDATORY (MM)+ DIPLOMA THESIS	57 + DIPLOMA THESIS	37 M, 14 MM, 4 ME, 2 E, DTH
2002-2004	32 MANDATORY (M) + Mechanical Engineering Capstone Project	6 MAJOR MANDATORY (MM) 4 ELECTIVE (E)	8 MAJOR MANDATORY (MM) + DIPLOMA THESIS	50 + DIPLOMA THESIS	32 M, 14 MM 4 E, DTH

ADMISSIONS	NUMBER of 1st CYCLE COURSES (1st-2nd - 3rd YEAR)	NUMBER of 2nd CYCLE COURSES (4th YEAR)	NUMBER of 3rd CYCLE COURSES (5th YEAR)	TOTAL NUMBER OF COURSES	TOTAL
1999-2001	31 MANDATORY (M)	6 MAJOR MANDATORY (MM) 4 ELECTIVE (E) + Mechanical Engineering Capstone Project	8 SMAJOR MANDATORY (MM) + DIPLOMA THESIS	49+ MECHANICAL ENGINEERING CAPSTONE PROJECT & DIPLOMA THESIS	31 M, 14 MM 4 E , DTH
Note: MECP = Mechanical Engineering Capstone Project, DTH = Diploma Thesis					

NOTE: When completing the course registration form, students must ensure they select the required number of courses in each category, namely, (M), (MM), (ME), and (E), as these are necessary to obtain their degree.

3.6. Curriculum adjustments for 2026-2025

To enhance curricula quality, the Department Assembly has made the following adjustments (effective from the academic year 2026-2027), without modifying degree requirements.

From the **2026–2027 academic year onward**, the two specialisation tracks of the Energy Major

- *Energy Generation and Transfer*
- *Environment and Energy Applications*

which previously applied in the 5th year of studies, will be merged into a single unified specialisation track, **Environment and Energy Applications.**

For the current academic year (2025–2026), 4th- and 5th-year students (Energy Major) will continue to follow the courses outlined in the Course Guide of the previous academic year (2024–2025).

3.7. Course Outline

The tables below provide an overview of the courses offered for each semester.

First course cycle (1st -3rd year)

	1st semester	2nd semester	3rd semester	4th semester	5th semester	6th semester
1	Mathematics I	Mathematics I	Strength of Materials	Fundamentals of Machining	Electrotechnics	Electrical Machines
2	Chemistry	Materials Science II	Statistics	Machine Elements I	Mechanical Vibration and Machine Dynamics	Industrial Manage-ment
3	Physics	Engineering Statics	Mathematics III	Fluid Mechanics I	Heat Transfer	Alternative Energy Systems
4	Mechanical Drawing I	Mechanical Drawing II	Thermodynamics I	Thermodynamics II	Operations Research I	Automatic Control Systems
5	Materials Science I	Introduction to Programming	Dynamics	Mathematics IV	Machine Elements II	Internal Combu-stion Engines
6	English	English for Specific & Academic Purposes		Numerical Analysis		

Second course cycle (4th year)

Major	ENERGY	
Semester	7th semester	8th semester
Mandatory courses (M)	Power Plants	Turbomachinery
	Heating	Fluid Mechanics II
	Environmental Technology	Cooling – Air Conditioning

Compulsory selection of one (1) course per semester from the Major Elective (ME) course list	Experimental Methods & Measurement Technology	Computational Fluid Dynamics
	Computational Mechanics	Unit Operations
Selection of two (2) courses per semester from the Elective (E) course list NOTE: E + ME (per semester) = 3	Quality Control	Inventory Management
	Advanced Materials – Nanomaterials	Technological Systems Reliability & Maintenance
	Operations Research II	Numerical Methods In Mechanical Engineering
	Computer-Aided Design	Computer-Aided Manufacturing in Industry
	Decision-Making Theory & Data Analysis	Nondestructive Testing
	Subtractive Manufacturing Processes	Experiment Design & Analysis
	Mechanical Engineering Capstone Project	Biomedical Engineering Structural Dynamics
	Internship	Energy Economics & Energy Markets
	Robotics	Startup Management / International Business Strategy
		Internship
	Robotics	Internship

Major	INDUSTRIAL MANAGEMENT	
Semester	7th semester	8th semester
Mandatory courses (M)	Quality Control	Technological Systems Reliability & Maintenance

	Operations Research II	Inventory Management
	Decision-Making Theory & Data Analysis	Experiment Design & Analysis
Compulsory selection of one (1) course per semester from the Major Elective (ME) course list	Experimental Methods & Measurement Technology	Nondestructive Testing
	Computational Mechanics	Biomedical Engineering
Selection of two (2) courses per semester from the Elective (E) course list NOTE: E + ME (per semester) = 3	Power Plants	Turbomachinery
	Heating	Cooling – Air Conditioning
	Environmental Technology	Fluid Mechanics II
	Computer-Aided Design	Numerical Methods In Mechanical Engineering
	Subtractive Manufacturing Processes	Unit Operations
	Advanced Materials – Nanomaterials	Computational Fluid Mechanics
	Mechanical Engineering Capstone Project	Computer-Aided Manufacturing in Industry
	Robotics	Energy Economics & Energy Markets
	Internship	Internship
		Startup Management / International Business Strategy

Major	MANUFACTURING	
Semester	7th semester	8th semester
Mandatory courses (M)	Computer-Aided Design	Nondestructive Testing
	Advanced Materials – Nanomaterials	Biomedical Engineering
	Subtractive Manufacturing Processes	Computer-Aided Manufacturing in Industry

Compulsory selection of one (1) course per semester from the Major Elective (ME) course list	Quality Control	Numerical Methods In Mechanical Engineering
	Decision-Making Theory & Data Analysis	Technological Systems Reliability & Maintenance
Selection of two (2) courses per semester from the Elective (E) course list	Power Plants	Turbomachinery
	Heating	Fluid Mechanics II
	Experimental Methods & Measurement Technology	Cooling – Air Conditioning
	Computational Mechanics	Computational Fluid Mechanics
	Operations Research II	Unit Operations
	Environmental Technology	Inventory Management
	Mechanical Engineering Capstone Project	Experiment Design & Analysis
	Robotics	Energy Economics & Energy Markets
	Internship	Startup Management / International Business Strategy
		Internship

Third course cycle (5th year)

Major	ENERGY	
Specialisation	Environment and Energy Applications	
Semester	9th semester	10th semester
Mandatory courses (M)	Energy Design For Buildings	
	Wind And Water Turbines, Hydroelectric Plants	
Compulsory selection of two (2) courses from the Major Elective (ME) course list (from any semester)	Solar Technology/Photovoltaics	Gas Turbine Technology
	Special Topics on Power Generation	Special Topics on Pollution Control Technology

	Air Pollution	Materials For Energy & Environmental Applications
	Aircraft Aerodynamic Design and Control	Unsteady Flows and/or Combustion Phenomena
Selection of two (2) courses from the Elective (E) course list (from any semester) NOTE: ME + E =4	Design of Welded Structures	Unsteady flows
	Risk Management and Safety of Large Industrial Systems	Combustion Phenomena
	Engineering and Energy Legislation	Renewable Energy Sources Laboratory
	Supply Chain Management	Simulation and System Dynamics
	Product Design and Development	Project Management
	Additive Manufacturing Processes	Total Quality Management
	Techno-Economic Assessment	Conventional and Advanced Energy Storage Systems
	Solid Waste Management	Vehicle Design Methods
	Structural Dynamics	Structural Optimisation
	Advanced Topics in Engineering	Engineering Applications of Machine Learning and Artificial Intelligence
	Internship	Internship

Major	INDUSTRIAL MANAGEMENT	
Specialisation	Industrial Management	
Semester	9th semester	10th semester
Mandatory courses (M)	Techno-Economic Assessment	Project Management
Compulsory selection of two (2) courses from	Advanced Topics in Engineering	Structural Optimisation

the Major Elective (ME) course list (from any semester)	Risk Management and Safety of Large Industrial Systems	Engineering Applications of Machine Learning and Artificial Intelligence
	Supply Chain Management	
	Advanced Information Technologies And Programming for Mechanical Engineers	
Selection of two (2) courses from the Elective (E) course list (from any semester) NOTE: ME + E =4	Wind And Water Turbines, Hydroelectric Plants	Gas Turbine Technology
	Solar Technology/Photovoltaics	Combustion Phenomena
	Special Topics on Power Generation	Renewable Energy Sources Laboratory
	Energy Design for Buildings	Special Topics on Pollution Control Technologies
	Engineering and Energy Legislation	Materials for Energy & Environmental Applications
	Structural Dynamics	Thermal Process Equipment
	Product Design & Development	Vehicle Design Methods
	Design of Welded Structures	Conventional and Advanced Energy Storage Systems
	Aircraft Aerodynamic Design and Control	Simulation and System Dynamics
	Research, Technology & Innovation Policies	Unsteady Flows
	Additive Manufacturing Processes	Advanced Robotics Technology in Manufacturing
	Solid Waste Management	Total Quality Control

	Air Pollution	Internship
	Internship	

Major	MANUFACTURING	
Specialisation	Manufacturing & Materials	
Semester	9th semester	10th semester
Mandatory courses (M)	Design of Welded Structures	
	Additive Manufacturing Processes	
Compulsory selection of two (2) courses from the Major Elective (ME) course list (from any semester)	Structural Dynamics	Vehicle Design Methods
	Product Design & Development	Advanced Robotics Technology in Manufacturing
	Advanced Information Technologies And Programming for Mechanical Engineers	
Selection of two (2) courses from the Elective (E) course list (from any semester) NOTE: ME + E =4	Special Topics on Power Generation	Gas Turbine Technology
	Wind And Water Turbines, Hydroelectric Plants	Unsteady Flows
	Solar Technology/Photovoltaics	Combustion Phenomena
	Air Pollution	Renewable Energy Sources Laboratory
	Energy Design for Buildings	Special Topics on Pollution Control Technologies
	Risk Management and Safety of Large Industrial Systems	Materials for Energy & Environmental Applications

	Engineering and Energy Legislation	Simulation and System Dynamics
	Supply Chain Management	Project Management
	Solid Waste Management	Total Quality Control
	Techno-Economic Assessment	Conventional and Advanced Energy Storage Systems
	Aircraft Aerodynamic Design and Control	Engineering Applications of Machine Learning and Artificial Intelligence
	Advanced Topics in Engineering	Structural Optimisation
	Internship	Internship

3.8. Mechanical Engineering Capstone Project

The Mechanical Engineering Capstone Project involves an in-depth analysis of a device or process related to design, development, or construction. It builds on previously acquired knowledge and strengthens students' learning competence and problem-solving skills. Depending on the chosen methodology, the project also fosters collaboration and team spirit.

The Project is optional and is normally undertaken during the Second or Third Course Cycle. It may be completed as an individual or group assignment, in close consultation with and under the guidance of an academic supervisor. The assessment is on a pass/fail basis and carries 5 ECTS credits and can be chosen to replace an elective course. The Mechanical Engineering Capstone Project must be submitted before beginning the Diploma Thesis.

3.9. Diploma Thesis

Mechanical Engineering courses are complete with a Diploma Thesis. The Thesis is a full-length research paper involving a topic relevant to the prescribed curriculum subjects (30 ECTS). It aims to demonstrate the students' competence, and thorough understanding and sustained engagement with their chosen academic field.

All students can choose the topic of their Diploma Thesis, provided it **directly related to (at least) one subject within their chosen Major.**

3.10. Student Placement / Internship

For Placements/Internships, Mechanical Engineering students are advised to apply to the Department Administration Service, after a prior agreement between the Department and companies/organisations, clearly defining the terms of employment and work responsibilities during the internship. Once applications have been examined by the Internship Placement Coordinator and competent Teaching Staff, applicants are placed for work.

Student placements/Internships are optional and can replace an elective course, as they carry 5 ECTS credits. They typically take place in the third year of studies during summertime and last three (3) months (June, July, and August). All students are encouraged to undertake relevant work experience, but priority is mainly given to students under graduation.

3.11. Final Grade: Calculator

The final grade is calculated as follows:

a) all 32 first-cycle courses (excluding English in the first semester), 12 second-cycle courses (Major Mandatory, Major Elective, and Elective), and 6 third-cycle courses (Specialisation Mandatory, Specialisation Elective and Elective) are required for the degree (weighting factor Wi=1).

b) Diploma thesis W_δ=6.

Thus,

$$D.G. = \frac{W_\delta B_\delta + \sum_{i=1}^{M} W_i B_i}{W_\delta + \sum_{i=1}^{M} W_i}$$

where M is the number of course units, B_i is the exam score of course I, and B_δ is the Diploma Thesis score.

3.12. Degree

UoWM Mechanical Engineering graduates are awarded a single, uniform Integrated Master’s degree in Mechanical Engineering, Level 7 (National and European Qualifications Framework).

3.13. Transcript of Records and Diploma Supplement

Starting in December 2014, and under Law 3374/2005 and Ministerial Decision F. 5/72535/B3/10.08.2006, all graduates receive a Diploma Supplement. Transcripts of Records, which include a comprehensive list of all courses, represent graduates' specific study programmes and provide information about their Major and Specialisation.

4. USEFUL INFORMATION

4.1. Facilities

The Department of Mechanical Engineering, one of the five departments of the School of Engineering at the University of Western Macedonia (DME-UoWM) is located on the University Campus in the Active Urban Planning Zone (ZEP area), a few kilometers from Kozani centre. Courses are taught on the main campus in ZEP, but a limited number of laboratory courses take place on the University Campus in Kila. Access to the campus is by road, using public transportation.

4.2. Academic calendar

Start and end dates for courses, exams, holidays, and breaks are set by the Senate's decision and posted on the official websites of the Department and the University.

4.3. First-Year Students

Registration deadlines for successful candidates are determined by the Ministry of Education for each academic year, based on the results of the University Entrance Exam (Panhellenic Exams). To enroll, successful candidates (or legally authorized people) should submit or send a set of documents (i.e., high school graduation certificate, a copy of their identity card, etc.) to the Department Administration Service. The list of required documents is announced on the Department's website (www.mech.uowm.gr) at the beginning of each academic year and may be updated in accordance with the Ministry of Education guidelines.

4.4. Student ID card

Once enrolled, students apply for a Student ID Card at http://academicid.minedu.gov.gr/. Student ID Cards are valid for the entire duration of studies and are proof of identity, granting access to various facilities and benefits, including public transport discounts (valid for n + 2 years), according to relevant regulations.

Student ID Cards are returned to the Department Administration Office before graduation or in case of interruption of studies. No benefits are granted to students registered after placement qualifying exams (Higher Education graduates).

4.5. Maximum study duration and Interruption of studies

Maximum course duration is 10+6=16 academic semesters. Students who have not exceeded this limit may request interruption of studies for up to two (2) academic years by submitting a request to the Department Administration Service. The right to interrupt studies can be exercised once or in parts, with a minimum duration of one (1) academic semester for each interruption; however, the total duration cannot exceed two (2) years if taken in parts. During the interruption period, student status is suspended, and participation in educational activities is not allowed.

4.6. Changing your Major

Students who wish to change their Major are eligible to apply for a different one at the beginning of the following term. Applications are submitted during course registration, provided that students pass the new major courses (both mandatory and elective), regardless of the number of courses they had previously passed before deciding to change. In such cases, any courses already passed but not required for the new Major will be listed in the Diploma Supplement (see below).

4.7. Course material

Enrolled students are entitled to free coursebooks and further educational material (one textbook and/or additional material. This also includes access to relevant Greek and foreign literature for information and reference purposes (Article 37, Law 4009/2011). Coursebooks are available through the 'Eudoxus' information system (https://eudoxus.gr), which enables students to select their coursebooks from a recommended list for each course.

4.8. Course transfer

Students who are admitted to the Mechanical Engineering Department after completing at least one semester at another higher education institution (e.g., through transfer exams) as well as those accepted in another department (upon application under the 10% admissions category) may request the transfer of courses they successfully completed at their previous institution.

Applications must include the courses applicants have passed and the corresponding equivalence to the courses listed in the Department current Course Guide. Course transfer requests and changes are submitted only once during studies in the new Department and are accompanied by a reasoned statement. Responsibility for approving course transfers lies exclusively with the Department Assembly.

4.9. Administration Service: Responsibilities And Duties

The Administration Service staff are responsible for providing competent services to students and handling administrative issues, such as:

1. Admissions and registration processes
2. Student record files (exam grades, scholarships, degrees)
3. Course registration files based on the list of the students' registered courses.
4. Certificates and other documents

Office hours: all working days from 11:00 am to 13:00 pm.

4.10. Student Welfare

The University of Western Macedonia runs a Student Welfare Service for all student welfare activities, in accordance with available state funding and university administration decisions. The Student Welfare Service coordinates and delivers high-quality support and accurate information, mainly about free meals, accommodation, and social welfare issues (e.g., student accommodation benefits). The Department Administration Service promptly announces the relevant terms and application deadlines.

UoWM also runs a Support Unit for Vulnerable Groups, which ensures equal access to education for students with diverse abilities, needs, and requirements. The Unit provides psychological and counselling support to the

University community, including students and staff in all five University cities. In addition, it offers transportation services (taxis) for students with mobility difficulties and ensures that students with sensory disabilities receive assistance from qualified professionals (e.g., Greek Sign Language interpreters or Braille specialists).

Finally, the Student Welfare Service awards 100 annual scholarships (accommodation subsidies), two per University Department, to students from low-income families.

4.11. UoWM Administration

Administration Building

School of Engineering, ZEP 50131 Kozani

Tel.: +30 24610 56200

Website: www.uowm.gr

5. STAFF

5.1. Academic Staff (DEP, in Greek)[1]

1. Agapi Altini, Assistant Professor
2. Alexandros Arailopoulos, Assistant Professor
3. Emmanouil Varitis, Assistant Professor
4. Stefanos Gerardis, Assistant Professor
5. Savvas Douvartzidis, Associate Professor
6. Theodoros Theodoulidis, Professor
7. Paraskevi Kapetanopoulou, Assistant Professor
8. Loukas Karagiannakis, Lecturer
9. Athena Krestou, Assistant Professor
10. Efstathios Konstantinidis, Professor (Head)
11. Georgios Nenes, Professor
12. Stergios Maropoulos, Professor

[1] *More information about the academic staff's profiles and research activities can be found on the Department website* (www.mech.uowm.gr).

13. Nikolaos Sapidis, Professor
14. Georgios Skodras, Professor
15. Raphaela-Eleni Sotiropoulou, Assistant Professor
16. Nikolaos Taousanidis, Professor (Deputy Head)
17. Konstantinos Tasias, Assistant Professor
18. Antonios Tourlidakis, Professor
19. Alkiviadis Tsamis, Associate Professor
20. Alexandros Tsouknidas, Assistant Professor
21. Konstantinos Filippidis, Professor

5.2. Emeriti Professors

- Ioannis Bartzis
- Petros Pilavakis

5.3. Special Laboratory Teaching Staff (EDIP, in Greek)

- Kyriakos Vafiadis
- Christos Grompanopoulos
- Nikolaos Dinas
- Evangelos Tolis

5.4. Special Laboratory Technical Staff (ETEP, in Greek)

- Ioannis Karmalis
- Sofia Papanikolaou
- Athanasios Patsouras
- Dimitrios Fasnakis

5.5. Administration Service Anna V. Tzika, Head

Phone Numbers: 24610 56600, 24610 56604, 24610 56605

Address: University Campus, Building B, ZEP, 50131 Kozani

6. MAJORS AND LABORATORIES

6.1. Energy

- Laboratory of Thermodynamics and Heat Engines
- Laboratory of Fluid Mechanics and Turbomachinery
- Laboratory of Energy & Pollution Control Systems (EPSEL)
- Air and Waste Management Laboratory (AWMA Lab)
- Centre for Renewable and Alternative Energy Sources & Rational Use of Energy

6.2. Manufacturing

- Laboratory of Mechanical Systems (LMS)
- Laboratory of Vibration and Machine Dynamics (LVDM)
- Laboratory of Magnetic Electric Analysis for Non-Destructive Evaluation Research (MEANDER NDT Lab)
- Laboratory of Manufacturing Processes and Quality Control
- Laboratory for Biomaterials and Computational Mechanics (BCM)

6.3. Industrial Management

- Laboratory of Quantitative Methods of Operations Research and Statistics in Engineering (MORSELAB)

7. CURRICULUM

The curriculum is structured into course units offered each semester and includes course titles, descriptions, prerequisites or interdependencies, and credit units (ECTS).

Course allocation across semesters follows clear educational objectives and is not mandatory for students. It is, however, aligned with the conditions for regular attendance and designed to meet the minimum number of semesters required for graduation, considering prerequisite and interdependent course sequences during curriculum planning.

Student timetables can generally be tailored to individual needs; however, to facilitate learning processes, it is highly recommended that compulsory core courses follow, in any case, the suggested chronological order to ensure that students will avoid potential problems and will be able to acquire fundamental knowledge during courses. It is also worth noting that, if students get a fail score in a mandatory, major mandatory, or elective course, they must reapply in a following semester.

Overall, regular attendance at lectures and active engagement with coursework are strongly recommended, as they support a deeper understanding of the subjects taught and enable students to address any questions or challenges that may arise during their studies.

Symbols

E.: Major in Energy

IM: Major in Industrial Management, Specialisation 'Industrial Management'

M: Major in Manufacturing, Specialisation 'Manufacturing and Materials'

EG&T: Specialisation 'Energy Generation and Transfer'

E&EA: Specialisation 'Environment and Energy Applications'

MM/SM: /Major/Specialisation Mandatory

ME/SE: Major/Specialisation Elective

E: Elective

1st semester

s/n	Course number	Course	Instructor	Assisting	Description	Hours	ECTS
1	101	Mathematics I	Adjunct staff		Mandatory	4	5
2	103	Physics	Evaggelopoulos (ChemEng)		Mandatory	5	6
3	104	Chemistry	Tolis		Mandatory	4	5
4	113	Mechanical Drawing I	Sapidis		Mandatory	4	5
5	109	Materials Science I	Maropoulos	Papanikolaou Fasnakis	Mandatory	5	6
6	141	English	Altini		Mandatory	3	3

Note: English is a mandatory requirement for obtaining the degree; however, it is not included in the calculation of the degree grade.

2nd semester

s/n	Course number	Course	Instructor	Assisting	Description	Hours	ECTS
1	102	Mathematics II	Adjunct staff		Mandatory	4	5
2	105	Introduction to Computing	Grompano-poulos		Mandatory	5	5
3	111	Statics	Tsamis		Mandatory	5	6
4	146	Mechanical Drawing II	Sapidis		Mandatory	4	5
5	135	Materials Science II	Adjunct staff	Tsamos, Fasnakis	Mandatory	5	6
6	142	English for Specific & Academic Purposes	Altini		Mandatory	3	3

3rd semester

s/n	Course number	Course	Instructor	Assisting	Description	Hours	ECTS
1	110	Strength of Materials	Tsamis		Mandatory	5	6
2	107	Statistics	Kapetano-poulou		Mandatory	5	6
3	119	Thermodynamics I	Skodras		Mandatory	5	6
4	132	Mathematics III	Adjunct staff		Mandatory	4	6
5	112	Dynamics	Arailopou-los		Mandatory	5	6

4th semester

s/n	Course number	Course	Instructor	Assisting	Description	Hours	ECTS
1	114	Fundamentals of Machining	Gerardis	Loizos, Sirganis	Mandatory	5	5
2	108	Machine Elements I	Varytis	Rinos	Mandatory	5	5
3	120	Fluid Mechanics I	Tourlidakis	Theodorou	Mandatory	5	5

s/n	Course number	Course	Instructor	Assisting	Description	Hours	ECTS
4	137	Mathematics IV	Adjunct staff		Mandatory	4	5
5	133	Thermodynamics II	Skodras		Mandatory	5	5
6	106	Numerical Analysis	Sotiropoulou Grompano-poulos		Mandatory	5	5

5th semester

s/n	Course number	Course	Instructor	Assisting	Description	Hours	ECTS
1	118	Heat Transfer	Konstadinidis Karagiannakis		Mandatory	5	6
2	140	Mechanical Vibration and Machine Dynamics	Arailopoulos		Mandatory	5	6
3	147	Operations Research I	Tasias	Krommy-das	Mandatory	5	6
4	116	Electrotechnics	Adjunct staff		Mandatory	4	6
5	138	Machine Elements II	Varytis	Rinos	Mandatory	5	6

6th semester

s/n	Course number	Course	Instructor	Assisting	Description	Hours	ECTS
1	117	Electrical Machines	Adjunct staff		Mandatory	4	6
2	123	Industrial Management	Tasias		Mandatory	5	6
3	219	Automatic Control Systems	Adjunct staff		Mandatory	4	6
4	127	Renewable & Alternative Energy Sources	Skodras		Mandatory	4	6
5	206	Internal Combustion	Douvartzidis		Mandatory	5	6

s/n	Course number	Course	Instructor	Assisting	Description	Hours	ECTS
		Engines					

7th semester

s/n	Course number	Course	Instructors	Assisting	Course Description per major			Hours	ECTS
					E	IM	M		
1	204	Power Plants	Douvartzidis		MM	E	E	5	5
2	208	Heating	Karagiannakis	Zouloumis	MM	E	E	5	5
3	250	Experimental Methods and Measurement Technology	Konstantinidis		ME	ME	E	5	5
4	228	Computational Mechanics	Adjunct staff		ME	ME	E	4	5
5	230	Quality Control	Kapetanopoulou		E	MM	ME	4	5
6	380	Computer-Aided Design	Sapidis	Dinas	E	E	MM	4	5
7	262	Advanced Materials - Nanomaterials	Krestou	Tsamos,	E	E	MM	4	5
8	377	Operations Research II	Kapetanopoulou	Krommydas	E	MM	MM	4	5
9	260	Decision-Making Theory & Data Analysis	Tasias		E	MM	ME	4	5
10	266	Subtractive Manufacturing Processes	Gerardis	Loizos, Sirganis	E	E	MM	4	5
11	131	Environmental Technology	Sotiropoulou		MM	E	E	4	5
12	199	Mechanical Engineering Capstone Project	Tourlidakis		E	E	E	4	5
13	410	Internship	Gerardis		E	E	E	3	5

s/n	Course number	Course	Instructors	Assisting	Course Description per major			Hours	ECTS
					E	IM	M		
			(Co-ordinator)					months	
14	E4	Robotics	Fragoulis (ElEng)		E	E	E	4	5

8th semester

s/n	Course number	Course	Instructors	Assisting	Course Description per major			Hours	ECTS
					E	IM	M		
1	205	Turbines	Tourlidakis	Stamos	MM	E	E	5	5
2	249	Fluid Mechanics II	Konstantinidis		MM	E	E	4	5
3	263	Computational Fluid Dynamics	Vafiadis		ME	E	E	4	5
4	210	Unit Operations	Krestou		ME	E	E	4	5
5	209	Cooling & Air Conditioning	Taousanidis		MM	E	E	4	5
6	241	Technological Systems Reliability and Maintenance	Tasias	Kampitsis	E	MM	ME	4	5
7	255	Inventory Management	Kapetanopoulou	Krommydas	E	MM	E	4	5
8	252	Computer-Aided Manufacturing in Industry	Gerardis Varytis	Loizos Dinas Sirganis	E	E	MM	4	5
9	256	Non-destructive Testing	Adjunct staff		E	ME	MM	4	5

s/n	Course number	Course	Instructors	Assisting	Course Description per major			Hours	ECTS
					E	IM	M		
10	257	Experiment Design and Analysis	Kapetanopoulou		E	MM	E	4	5
11	258	Biomedical Engineering	Tsamis	Kroustalias, Dinas, Hatzisavvas	E	ME	MM	4	5
12	372	Numerical Methods for Mechanical Engineering Design	Arailopoulos		E	E	ME	4	5
13	410	Internship	Gerardis (Co-ordinator)		E	E	E	3 months	5
14	EEH10	Energy Economics and Energy Markets	available from the Dept. of Electrical & Computer Engineering		E	E	E	4	5
15	DET710	Startup Management / International Business Strategy	available from the Dept. of Management Science &Technology		E	E	E	3	5

9th semester

s/n	Course number	Course	Instructors	Assisting	Course Description per specialisation			Hours	ECTS
					E	IM	M		
1	327	Energy design for buildings	Karagiannakis	Zouloumis, Papadopoulos	MM	E	E	4	5
2	318	Wind and water turbines, hydroelectric plants	Tourlidakis	Stamos	MM	ME	E	4	5
3	316	Solar Technology/ Photovoltaics	Taousanidis		ME	E	E	4	5
4	391	Air Pollution	Sotiropoulou		MM	-	E	4	5

s/n	Course number	Course	Instructors	Assisting	Course Description per specialisation			Hours	ECTS
					E	IM	M		
5	349	Special topics on Power Generation	Douvartzidis Tolis		ME	E	E	4	5
6	398	Design of Welded Structures	Gerardis	Loizos Fasnakis Sirganis	E	E	MM	4	5
7	396	Product Design and Development	Varytis	Dinas	E	E	ME	4	5
8	393	Supply Chain Management	Not available		E	ME	E	4	5
9	389	Risk Management and Safety of Large Industrial Systems	Not available		E	ME	E	3	5
10	406	Additive Manufacturing	Varytis	Dinas	E	E	MM	4	5
11	382	Structural Dynamics	Not available		E	E	ME	4	5
12	352	Techno-economic Assessment	Skodras		E	MM	E	4	4
13	376	Engineering & Energy Legislation	Not available		E	E	E	3	5
14	261	Advanced topics in Engineering	Not available		E	ME	E	4	5
15	403	Aircraft Aerodynamic Design and Control	Vafiadis		ME	E	E	4	5
16	410	Internship	Gerardis (Co-ordinator)		E	E	E	3 months	5
17	259	Advanced Information Technologies & Programming for Mechanical Engineers	Grompano-poulos		E	E	ME	4	5

s/n	Course number	Course	Instructors	Assisting	Course Description per specialisation			Hours	ECTS
					E	IM	M		
18	405	Solid Waste Management	Tagaris (available from the Dept. of Chemical Engineering		E	E	E	4	5

10th semester

s/n	Course number	Course	Instructors	Assisting	Course Description per study track			Hours	ECTS
					E	IM	M		
1	385	Gas Turbine Technology	Tourlidakis	Vafiadis, Kougioumtzidis	ME	E	E	4	5
2	404	Unsteady Flows	Konstantinidis		ME	E	E	4	5
3	348	Combustion Phenomena	Douvartzidis		E	E	E	4	5
4	390	Renewable Energy Sources Laboratory	Not available		E	E	E	3	5
5	350	Special topics on pollution control technologies	Sotiropoulou		ME	E	E	4	5
6	379	Materials for Energy and Environmental Applications	Krestou	Tsamos	ME	E	E	4	5
7	367	Simulation and System Dynamics	Not available		E	MM	E	4	5
8	395	Total Quality Management	Not available		E	ME	E	4	5
9	264	Structural Optimisation	Arailopoulos		E	ME	E	4	5

s/n	Course number	Course	Instructors	Assisting	Course Description per study track			Hours	ECTS
					E	IM	M		
10	392	Project Management	Konstantas		E	MM	E	4	5
11	394	Advanced Robotics in Manufacturing	Not available		E	E	ME	4	5
12	371	Vehicle Design Methods	Not available		E	E	ME	4	5
13		Applications of Machine Learning and Artificial Intelligence in Mechanical Engineering	Adjunct staff		E	ME	E		
14	402	Conventional & Advanced Energy Storage Systems	Not available		E	E	E	4	5
15	410	Internship	Gerardis (Co-ordinator)		E	E	E	3 months	5

COURSE SYLLABUS

8. COURSE DESCRIPTIONS

Detailed Course descriptions

Abbreviations

S.: Semester

TH: Teaching hours

Term duration: 13 weeks

Language: Greek

MATHEMATICS I	
Course number	101
URL	-
Recommended Prerequisites	-
Course content	Analytical Geometry of the Plane i) Lines in the plane, ii) Locus, Straight line, Second-degree curves (conic sections): Parabolas, Ellipses, Hyperbolas iii) Polar coordinates Complex Numbers i) Definition of a complex number, Image, Vector radius, Modulus and argument of a complex number, Complex conjugate, Properties of conjugates and modulus, Properties of the argument ii) Sum, Difference, Product, and Quotient of complex numbers iii) Powers of the imaginary unit i, Second-degree equation of a complex number iv) Geometric locus of complex numbers Matrices i) The concept of a matrix, Definition, Matrix order ii) Matrix operations: Addition, Subtraction, Multiplication, Properties iii) Types of matrices: Zero matrix, Square matrix, Symmetric matrix, Antisymmetric matrix, Inverse matrix, Identity matrix, Diagonal matrix, Upper and lower triangular matrices iv) Determinant, Dimension and expansion of the determinant, Properties, Triangulation of the determinant v) Inverse of a square matrix, Inverse matrix vi) Matrices and linear systems, Cramer's rule, Gauss method Vector Spaces - Linear Transformations i) The concept of a real vector space, Linear dependence, Basis and dimension of a vector space

	ii) Linear transformations in a vector space, Matrix of a linear transformation iii) Eigenvalues and eigenvectors Inverse Trigonometric and Hyperbolic Functions i) Definition of a real function, One-to-one (bijective) function, Definition of an inverse function, Basic identities ii) Inverse trigonometric and hyperbolic functions (may be requested in combinatorial exercises) Indefinite Integral i) Definition, Basic concepts, Antiderivative or primitive, Properties ii) Indefinite integrals of trigonometric, hyperbolic, inverse trigonometric, and inverse hyperbolic functions iii) Methods of integration: substitution method applied to composite functions, integration by parts, calculation of the integral of a rational function Definite and Generalized Integrals i) Definition, Basic concepts, Properties ii) Applications of integrals Practical Training in Numerical Analysis Programs (Matlab)
Expected learning outcomes and competences	The course aims to develop a deep understanding of the basic concepts in single-variable function analysis, linear algebra, and analytical geometry. Upon successful completion of the course, students will be able to recognize and solve engineering-related problems involving the analytical geometry of the plane, complex numbers, matrix algebra, systems of linear equations, vector spaces, linear transformations, inverse trigonometric and hyperbolic functions, indefinite integrals, and more. Students will become familiar with all the mathematical procedures related to the optimisation of scientific processes and situations. Other Skills: • Research, analysis, and synthesis of data and information using the necessary technologies • Decision-making • Creative and inductive thinking

	• Independent and team-based work
Teaching methods	Lectures, exercises

PHYSICS	
Course number	103
URL	http://eclass.uowm.gr/courses/MECH201/
Recommended Prerequisites	-
Course content	Basic Theory of Mechanics. Newton's Laws. Forces. Principles of Energy Conservation of Momentum and Angular Momentum. Kinematics and Dynamics of Material Point. Rigid Body Kinematics. Relative Motion. Rigid Body Dynamics in the Plane and in Space. Oscillations, Electric charge and Electric Field, Electric Potential, Electric Currents, DC Circuits, Magnetism, Electromagnetic Induction and Faraday's Law, Electromagnetic Waves.
Expected learning outcomes and competences:	The course outlines basic knowledge of Mechanics and Electromagnetics. After the completion of the course the students should be able to: • extract the equations defining the variation of the space, speed and acceleration in one, two and three dimensions • extract equations of the motion of material point • apply the law of Conservation of Energy • calculate Rolling, Torque, and Angular Momentum • apply Coulomb's Law • calculate the Intensity of Electric Fields • calculate electric potential • apply Gauss law • calculate capacitance • calculate resistance • calculate the intensity of magnetic fields • apply Kirckoff laws for electrical circuits
Teaching methods	Lectures (13 weeks x 3 hours lectures + 1-hour practical session)

CHEMISTRY	
Course number	104
URL	http://eclass.uowm.gr/courses/MECH118/
Recommended Prerequisites	-
Course content	Introduction to the basic principles of the structure of atoms, Quantum mechanical approach of atoms, Electronic configuration of atoms, Periodic system of elements, Ionic and co-valent bonds, Molecular geometry, Hybridization, Molecular orbital theory, Metallic bonds, Intermolecular forces, Chemical kinetics, Chemical equilibrium, Chemical solutions, Acids – Bases – Salts, Redox processes & electrochemistry, Spectroscopic techniques.
Expected learning outcomes and competences:	The course introduces the basic principles of chemistry with particular emphasis on inorganic chemistry and physical chemistry. Through lectures and by solving related exercises, the students are introduced to the basic principles and applications of chemistry related to the discipline of Mechanical Engineering (i.e., Materials, Kinetics, Thermodynamics, Electrochemistry, etc.). Upon successful completion of the chemistry course the student will be able to: • understand the basic principles of Chemistry and Physical Chemistry • understand the structure of atoms and their properties according to their position on the periodic table • demonstrate knowledge of their electronic configuration and how their orbits are completed • gain knowledge of the types of bonds (ionic, polar covalent, nonpolar covalent, hydrogen bonds, London dispersion forces) to which the elements are linked to form compounds (gases, liquids, solids) • understand geometrical configuration • be familiar with the concepts of Chemical kinetics and the rate of reactions (activation energy, reaction order) • explore reaction mechanisms and kinetics by applying experimental data

	• understand how temperature, pressure and concentration affect collisions of elements for the reaction process • demonstrate knowledge of catalysis and its applications • be familiar with the concept of chemical equilibrium and its role in selecting the reaction conditions for industrially important reactions • be aware that the reaction conditions affect the position of equilibrium • understand chemical solutions, the concept of solubility, the effect of conditions (temperature, pressure) on the solubility of compounds in various solutions • be able to define concentrations in solutions in various ways • identify which compounds are considered as acids, bases and salts • determine which acids or bases are strong or weak • define the pH value of solutions • be aware of the phenomenon of acid rain • gain knowledge of the importance of solutions in everyday life • define which reactions are oxidation or reduction processes • understand redox • equilibrate redox reactions • estimate the open circuit potential in electrochemical cells • understand the principles of operation of electrolyzers, fuel cells and batteries
Teaching methods	Lectures (13 weeks x 2-hour lectures + 2-hour practical session)

INTRODUCTION TO COMPUTING

Course number	105
URL	http://eclass.uowm.gr/courses/MECH154/
Recommended Prerequisites	-
Course content	General computing literacy, hardware design and operation,

	and basic problem-solving techniques. Basic principles of programming using the MATLAB environment and language: the command prompt, scripts, function, tables, graphics and data visualization, flowcharts, selection and repetition structures, data input-output. Fundamental methods for developing and debugging programmes in Matlab.
Expected learning outcomes and competences:	Upon successful completion of this course, the students should be able to: • identify the main parts of a Computer System (processor, memory, peripherals) and understand their operation during the execution of an application, • have adequate knowledge of the basic programming principles (variables, selection, repetition, functions) through a high-level programming language (Matlab/Octave), • formulate ways of solving simple algorithmic problems and demonstrate their solution with the creation of the appropriate scripts, • apply mathematical knowledge (arrays, functions) with the use of Matlab/Octave, • collect/store (from/into files) and represent graphically data with the use of Matlab/Octave, • utilize files to collect/store data and create plots with the use of Matlab/Octave, • utilize computing systems and their applications for the solution of problems in the field of Mechanical Engineering, • engage in collaborative problem-solving of complex problems during group projects
Teaching methods	Lectures (13 weeks x 2-hour lectures and 2-hour lab practice)

MECHANICAL DRAWING I

Course number	113
URL	http://eclass.uowm.gr/courses/MECH115
Recommended Prerequisites	-

Course content	Fundamental ISO rules for drawing (types of technical drawings, drawing tools and sheets, title block, parts list, drawing scales, types of lines and line widths, lettering), introduction to Computer-Aided Design/Drafting (CAD), views and representation of mechanical components (types of views, technical sketch, construction drawing, assembly drawing, rules and basic conventions for views), dimensions (ISO rules and principles for dimensioning, special symbols for dimensioning, basic methods and paradigms for dimensioning), Sections (general principles and rules for drawing sections, special types of sections, sections in multiple cutting planes).
Expected learning outcomes and competences:	Upon successful completion of the course, the students should be able to • fully comprehend fundamental concepts related to the various kinds of Engineering/Technical Drawings, • comprehend and apply ISO rules dealing with Technical/Mechanical Drawings, • construct a correct, according to the related ISO rules, Technical Drawing for an object of low or medium complexity, • evaluate correctness of a given Technical Drawing regarding both accuracy of representation (of the corresponding object) as well as agreement with applicable ISO rules, • demonstrate basic knowledge of industrial application of Technical/Mechanical Drawings, • construct a correct Technical Drawing (for an object of low complexity) using appropriate Computer-Aided Design software, • demonstrate basic knowledge of difficulties (and research issues) related to applying ISO rules in Mechanical Drawing and in engineering work in general
Teaching methods	Lectures (13 weeks x 2-hour lectures and 2-hour Drawing practice)

LINEAR ALGEBRA	
Course number	144
URL	eclass.uowm.gr/courses/ICTE211/
Recommended Prerequisites	-
Course content	Vector Calculus. Straight Lines, Surfaces and Curves in Space. Vector Spaces and Vector Subspaces. Linear independence, Bases and dimension of vector Spaces. Matrices and Determinants. Finite-dimensional linear mappings. Matrices of linear maps. Systems of Linear Equations and Matrices. Solution of Systems of Linear Equations. Eigenvalues-Eigenvectors. Matrix Diagonalization, Quadratic Forms.
Expected learning outcomes and competences:	Upon successful completion of this course, students will be able to: • gain knowledge and manage the general form of curves and surfaces, • understand and use concepts of vector spaces, • use matrices as tools in theoretical and numerical computations, • compute eigenvalues and eigenvectors, • compute determinants, • solve systems of linear equations, • manage and use matrix diagonalization
Teaching methods	Lectures, exercises

ENGLISH FOR SPECIFIC & ACADEMIC PURPOSES (ESP/EAP)	
Course number	141
URL	eclass.uowm.gr/courses/ICTE141/
Recommended Prerequisites	-
Course content	• What is Engineering

	• Basic Concepts in Engineering: Materials • Manufacturing Processes & Machine Tools • Conventional Machine Tools: lathe • Conventional Machine Tools: milling machine • CNC Machines
Expected learning outcomes and competences:	The course aims at enabling students to: • become familiar with ESP/EAP discourse and structure and identify lexical and grammatical structures in authentic academic texts • activate and combine already acquired knowledge in Engineering, and develop reading comprehension of authentic texts, charts, tables etc. • learn and apply basic academic writing skills to produce descriptions, comparisons, references, etc. • develop independent learning skills and critical thinking • enhance inter- and multicultural awareness
Teaching methods	3 hours per week (lectures)

MATHEMATICS II

Course number	102
URL	-
Recommended Prerequisites	Mathematics I
Course content	The ℝn space, Quadratic surfaces, Real functions of several variables, Partial derivatives, Chain differentiation, Directional derivative, Extreme values, Taylor series, Double integrals, Triple integrals, Vector functions, Curves, Line integrals, Differentiation of scalar and vector fields, Conservative fields, Green's theorem, Surface integrals, Gauss και Stokes theorems.
Expected learning outcomes and competences:	Upon successful completion of this course, students will be able to: • differentiate variables of several functions, • use cylindrical and spherical coordinates,

	• find extreme values (free/constraint) and saddle points, • linearize functions and find tangent planes, • perform double and triple integration, • manipulate vectors, • differentiate vector functions, • detect irrotational and solenoidal fields, • determine potentials for conservative fields, • parametrically describe curves and surfaces, • calculate line integrals and fluxes through surfaces of vector fields, • use Green's, Gauss, and Stokes theorems
Teaching methods	Lectures, exercises

MATERIALS SCIENCE I	
Course number	109
URL	https://eclass.uowm.gr/courses/MECH200/
Recommended Prerequisites	• Physics • Chemistry
Course content	Atomic structure and chemical bonds (covalent, ionic, metallic, secondary bonds), Crystallography and Crystal Structure (Crystalline systems, Bravais lattices, Elementary cells (Comparison of FCC, HCP and BCC crystal structures), Crystallographic directions, levels & amp; density, single- and poly-crystalline materials), Crystallographic structure imperfections (point, linear, flat, three-dimensional). Granules, grain microstructure limits, microscopy, particle size. Equilibrium phase diagram (complete solid solubility, lever rule, eutectic phase diagrams, peritectic phase diagrams, solid solutions, thermodynamic interpretation of Gibbs law, binary diagrams). The Fe-C system. Basic solidification mechanisms. Nucleation and Growth, Casting, Segregation. Phase transformations and thermal processing of steel alloys and cast metals (fabrication processes, precipitation processes, annealing processes, recovery, recrystallization, and grain growth).

	The course comprises seven distinct units, aimed at covering the basic concepts of Materials Science (theoretical and laboratory level): 1. Historical overview of materials and their classification (categories and applications). 2. Atomic structure and chemical bonds (Metallic, Ionic, Covalent bonds, VandeWaals bonds). The effect of bonds on material properties. Crystal lattice/unit cells. 3. Crystallography: Crystal systems and Bravais lattices. Main metallic crystal structures. Atom positions in cubic unit cells. Directions in cubic unit cells. Miller indices for crystallographic planes in cubic unit cells. Crystallographic planes and directions in hexagonal unit cells. Comparison of FCC, HCP, and BCC crystal structures. 4. Crystal structure defects: Vacancies/point defects. Line dislocations. Planar defects and three-dimensional defects. 5. Phase equilibrium diagrams: One-component systems, Solid solutions (interstitial, substitutional). Two-component diagrams (complete solid solubility, eutectic, complex). Phase analysis, phase percentages. The Fe-C system. Three-component diagrams. Solidification. Undercooling. Nucleation (homogeneous-heterogeneous). Growth (planar-dendritic). 6. Industrial alloys: Steels. Cast irons. Copper alloys, Light metals (Al, Mg). Titanium alloys, Zinc alloys, Lead alloys, Superalloys. 7. Microstructure: Heat treatments of metals.
Expected learning outcomes and competences:	Upon successful completion of the course, students will be able to: • understand the modern achievements in materials science and the latest trends in their applications. • recognise the necessity of materials science in mechanical engineering. • comprehend the relationship between the

	macroscopic properties of materials and their microstructure. • identify the main characteristics of metallic, ceramic, polymer, and composite materials. • recognise the morphological characteristics of crystalline and amorphous structures in materials. • classify alloys based on phase equilibrium diagrams. • monitor the structural changes in materials due to thermal variations.
Teaching methods	Lectures (13 weeks x 3-hour lectures + 2-hour practical session)

ENGINEERING STATICS	
Course number	111
URL	http://eclass.uowm.gr/courses/MECH151/
Recommended Prerequisites	• Mathematics I • Physics • Linear Algebra
Course content	Force and moment. Addition and resolution of forces. Free body diagram. Equilibrium conditions. Elementary structures: rods, beams, cables. Advanced structures: frames, trusses. N-Q-M diagrams. Friction: brakes, clutches, couplings, belts. Center of mass. Moments of Inertia.
Expected learning outcomes and competences:	Upon successful completion of this course the students should be able to • have/demonstrate a full understanding of the basic types of structures involved in standard engineering applications, • know about and handle the various types of external loads for all kinds of structures considered in this course, • comprehend issues related to supporting a structure either on the "ground" or on some other structure, • analyze beams and frames of various geometric configurations,

	• thoroughly analyze a truss of medium complexity regarding both geometric rigidity as well as member forces, • calculate the centroid of a complex planar area, • analyze a flexible chain or cable subjected to loads appearing in standard applications
Teaching methods	Lectures (13 weeks x 2.5 hours of lectures + 2.5 hours of practice)

MECHANICAL DRAWING II	
Course number	146
URL	http://eclass.uowm.gr/courses/MECH140
Recommended Prerequisites	• Mechanical Drawing I • Mathematics I • Physics • English
Course content	Computer-aided mechanical drawing (CAD), Drawing of connection elements (geometric features and categories of threads, standard threads, drawing of thread holes, dimensions and types of screws, standardization of bolts, nuts and tools, bolted joints and related components, rivets, welding methods and drawing of welds), Manufacturing processes (surface quality, surface roughness, selection criteria for manufacturing processes, symbols and regulations, notations for heat treatments and hardness processes), Tolerances (dimensional tolerances, fits and fittings, standardization according to ISO, tolerances of form/orientation/location), Power transmission elements (shafts, bearings, wedges, splines, gear geometry and notation, types of gears, sprockets), drawing of mechanical assemblies (e.g., gearboxes), three-dimensional (3D) representation (types of 3D representations, oblique projection, axonometric projection, perspective representation).
Expected learning outcomes and	Upon successful completion of this course the students should be able to:

competences:	• comprehend fundamental concepts related to connection elements and construct a correct Mechanical Drawing employing these, • demonstrate knowledge about symbolic representation of welded/brazed/soldered joints in drawings, • comprehend issues related to assembly drawings and construct such a drawing, • demonstrate knowledge and apply drawing techniques related to manufacturing processes, • fully comprehend issues related to tolerances/deviations/fits and apply them in Mechanical Drawing, • construct a correct Mechanical Drawing (for an object of low or medium complexity) using appropriate Computer-Aided Design (CAD) software, • demonstrate basic knowledge of difficulties (and research issues) related to applying ISO rules and mechanical CAD in manufacturing
Teaching methods	Lectures (13 weeks x 2-hour lectures and 2-hour practical session in Drawing)

FUNDAMENTALS OF MACHINING	
Course number	114
URL	http://eclass.uowm.gr/courses/MECH140
Recommended Prerequisites	• Science and Technology of Materials I • Science and Technology of Materials II • Strength of Materials
Course content	Introduction to engineering analysis. Load, stress and strain. Normal, torsional, bending, and transverse shear stresses and strains. Failure prediction for static and dynamic loading. Operating stresses. Calculation of static and dynamic strength. Combined stresses and equivalent stresses. Permissible stresses. Strength safety factors. Fasteners and screws. Welded joints.
Expected learning outcomes and	Upon successful completion of the course, students will be able to: • obtain a first look with the subject of machining

competences:	processes, • understand the basics of forming methods, • choose the most appropriate machining method for an object • considering dimensional precision requirements and general qualities and quantities, • recognise and understand concepts related to the modern systems, • compose and re-design products according to the needs of construction, • select the optimum parameters required at various machining processes, • have a theoretical background concerning the knowledge of conventional machine tools.
Teaching methods	Lectures (13 weeks x 5-hour lectures)

ENGLISH for SPECIFIC & ACADEMIC PURPOSES (ESP/EAP)	
Course number	142
URL	eclass.uowm.gr/courses/ICTE142/
Recommended Prerequisites	-
Course content	• Internal Combustion Engines • Electricity Generation • Renewable Energy Sources • Turbines • Heating – Ventilation – Air Conditioning • Computer-Integrated- Manufacturing • Production Planning & Control • Supply Chain Management
Expected learning outcomes and competences:	The course focuses on improving already acquired learning strategies, and further developing critical thinking and academic skills to identify, understand, and write academic discourse (scientific texts, instruction manuals, reports, descriptions, etc.), and be able to use the relevant literature.

	In particular, the course emphasises the development of two basic skills, reading and writing, which are required at all levels of Higher Education, and qualifies students with: • further improving and expanding knowledge of the lexis and structure of various academic and scientific texts (research papers, theses, etc.) • interpreting key information and producing information from charts, tables, etc. • developing skills and strategies employed in academic discourse (paraphrasing, paragraph composition, abstracts, etc.) • practising writing skills for research papers and theses • using referencing and bibliography
Teaching methods	Lectures (13 weeks x 3-hour lectures and practice [e-class])

STRENGTH OF MATERIALS	
Course number	110
URL	http://eclass.uowm.gr/courses/MECH155/
Recommended Prerequisites	• Statics • Science and Technology of Materials I • Science and Technology of Materials II
Course content	Axial loading, shearing stress, bearing stress in connections, stress under general loadings, Safety Factor, Hooke's law, Modulus of Elasticity, elastic vs. plastic behavior, static indeterminacy, thermal stresses, Poisson's ratio, generalized Hooke's law, shearing strain, Saint-Venant's principle. Torsion: Stress, strain, angle of twist in elastic range, statically indeterminate shafts, design of transmission shafts, stress concentrations. Pure Bending: Deformations in symmetric member, strain due to bending, bending of members made of several materials, stress concentrations, asymmetric bending, general case of eccentric axial loading. Design and analysis of beams: N,Q,M diagrams, determination of the shearing stress in common or complex types of beams, shear stresses in thin-walled members. Stress–Strain Transformations: Plane stress transformation, principal stresses, maximum shear stress, Mohr's Circle for plane stress and general Three-Dimensional

	analysis of stress and strain.Deflection of beams: Deformation of a beam under transverse loading, equation of the elastic curve, determination of the elastic curve from the load distribution, method of superposition, moment–area theorems.
Expected learning outcomes and competences:	Upon successful completion of this course, students will be able to: • analyse a given problem in a simple and logical manner, • apply fundamental and well-understood principles, • understand the concepts of deformable solid body by applying the principles of the theory of elasticity, • acquire knowledge of analysing stresses in particular building blocks, components of machines or devices, with specific support, at constant or anticipated external loads applied in certain ways, • understand the concepts of tension, compression, torsion, bending, eccentric axial loading and deflection, • determine the expected mechanical behaviour of structural elements or components of machines or devices, as the basis of proper design or validation of their safety factor
Teaching methods	Lectures (13 weeks x 3-hour lectures + 2-hour practical session)

STATISTICS	
Course number	107
URL	http://eclass.uowm.gr/courses/MECH164/
Recommended Prerequisites	Mathematics I & II
Course content	Descriptive statistics: data summary and presentation, frequency distribution, histogram, characteristic values (mean, median, mode, range, variance, standard deviation). Probability theory: basic concepts, events, conditional probability, addition and multiplication law of probabilities, Bayes theorem. Probability distributions, discrete and continuous random variables, expected value, variance and standard deviation. Important distributions: Bernoulli, binomial, geometric, Poisson, uniform, exponential, gamma, normal distribution and the

	central limit theorem, Student, X2 and F distributions. Statistical estimation: sampling distributions, point estimation, properties of estimators, confidence intervals. Statistical hypotheses: hypothesis testing, type I and type II errors, required sample size, goodness of fit tests.
Expected learning outcomes and competences:	The course is an introduction to the concepts, techniques and tools of statistics. The course aims to introduce the basic concepts of probabilities and statistics and present the main tools and scientific methods of both descriptive and inferential statistics. An additional course objective is to present alternative applications of statistical methods used in a variety of operational (and not only) problems. The course provides background knowledge for several advanced courses in the industrial management direction of studies, on which specific statistical methodologies and techniques are developed and applied. After successful completion of the course, students will be able to: • process data sets • apply the basic principles of the probability theory • perform Bayesian updating • identify and use the basic probability distributions • calculate probabilities using probability (density) functions • perform statistical estimates • calculate confidence intervals • perform and interpret statistical hypothesis testing
Teaching methods	Hours of Instruction 65 (Lectures: 39, Exercises: 26)

THERMODYNAMICS I	
Course number	119
URL	http://eclass.uowm.gr/courses/MECH105/
Recommended Prerequisites	• Physics • Mathematics I • Mathematics II
Course content	Introduction – Basic concepts and definitions (thermodynamics, system and state, pressure, temperature, thermodynamic

	process, mechanical work, energy, heat, reversibility). First law of thermodynamics (internal energy, enthalpy, work, closed systems, steady-flow processes). Second law of thermodynamics (entropy and thermodynamic equilibrium, entropy, heat, and dissipation energy, heat engines, heat pumps, entropy of a perfect gas, Carnot cycle for a perfect gas, application in energy conversions). Mathematical foundation of thermodynamics (total differential and state functions, transformation relations, Legendre transformations, basic property relations for PVT systems with variable composition and heat capacities for PVT systems with constant composition, equilibrium in closed heterogeneous systems). Thermodynamic properties of pure substances (thermodynamic state quantities, liquid-vapor region, solid region, equations of state, compressibility factor, corresponding state correlations). Ideal gases and gas mixtures and gas-vapor mixtures (ideal gases, ideal gas mixtures, gas-vapor mixtures, moist air). Thermodynamic analysis of steady-flow processes (work, dissipation energy, flow processes, mixing processes, work processes). Power cycles (steam cycles, internal combustion engines, Carnot, Otto, Diesel, Brayton, Rankine, Stirling, Kalina). Thermodynamics of refrigeration and liquefaction (heating and cooling as fundamental thermodynamic problems, refrigeration production methods, Carnot refrigeration cycle, heat pumps, liquefaction processes). Thermodynamics of power generation systems with heat and combustion (conversion of chemical and nuclear energy into work and electrical energy, work production with steam, improvements, work production with gas). Thermodynamic process analysis (work of a reversible process, energy non-convertible to work).
Expected learning outcomes and competences:	The course focuses on understanding the fundamental concepts and principles in thermodynamics, emphasising the solution of engineering problems and analysing energy

	systems and flow processes.
Teaching methods	Oral presentations and exercises
Assessment methods	Written exam, 70% final exam, 30% midterm exam

MATHEMATICS III

Course number	132
URL	http://eclass.uowm.gr/courses/ ICTE109/
Recommended Prerequisites	• Mathematics I • Mathematics II • Linear Algebra
Course content	Introduction. First-order ordinary differential equations. Separable equations. Exact equations, integrating factors. Linear equations. Solution via substitution. Higher-order ordinary differential equations. Linear equations with constant coefficients. Order reduction. Solution of inhomogeneous differential equations. Laplace transform and its use for solving differential equations. Series solution of differential equations, ordinary and singular points. Systems of differential equations, solution with the matrix method. Complex numbers. Complex functions. Differentiation of complex functions. Integration of complex functions.
Expected learning outcomes and competences:	Upon successful completion of this course, students will be able to: • tilize the mathematical models for certain physical problems, • identify the general form of differential equations, • apply appropriate methods for determining partial and general solutions, • solve initial value problems, • determine solutions in the form of power series, • exploit the Laplace transform, • solve systems of differential equations, • graphically solve certain types of differential equations, • deal with fundamental problems of complex analysis
Teaching methods	Lectures, exercises

MATERIALS SCIENCE II	
Course number	135
URL	http://eclass.uowm.gr/courses/MECH199/
Recommended Prerequisites	• Strength of Materials I
Course content	Use of defects to modify the mechanical and physicochemical properties of alloys. Basic concepts of Mechanical Properties: Stress, strain, tension, compression, stress-strain diagrams, Hooke's law, modulus of elasticity, yield strength, strength, mechanical and true stress and strain, plastic deformation, ductility. Strength and microstructure, Hall-Petch equation, superplasticity. Fracture (brittle, ductile, fracture surface morphology). Methods of modifying mechanical properties: Strengthening mechanisms (dislocations, grain size, strain hardening, solutions, precipitation, and precipitation processes) and recovery (thermal processes, annealing, recrystallization, grain growth). Atom mobility and diffusion in solids (mechanisms, Fick's laws). Fracture mechanics (stress concentration, Griffith's theory, critical stress intensity factor). Toughness (experimental determination, impact testing, temperature dependence, ductile to brittle transition curve – DBTT). Fatigue (description, characteristics, fracture morphology, experimental determination, mechanisms, factors affecting the phenomena). Creep (Creep curve, stages and mechanisms of creep, effect of temperature and stress, alloy design). Wear and friction (Basic concepts and mechanisms, experimental wear-friction testing, lubricants).
Expected learning outcomes and competences:	Upon successful completion of the course, students will be able to: • analyze and compose information about materials using literature and material databases, • understand experimental methods for testing

	• mechanical strength (tensile testing, hardness testing, etc.), • interpret deformations and fracture surfaces of specimens due to failure, • identify criteria for selecting optimal materials for engineering applications, • analyze results from material structure characterization techniques (XRD, optical microscopy, etc.), • select appropriate methods for protecting materials from corrosion, oxidation, and wear.
Teaching methods	Lectures [13 weeks x 5 hours (3-hour lectures + 2-hour practical session)].

DYNAMICS	
Course number	112
URL	http://eclass.uowm.gr/courses/MECH127/
Recommended Prerequisites	• Statics
Course content	Kinematics of particles (position vector, velocity, acceleration, rectangular coordinates, cylindrical coordinates, tangential coordinates, relative motion), Kinetics of particles (Newton's and Euler's laws of motion, principles of impulse and momentum, principles of work and energy). Applications (central collision, central forces – space mechanics, variable systems of material points). Kinematics of rigid bodies (translation, pure rotation, plane motion, rotation about a fixed point, spatial motion, relative motion), Kinetics of rigid bodies (inertia tensor, Newton's and Euler's laws of motion, principles of impulse and momentum, principles of work and energy, inertia forces, virtual forces). Applications (eccentric impact, balancing of rotating rigid bodies, axisymmetric rigid body rotation).
Expected learning outcomes and competences:	Upon successful completion of this course, students will be able to: • have a thorough understanding of the basic principles of dynamics

	• understand the relationship between the movement of material bodies and the forces that cause motion or develop during motion • classify the equilibrium benefits of material points and solid bodies • analyse the movement of dynamic systems consisting of material points or solid bodies • calculate mass parameters of inertia of solid bodies • apply the basic principles of dynamic problem solving with emphasis on the analysis and determination of motion and the forces that develop during the motion of the bodies • solve typical examples using analytical and numerical methods
Teaching methods	Lectures (13 weeks x 3-hour lectures and 2-hour Exercises) and homework.

MACHINE ELEMENTS I	
Course number	108
URL	-
Recommended Prerequisites	• Statics • Strength of Materials • Mechanical Drawing
Course content	Introduction to engineering analysis. Force flow, power flow, form-fit connections, friction-fit connections, form-friction-fit connections. Identification of critical wear calculation points. Operating stresses. Notch stresses. Calculation of static and dynamic strength. Combined stresses and equivalent stresses. Permissible stresses. Strength safety factors. Fasteners and screws. Welded joints. Shafts, rolling bearings, shaft-hub connections, and bearings. Design of simple structures.
Expected learning outcomes and	Upon successful completion of the course, students will be able to:

competences:	• be aware of the importance of materials choice in engineering • perform study calculations and control studies on simple parts of machine components • understand the importance of machine elements design • construct and assembly various machine elements • carry out simple machine components project studies • work as designers or manufacturers
Teaching methods	Lectures (13 weeks x 3-hour lectures and 2-hour practical session) and one assignment (optional)

FLUID MECHANICS I

Course number	120
URL	http://eclass.uowm.gr/courses/MECH103/
Recommended Prerequisites	• Physics • Thermodynamics I • Mathematics II
Course content	Basic definitions. Properties of fluids. Fluid Statics: Measurement of pressure, hydrostatic forces, buoyancy and Archimedes's law. Introduction to Fluid Dynamics: Bernoulli's equation and its applications. Kinematics of fluids, Eulerian and Lagrancian description of flow. Reynolds transport theorem. Control volume formulation and application in mass, momentum and energy conservation. Differential analysis of flow fields: stream function, vorticity and potential; elementary ideal, potential, flows and their combinations, examples and applications. Continuity equation, Euler and Navier Stokes equations of motion, Energy equation and their applications. Viscous flows and their application in simple geometries: Poiseuille flow in a slit channel and a cylinder, Quette flow. Dimensional analysis, similarity and dimensionless numbers. Π-Buckingham's theorem. Flow in tubes: Fully developed flow, introduction to turbulence and the concept of the boundary layer. Dimensional analysis and the use of Moody's charts to determine the pressure drop in smooth and rough tubes.
Expected learning	The course is an introduction to the basic principles of Fluid

outcomes and competences:	Mechanics, and aims at enabling students to: • acquire knowledge of the application field, laws and basic principles of Fluid Mechanics • learn about principles and methods, as well as the importance of applying them to solve technical problems • learn about how to evaluate the suitability of methods, given the characteristics and particularities related to each specific problem • acquire knowledge to solve, among others, the following problems: - measurement/estimation of hydrostatic pressure - application of Bernoulli's equation for ideal flows - implement control volume analysis - application of Poiseuille's equation for viscous flows determination of pressure drop in tubes, etc
Teaching methods	Lectures and practical sessions

MATHEMATICS IV	
Course number	137
URL	http://eclass.uowm.gr/courses/ICTE217/
Recommended Prerequisites	• Linear Algebra • Mathematics II • Mathematics III
Course content	Introduction to Partial Differential Equations (PDEs). Examples of PDEs. First-order PDEs. Linear, semi-linear, and quasi-linear PDEs. Characteristic curves. The Cauchy problem. Second-order PDEs, classification, standard forms. Eigenvalue problems. The Laplace equation, solution in Cartesian and polar coordinates, cases of homogeneous and inhomogeneous boundary conditions and infinite domains. Orthogonal functions, Fourier series and Fourier integrals. The heat equation, solution in finite and infinite spaces. Special functions. The wave equation, finite and infinite strings.

Expected learning outcomes and competences:	Upon successful completion of this course, students will be able to: • identify different types of PDEs, • derive thematical models for different problems, • solve PDES with the method of characteristics, • deal with eigenvalue problems, • reduce PDES to their canonical forms, • apply separation of variables and other techniques for the solution of PDEs, • solve problems in different coordinate systems, • solve problems in finite, semi-infinite or infinite spaces, • use orthogonal functions and exploit Fourier series and integrals
Teaching methods	Lectures, practical session (exercises)

THERMODYNAMICS II	
Course number	133
Instructor(s)	D. Kolokotronis
Semester	6
ECTS	5.5
URL	http://eclass.uowm.gr/courses/MECH129/
Hours per week	5
Recommended Prerequisites	• Mathematics I • Mathematics II • Physics • Thermodynamics I
Course content	Exergy, Ideal gas mixtures, Gibbs and Helmholtz functions. Combustion process. Mass transfer calculations in complete combustion, application of the first law of thermodynamics in combustion processes, heating value, enthalpy of reaction. Application of the second law in combustion processes. Thermodynamic relations, Maxwell's equations.

	Thermodynamic properties of systems with variable chemical composition, Equilibrium of thermodynamic systems. Chemical potential and chemical equilibrium. Dissociation. Thermodynamics of special systems.
Expected learning outcomes and competences:	Upon successful completion of the course, students will be able to: • calculate exergy and its changes in several thermodynamic systems • calculate intensive and extensive properties of mixtures • apply the 1st and 2nd thermodynamic laws to reactive systems • calculate adiabatic flame temperature and heat of reaction in combustion applications • calculate the changes in entropy, enthalpy and internal energy of thermodynamic systems based on measured sizes and the use of Maxwell equations • choose the appropriate equation of state for each thermodynamic system • calculate concentrations and temperatures in thermodynamic systems where chemical equilibrium has occurred
Teaching methods	Oral presentations and coursework
Assessment methods	Written exam with optional midterm exam

HEAT TRANSFER	
Course number	118
URL	http://eclass.uowm.gr/courses/MECH105/
Recommended Prerequisites	• Thermodynamics I • Fluid Mechanics I
Course content	Introduction to the mechanisms of heat transfer: conduction, convection and radiation. Conduction: Fourier's law, thermal conductivity, heat diffusion equation in Cartesian, polar and spherical coordinates. Steady-

	state conduction: heat resistance concept, critical radius of insulation, multi-dimensional configurations (analytical, graphical and numerical solutions), shape factor in common configurations, heat-transfer enhancement via fins. Multidimensional heat conduction: Analytical, graphical, and numerical methods, view factor in common geometries. Transient heat conduction: Biot number, lumped-capacitance method, analytical solutions in simple geometries (plane, cylinder, sphere), Heissler charts, semi-infinite media, numerical methods. Forced convection: Newton's law of cooling, local and average heat-transfer coefficient, Navier-Stokes and energy equations, dimensional analysis, Nusselt number, Prandtl number, Reynolds number, empirical correlations for internal and external flows (laminar and turbulent flows). Natural convection: natural convection currents, Bernard cells, Grashof number, empirical correlations for the convection coefficient on external surfaces and enclosed spaces, combined natural and forced convection. Boiling and condensation: pool boiling, boiling curve, empirical relationships for nucleate boiling, tube boiling, drop and film condensation, condensation over tubes and tube bundles. Heat exchangers: Types, functional analysis, sizing, correction factor method, effectiveness, and number of transfer units (NTU). Thermal radiation: fundamentals of electromagnetic radiation and waves, Wien's displacement law, black-body radiation, Stefan-Boltzmann equation, interaction between radiation and real surfaces, heat exchange between surfaces, view factor.
Expected learning outcomes and competences:	Upon successful completion of the course, the students will be able to: • understand the mechanisms of heat transfer and impact on practical problems • carry out energy balances • solve heat diffusion equations for specific cases • utilize the concept of heat resistance to calculate the rate of heat transfer • estimate the efficiency and effectiveness of fins • understand and use different methodologies to estimate the time required for the transfer of specific amount of heat

	• identify the dimensionless variables that govern heat convection problems • estimate the convection heat transfer coefficients in internal and external flows • understand the physical mechanisms of boiling and condensation • estimate heat transfer coefficients associated with phase change • learn the basic types of heat exchangers • analyse the performance and design of heat exchangers
Teaching methods	Lectures and Tutorials (13 weeks x 3-hour lectures and 2-hour practical session).

MECHANICAL VIBRATION AND MACHINE DYNAMICS

Course number	140
URL	http://eclass.uowm.gr/courses/MECH107
Recommended Prerequisites	• Dynamics
Course content	Free vibration and forced response of single degree of freedom linear oscillators to impulsive, harmonic, periodic, and transient excitation (natural frequency, damping ratio, resonance). Response of multiple degree of freedom linear oscillators (formulation of the equations of motion, determination of natural frequencies and mode shapes, modal analysis). Axial, torsional and bending vibration of bars. Applications (measurement and evaluation of vibration characteristics, vibration isolation, vibration absorption, balancing, torsional vibration). Apart from its theoretical part, the course is also an introduction to programming, based on application programs in MATLAB environments. During the course, the students are called to work on three (3) laboratory exercises to learn about the experimental methods in vibrations of mechanical systems and have the opportunity to gain insight into how theoretical issues are interlinked with

	actual constructions.
Expected learning outcomes and competences:	Upon successful completion of this course, students will be able to: • have a thorough understanding of the underlying principles of oscillation • develop simplified models of mechanical systems • develop and solve the motion equations of mechanical systems • predict dynamic and oscillating behavior of systems based on model analysis • understand the basic dynamic characteristics that affect the dynamics of mechanical systems • apply methodologies for designing mechanical vibration isolation devices • solve typical examples using analytical and numerical method
Teaching methods	Lectures (13 weeks x 3-hour lectures and 2-hour practical session) and homework.

OPERATIONS RESEARCH I

Course number	147
URL	http://eclass.uowm.gr/courses/MECH165
Recommended Prerequisites	• Statistics
Course content	Introduction to optimization, mathematical programming models, variables, objective function parameters, constraints. Linear programming theory, graphical solution, Simplex method, sensitivity analysis. Linear programming problem solving using computer software (lindo, lingo, EXCEL solver). Integer programming. Branch and Bound algorithm. Binary programming. Applications to real-world problems.
Expected learning outcomes and competences:	The course introduces students to the basic knowledge of Quantitative Analysis. Particular emphasis is given to tilize ion techniques for real production processes and systems. The course also focuses on case studies to prepare

	students for modelling real process tilize ion problems. Upon completion of the course, students will understand the basic functions and the most important decision-making tools within production systems (i.e., inventory management, equipment maintenance, quality control, demand forecasting, production planning) as well as their interactions, and they should be able to: • understand the relationship between real problems and mathematical modelling • identify and use basic operations research tools • model real problems using mathematical programming • solve and obtain optimum solutions for various engineering problems • analyse solutions to engineering problems
Teaching methods	Lectures (3-hour lectures and 2-hour practical session).

ELECTROTECHNICS	
Course number	116
URL	http://eclass.uowm.gr/courses/ICTE163/
Recommended Prerequisites	-
Course content	Electrical charge, current, voltage, power. Kirchhoff laws and Tellegen theorem. Electrical components and their connection. Resistance, impedance, conductivity, complex conductivity. Methods of analysis of circuits in DC and AC (voltage division, current division, Millman theorem). Use of phasors and complex numbers. Systematic methods of analysis of electrical circuits (loop method, node method). Electrical circuit theorems (superposition, maximum power transfer, Thevenin, Norton). Power and energy in sinusoidal excitation circuits. Power triangle, power factor and correction. Symmetric three-phase circuits.
Expected learning outcomes and	The course aims to introduce students to the basics of the theory and analysis of electrical circuits. During the course, students acquire knowledge of aspects of electric machines as

competences:	well as issues of power generation, transmission, distribution, and use. Upon successful completion of the course, students will: • be familiar with the basic principles for electrical circuits (DC and AC) • be able to analyse DC and AC electrical circuits and calculate basic current, voltage and power quantities • in the case of AC circuits, to convert circuits to frequency domain, and analyse them with phaset using the complex number theory • use electrical circuit principles and build circuits • apply general methods of solving and analyse all types of electrical circuits • gain insight into the basics of three-phase circuits and perform basic calculations using the one-phase equivalent • understand the advantages and disadvantages of using DC, AC and AC three-phase current • develop problem-solving abilities and evaluate numerical calculations to understand the order of magnitude
Teaching methods	Hours of Instruction 52 (Lectures: 32, Laboratory: 20)

MACHINE ELEMENTS II

Course number	138
URL	http://eclass.uowm.gr/courses/ MECH121/
Recommended Prerequisites	• Statics • Strength of Materials • Mechanical Drawing • Machine Elements I
Course content	Lubricants and lubrication, Hydrodynamic bearings and seals, Shafting and associated parts, Power transmission, Flat, synchronous and V-belts, Parallel axis gears, Planetary gear trains, Nonparallel coplanar and non-coplanar gears, Gearboxes, Design of power transmission systems.
Expected learning	Upon successful completion of this course, students will be

outcomes and competences:	able to: • understand the different methods of support shafts and spindles and the diversity of bearings versus sliding bearings usage, • understand the basic concepts of motion and power transfer from axis to axis, by means of straps, chains, and gears, • have the ability to assess and solve complex problems of movement and power transfer, • develop operational provision engines in laboratory spaces, • carry out complex machine components project studies, • work as designers or manufacturers
Teaching methods	Lectures (13 weeks x 3-hour lectures and 2-hour practical session) and one assignment (optional).

ELECTRICAL MACHINES

Course number	117
URL	http://eclass.uowm.gr/courses/MECH170/
Course content	Fundamental principles of electromagnetism and principles of operation of AC and DC electric motors. Single-phase and three-phase transformers. Equivalent circuit. Synchronous generators. Equivalent circuit and parallel operation. Synchronous motors. Induction motors. Equivalent circuit. Typical torque-speed. Speed regulation, starting, and motor selection.
Expected learning outcomes and competences:	Upon successful completion of the course, students will: • be able to understand issues of electromechanical energy • be familiar with the basic types of AC electric motors • use equivalent electrical circuits to analyse electrical machines and extract their functional characteristics • gain knowledge of the behavior of generators and engines in changing loads

	• be able to choose the appropriate type and size of engines for specific applications • be able to choose appropriate engine start and engine methods • gain in-depth knowledge of the operation of the overall production, transmission, distribution and use of electricity • develop problem-solving abilities and evaluate numerical calculations to understand the order of magnitude
Teaching methods	Hours of Instruction 52 (Lectures: 32, Laboratory: 20)

INDUSTRIAL MANAGEMENT	
Course number	123
URL	http://eclass.uowm.gr/courses/MECH177/
Recommended Prerequisites	• Statistics • Operations Research
Course content	Introduction to production processes. Forecasting: time series and causal models; constant, linear-trend and seasonal models. Design of Production Systems: product design; process selection and capacity planning; facilities layout. Planning and Control of Production Systems: long, medium, and short-range production planning; inventory management; quality control; equipment maintenance and replacement.
Expected learning outcomes and competences:	The course aims at examining problems related to the design and operation of production units. Appropriate methods for decision-making are presented and analysed both for the design (position selection, organisation of production methods, means and administrative structure) and for the operation of production companies (production planning and control, work schedule, and procurement strategies). After successful completion of the course, students will be able to: • address problems related to the design and operation of a production plant • use forecasting techniques

	• apply specific methods for selecting a location • calculate the required capacity and equipment of a production unit • select the appropriate working method • apply production planning tools • tilize the job schedule • tilize the allocation of resources for a set of tasks • apply techniques for balancing and smoothing production lines • organise procurement decisions
Teaching methods	Lectures (39 hours), and practical session (26 hours).

NUMERICAL ANALYSIS	
Course number	106
URL	http://eclass.uowm.gr/courses/MECH172/
Recommended Prerequisites	-
Course content	Introduction to numerical analysis methods using MATLAB. Basic concepts of analysis. Representation of numbers and numerical solutions errors. Linear systems. Roots of equations. Nonlinear systems. Optimization. Curve fitting. Numerical interpolation and polynomial approximation. Numerical Differentiation and Integration. Ordinary Differential Equations. Gaussian elimination and matrix factorization techniques. Approximation Theory. Partial Differential Equations (PDEs). Practical applications using MATLAB.
Expected learning outcomes and competences:	The course aims at enabling students to acquire the necessary know-how to study engineering problems with emphasis on fluid flow using computational tools. Emphasis will be given to practical engineering applications. After completing the course, students will have the following skills: • ability to solve technical problems with computational techniques • ability to evaluate reasonable solutions and select

	appropriate levels of processing these solutions • understanding of the important physical phenomena to be integrated to the solution of the system • development of appropriate equations and computational models for the given system • ability to solve computational models for various processes/modules and simulation of the processes involved
Teaching methods	Lectures (26 hours), Lab – Exercises (39 hours)

AUTOMATIC CONTROL SYSTEMS	
Course number	219
URL	http://eclass.uowm.gr/courses/MECH219/
Recommended Prerequisites	• Physics • Introduction to Computing • Electrotechnics
Course content	The course introduces students to the basic principles of automatic control systems. Class lectures provide students with fundamental systems analysis skills with particular emphasis on the applications of control. Lectures cover the following topics: Mathematical model of a physical system and differential equations, electrical and mechanical dynamic systems, Open loop & Close loop control systems, Laplace Transform in control systems, Characteristics equation and Transfer Function, Block diagrams of systems, State space representation, time response for 1st order system, transient response specification of 2nd order system, Steady State error of a system, use of Matlab and Simulink in control topics, Stability of systems, Ruth-Hurwitz criterion.
Expected learning outcomes and competences:	By the end of the course, students must be able to understand the basic principle of theory, design and applications in all technical areas of control systems. Typically, students will have acquired the following skills: • distinguishing between open-loop and closed-loop control systems, recognizing the role of feedback and comparison in closed-loop systems.

	• extracting the mathematical model of electrical and mechanical dynamic systems • using the Laplace transform to calculate the time response • describing a system by the use of transfer function and state space representation • applying functional block diagrams of control systems • determining steady state and transient characteristics of first and second-order systems • defining stability by calculating positions of poles and using the Ruth-Hurwitz criterion • using Matlab and Simulink for analysis and design of control systems. • combining knowledge from different areas of control theory to evaluate control problems, identify specific characteristics, develop appropriate models, and choose the best control method.
Teaching methods	Lectures and tutorials

INTERNAL COMBUSTION ENGINES	
Course number	206
URL	http://eclass.uowm.gr/courses/MECH125/
Recommended Prerequisites	• Heat Transfer • Thermodynamics II
Course content	Energetic issues of internal combustion engines. Spark ignition engines. Compression ignition engines. Ideal, adopted, and real cycle. Mean pressures and efficiencies of the above cycles. Quality factor. Mechanical efficiency. Energy balances. Combustion chamber geometries. Fuel types and mixture formation, ignition, combustion, flame speed. Pollution due to IC Engines, pollution control. Analysis of indicator diagram. Control practices, representative operation curves at different loads. Operation at partial load. Detailed study of the real cycle

	of reciprocating engines. Experimental determination of representative cycle characteristics. Control. Heat losses. Basic phenomena and criteria. Cooling systems. Gas flow. Gas exchange mechanisms. Scavenging and supercharging systems. Comparison between commercial and racing internal combustion engines. Modern combustion technologies, homogeneous charge compression ignition engines, hydrogen engines.
Expected learning outcomes and competences:	This course provides knowledge of the basic principles of operation and thermodynamics of the internal combustion engines, such as analysis of the operational parameters, indicator diagram, combustion and intake and exhaust processes in natural aspirated and supercharged engines. At the end of the course, students will become familiar with the above issues and will be able to study and understand ICE operations for various applications. Upon successful completion of the course, the students will be able to: • have an understanding of the basic principles, operating parameters, and processes taking place in internal combustion reciprocating engines (atmospheric or supercharged) • gain knowledge of the tools and techniques used to study the operation of internal combustion engines • combine knowledge to choose the appropriate internal combustion engine depending on the application • apply acquired knowledge to examine the operation of an internal combustion engine • combine information of the course material or the extant literature to suggest optimisation of the operation of an internal combustion engine • evaluate the operation data of a reciprocating internal combustion engine and anticipate possible failures
Teaching methods	Lectures and practical session.

POWER PLANTS

Course number	204

URL	http://eclass.uowm.gr/courses/MECH162/
Recommended Prerequisites	• Heat Transfer • Thermodynamics II
Course content	Types of Power Generation Units (Steam, Gas, Combined, Cogeneration – Trigeneration, Nuclear Energy, Advanced Units), Steam Power Stations, Ideal and Real Rankine Cycle (Economizer, Evaporator, Superheater), Rankine Cycles with Reheating and/or Regeneration, Analysis of the Kardia Power Station in Western Macedonia, Gas Power Stations, Industrial and Aviation Gas Turbines, Compressors, Burners, Gas Turbines, Ideal and Real Brayton Cycle, Brayton Cycles with Regeneration, Multistage Compression and Multistage Expansion, Diesel Cycles and Engines, Combined Gas-Steam Cycles and Cogeneration Cycles, Combined Coal Combustion Cycles (Pressurized Fluidized Bed Combustion – PFBC, Integrated Gasification Combined Cycle – IGCC), Low-Grade Heat Utilization – Organic Rankine Cycles, Heat Recovery and Advanced Cogeneration Cycles, Urban District Heating Applications, Fuels and Fuel Management, Combustion Theory and Burner Types, Requirements and Safety in Buildings, Industry, and Transportation, General Combustion Calculations for Fuels with Known Chemical Composition or Elemental Structure, Thermodynamic Properties of Liquids and Gases according to NASA, JANAF, CHEMKIN, Properties of Mixtures, Solid Fuel Combustion in Grates, Pulverized Coal Burners, Liquid and Gas Fuel Burners, Burner Arrangements in Steam Boilers, Fluidized Bed Combustion, Historical Development of Steam Boilers, Vertical Water Tube Boilers, Horizontal Water Tube Boilers, Fire Tube Boilers (Lancashire, Scotch Marine, etc.), Water Tube Boilers, Variations of Small Units (Babckock & Wilcox, Stirling, etc.), Variations of Water Tube Boilers in Radiation Furnaces of Steam Power Plants, Convective and Radiation Superheaters, Steam Reheaters, Subcritical and Supercritical Pressure Boilers (Universal Pressure), Natural Circulation Boilers, Forced Circulation Boilers (Benson, Sulzer, Ramzin), Once-Through Boilers, Construction and Characteristics of Steam Drum Separators, Dissolved Solids Management and Blowdown, First Law Analysis (Energy

	Balance of Steam Boilers), Direct and Indirect Thermal Analysis Method, Classification and Calculation of Heat Exchangers, Economizer Sizing, Superheater and Reheater Sizing, Radiation Superheaters, Shell-and-Tube or Regenerative Air Preheaters (LUVO), Thermal Behavior Sizes of Furnaces, Methods for Calculating Flue Gas Temperature at the Furnace Exit, Radiation Furnace Design and Sizing, Fire Tube Furnace Design and Sizing, Particle Size and Properties of Solid Particles and Particle Beds, Fixed Bed Combustion, Fluidized Bed Combustion, Bubbling Fluidized Bed Boilers (BFB), Turbulent Fluidized Bed Boilers (TFB), Circulating Fluidized Bed Boilers (CFB), Fluidized Bed Gasification or Pyrolysis of Solid Fuels, Hydrodynamic Behavior of Fluidized Beds, Fluidized Bed Furnace Sizing, Steam Nozzles, Supersaturated Flow, Action and Reaction Steam Turbines, Steam Turbine Staging, Velocity Triangles in Action or Reaction Turbine Blades, Maximizing Efficiency of Action or Reaction Steam Turbine Blades, Reaction Degree and Maximizing Efficiency in Parsons Reaction Steam Turbine Blades, Environmental Impacts, Pollution and Pollution Control Technologies and Economics for Power Plants.
Expected learning outcomes and competences:	After successful completion of the course students will be able to: • understand about different thermoelectric power stations setups • calculate the energy efficiency of a thermal power station based on its operational parameters • suggest interventions to reduce the various energy losses • gain knowledge of the effect of the operating parameters of a thermoelectric power station on performance • calculate operational parameters and efficiency of combined cycles • understand the individual characteristics of combustion applications with different fuels • be aware of modern clean coal technologies for power generation
Teaching methods	Lectures and coursework

HEATING	
Course number	
URL	http://eclass.uowm.gr/courses/MECH271/
Recommended Prerequisites	• Heat Transfer • Thermodynamics I
Course content	Introduction: Objectives of thermal environment regulation. Issues of heat transfer and thermodynamics. Heating: Insulating behavior of materials, thermal insulation. Calculation of heating loads. Heating installations. Types of heating systems. Sizing of basic boiler room components: Calculation of the circulation pump, expansion tank, burner, chimney, and auxiliary components (safety valve, automatic filling valve, three-way and four-way valves). Heat transfer components. Terminal units. Legislation. Of Heating cost distribution.
Expected learning outcomes and competences:	The course introduces the basic principles of designing and analyzing heating systems and installations, including those for building complexes. Upon successful completion of the course, the students will have achieved/acquired: • understanding of the basic principles of analytical methods, and skills and relate them to already acquired knowledge (e.g. topics of Fluid Mechanics, Heat Transfer, etc.) • ability to appropriately apply relevant methods (e.g. calculation of thermal loads, thermal insulation capacity, etc.) • understanding of the particularities of each method (e.g. differences in heat load calculation methods) and skills of evaluating reliability by weighing the causes of possible complexity or the possibility of adopting more simplified approaches • ability to apply the methods for designing relevant installations
Teaching methods	Lectures, practical sessions, project.

COOLING – AIR CONDITIONING	
Course number	209
URL	http://eclass.uowm.gr/courses/MECH271/
Recommended Prerequisites	• Heat Transfer • Thermodynamics I
Course content	Air Conditioning: Comfort Conditions. Psychrometry (Thermodynamic properties of moist air, humidity parameters, psychrometric charts, typical processes in air conditioning). Climatic Data. Solar Loads. Air Conditioning Loads. Calculation of cooling loads (loads from walls, windows, lighting, occupants, appliances, air renewal, and infiltration). Description of Air Conditioning Systems and Components. Sizing of key components and duct networks. Cooling with Mechanical Vapor Compression. Basic refrigeration cycle, refrigeration cycle with subcooling and superheating, real refrigeration cycle, multistage vapor compression systems, refrigerants. Cooling with Absorption. NH3/H2O and H2O/LiBr absorption cooling systems. Adsorption cooling. Refrigeration Chambers. Refrigeration loads. Food preservation and freezing.
Expected learning outcomes and competences:	Upon successful completion of the course, students will be able to: • calculate cooling loads for air-conditioned spaces • design air conditioning processes on a psychrometric chart • size ductwork networks • select and size chillers, fans, and other cooling components • utilize Technical Guidelines, Standards, and Manuals • construct mass and energy balances • design cyclic processes for refrigeration machines on T-s diagrams and identify exergy losses in individual processes (compression, expansion, heat exchangers) • perform basic psychrometric calculations.
Teaching methods	Lectures, tutorials

EXPERIMENTAL METHODS AND MEASUREMENT TECHNOLOGY	
Course number	250
URL	http://eclass.uowm.gr/courses/MECH156/
Recommended Prerequisites	• Statistics • Fluid Mechanics I • Heat Transfer
Course content	Measurement science: mathematical description of measurement systems, input-output signal characteristics, transfer function, measurement standards, static and dynamic calibration, bias and random errors, statistical analysis of data, measurement uncertainty and error propagation, analogue and digital signal processing. Measurement techniques for temperature, static and dynamic pressure, local flow velocity, flowrate, strain, displacement, force and torque.
Expected learning outcomes and competences:	The course introduces the basic principles of measurements and experiments. The students become acquainted with measurement science and the methods of statistical analysis of the measurement data and with measurement techniques of mechanical properties. The course comprises laboratory exercises during which students get hands-on experience on conducting measurements and analyzing data. Upon successful completion of the course, the students will be able to: • understand measurement procedures and steps • properly state the results of a measurement • properly present data in graphical and tabular form • identify the sources of measurement errors and their attributes • classify deterministic (bias) and random errors • estimate the uncertainty of single-sample and multiple-sample direct measurements • utilize uncertainty analysis to estimate the uncertainty in indirect measurements

	• fit empirical relationships to measurement data • statistically process random data • understand the basic techniques for measuring temperature, pressure, fluid velocity, and flow-rate and their error sources
Teaching methods	lectures, tutorials, and laboratory exercises

COMPUTATIONAL MECHANICS	
Course number	228
Instructor(s)	M. Politis – R. Sotiropoulou
Semester	7
ECTS	4.5
URL	http://eclass.uowm.gr/courses/MECH186/
Hours per week	4
Recommended Prerequisites	• Introduction to Programming • Mathematics • Numerical Analysis • Fluid Mechanics I
Course content	Introduction. The conservation laws and their mathematical foundation and description using Partial Differential Equations (PDE's). Nondimensionalization and boundary conditions. Boundary value problems solution procedure. Finite difference methods. Physical domain discretization. Simple and complex expressions. Higher order approximations. Fundamental laws of gases, liquids, and particles. Gaseous, liquid, and particulate pollutants. Basic fluid flow equations. Eulerian and Lagrangian approaches to turbulent pollutant dispersion. Pollutant transport and diffusion equation in turbulent flow. Particle motion in turbulent flow. Modeling turbulent dispersion. Atmospheric pollutant diffusion. Characteristics of plumes. The Gauss model for plume dispersion. Presentation of computational tools and applications in a UNIX environment. Computational model WRF. Case study in real topography and

	conditions.
Expected learning outcomes and competences:	Upon completion of the course, the student will have acquired the following skills: • ability to solve technical problems using computational techniques. • ability to evaluate logical solutions and select appropriate levels of processing for these solutions. • understanding important physical phenomena that must be incorporated into system solutions. • development of the appropriate equations and computational models for the given system. • ability to solve computational models for various processes/units and simulate the involved processes.
Teaching methods	Lectures, practical sessions)

QUALITY CONTROL

Course number	230
URL	http://eclass.uowm.gr/courses/MECH167/
Recommended Prerequisites	• Statistics
Course content	Introduction: brief history of quality methodology, quality management, quality costs, methods for quality improvement. Acceptance sampling: lot-by-lot acceptance sampling for attributes, single, double, and multiple sampling plans, statistical and economic design. Statistical Process Control: capability analysis, control charts for attributes and variables, statistical and economic design. Planning, organizing and developing quality systems for industry.
Expected learning outcomes and competences:	The course discusses the modern methods of quality assurance placing special emphasis on the techniques of Statistical Quality Control (SQC). After the completion of the course, students should be able to: • understand the importance of quality in business • comprehend the economic and operational impact of quality on businesses

	• model problems related to control and assurance of quality of products and processes by means of scientifically rigorous quantitative methods • obtain optimum solutions to quality-related problems • tilize quality decisions with various criteria
Teaching methods	Lectures (2 hours), practical session (2 hours)

NUMERICAL METHODS IN MECHANICAL ENGINEERING

Course number	372
URL	http://eclass.uowm.gr/courses/MECH128
Recommended Prerequisites	• Mechanical Vibrations and Machine Dynamics • Statics • Strength of Materials
Course content	General Overview of Finite Elements. The Total Potential Energy of a System for Springs and Bars. The Energy Method and the Equations of Equilibrium of the Structure. Matrix Algebra and the Basic Principles of Elasticity Theory. Strain-Displacement and Stress-Strain Relationships in the Plane. Initial Stresses and Strains, Influence of Temperature. Finite Element of a Truss. Elastic Deformation, the Stiffness and Mass Matrices of the truss member and the structure in Local and Global Coordinate Systems. Equations of Equilibrium, Calculation of Displacements, Stresses, Support Reactions, Accelerations under Mechanical and Thermal Loads for Static or Dynamic Loading. Solution of Structural Problems (trusses). The Finite Element of the Beam. Elastic Deformations, the Potential Energy of the Beam and the Stiffness Matrix of the Element and the Beam, Calculation of Moment Forces and Support Reactions for Simply Supported, Cantilever, and Fixed Beams. Introduction to Plane Frames. In addition to the theoretical background of the energy method, the course also introduces students to programming using MATLAB, as well as commercial computational programmes for modelling and solving finite element

	problems.
Expected learning outcomes and competences:	Upon successful completion of this course, students will be able to: • understand and use finite elements to solve mechanical engineering problems and solids engineering with emphasis on the energy method based on the total dynamic energy of the body • develop programmes for layout and solving of motion equations, constructions consisting of one-dimensional elements, taking into account the properties of materials and the loads (mechanical and / or thermal) stressing structures • understand and use numerical integration methods • solve mechanical systems and constructions in eigen analysis, static analysis, dynamic analysis in the time and frequency domain, using all types of finite elements (one-dimensional, two-dimensional and three-dimensional elements) • understand and evaluate the numerical results with respect to the unknown nodal displacements of the finite elements of a structure and be able to make a design optimisation
Teaching methods	Lectures (13 weeks x 3-hour lectures and 2-hour Coursework) and homework.

COMPUTER-AIDED DESIGN	
Course number	380
URL	http://eclass.uowm.gr/courses/MECH117
Recommended Prerequisites	• Introduction to Computing • Linear Algebra • Mechanical Drawing II • Mathematics IV • Machine Elements II

Course content	Introduction to Computer-Aided Design and to CAD/CAE/CAM Systems. Coordinate systems and geometric transformations. Basic principles of CAD and related mathematical & information models. Elements of three-dimensional (3D) Computer Graphics. Mathematical models, data structures and algorithms for geometric modeling of curves, surfaces and 3D solids. Representation and processing/management of mechanical assemblies. Mechanical Computer-Aided Design. Laboratory exercises using CAD systems.
Expected learning outcomes and competences:	Upon successful completion of this course students should be able to • demonstrate knowledge of basic principles of software technology and of their application in Computer-Aided Design (CAD). • comprehend mathematical/information models for three-dimensional (3D) solid objects, • comprehend representation methods/models for mechanical assemblies in CAD, • sufficiently comprehend elementary concepts of 3D Computer Graphics used in CAD, • construct a correct Mechanical Drawing (for an object of medium complexity) using appropriate CAD software, and be experienced in using -at least- two different CAD systems, • comprehend fundamental concepts of Computer-Aided Engineering (CAE) and Computer-Aided Manufacturing (CAM), • sufficiently comprehend difficulties (and research issues) related to applying CAD-related software technologies in the manufacturing industry and in the work of mechanical engineers
Teaching methods	Lectures (13 weeks x 2.5 hours of Lectures and 1.5 hours of CAD practice)

ADVANCED STRUCTURAL MECHANICS

Course number	261

URL	
Recommended Prerequisites	• Statics • Mechanics of Materials • Dynamics • Vibrations and Machine Dynamics
Course content	Plasticity: Elastoplasticity Theory (Phenomenological approach to elastoplastic behavior, modeling of single-axial behavior in plasticity, curing laws, failure criteria, analysis of deformations /strains, perfect elastoplastic materials, curing elastoplasticity). Loading / unloading / reloading conditions. Boundary analysis method. Energy absorption. Remaining stresses and strains. Relationship of moments – curves. Effect of axial force on inelastic bending. Inelastic bending of beams and frames. Concept of plastic joint. Calculation of the plastic collapse mechanism. Inelastic torsion. Numerical solution of the problem of one-dimensional plasticity. Applications of nonlinear problems in finite element analysis software (modal time history analysis, pushover analysis). Bending of Structural Elements: Introduction to the Theory of Stability. Stability of simple elastic systems. Elastic beam with second order phenomena. Influence of border conditions. Bending and transverse loads. Influence of initial imperfections. Bending bars with numerical and approximate methods. Post-bending behavior. Simple models and columns. Introduction to Slab Theory. Elastic plates. Concept of twist. Slab analysis under specific loading and boundary conditions. Slabs under cylindrical bending.
Expected learning outcomes and competences:	Upon successful completion of this course, students will be able to: • have a thorough understanding of the basic concepts of elastoplasticity theory. • understand and use the appropriate failure criteria for each application. • understand the concept of non-linearity and be able to use appropriate methods for the numerical solution of non-linear problems. • solve complex problems of non-linear applications in

	appropriate finite element analysis software. • understand the concept of stability and bending. • have a complete picture of the behavior of slabs and shells. • understand the meaning and practical application of the boundary element method as well as the differences and similarities with the finite element method.
Teaching methods	Lectures and coursework

ADVANCED MATERIALS – NANOMATERIALS	
Course number	262
URL	
Recommended Prerequisites	• Materials Science and Technology I • Materials Science and Technology II
Course content	Introduction – Main principles, size – scale units, nanoscale phenomena. Definition – Need for advanced materials production. Shape memory alloys. Advanced Ceramics. Biomaterials. Smart materials. Structure – Properties – Application Relationships. Categories of nanomaterials – zero- /one- /two- dimensional nanostructures. Nanomaterials Properties – Optical – Mechanical/ Tribological. Property dependence on size. Nanomaterial Synthesis Techniques – Colloidal Gel Technique (Sol-Gel) – Microprocessing Techniques – Chemical Vapor Deposition Techniques. Characterization methods – Microscopy – Scanning Probe Microscopy (SPM) – Scanning Tunneling Microscopy (STM) – Atomic Force Microscopy (AFM) – Raman spectroscopy – Nanoindentation. Applications – Case study: ceramic nanomaterials for use as catalysts / catalysts supports. Social – environmental aspects of nanotechnology.
Expected learning outcomes and competences:	Upon successful completion of this course, students will be able to: • understand the importance of advanced materials –

	nanomaterials, • study the various categories of advanced materials with emphasis on nanomaterials, • correlate the structure, properties and applications of advanced materials – nanomaterials • to search for appropriate scientific sources, to combine data and to present their scientific work
Teaching methods	Lectures and laboratory experiments.

OPERATIONS RESEARCH II	
Course number	377
URL	http://eclass.uowm.gr/courses/MECH204/
Recommended Prerequisites	• Statistics • Operations Research I
Course content	Stochastic processes and discrete-time Markov chains: classification of states, long-run properties. Markovian processes with rewards, control and optimization. Applications in inventory control and maintenance management. Continuous-time Markov chains, birth-and-death processes. Queuing theory: classification of queuing systems and examples of queuing phenomena. Queuing models with a single or multiple servers, finite or infinite queue, finite or infinite population. Priority in queues service. Linear and nonlinear queuing networks. Optimization of queuing systems and networks.
Expected learning outcomes and competences:	The course includes fundamental tools and techniques of stochastic operational research. After the successful completion of the course, students will be able to: • identify and analyse discrete and continuous Markov processes • calculate the steady state characteristics of Markov processes

	• tilize the operation of Markov processes in steady state • apply Markovian techniques in engineering problems (inventory management, equipment maintenance, quality control, etc.) • solve queuing problems • study networks in series and Jackson networks • utilize queuing networks
Teaching methods	Hours of Instruction 52 (Lectures: 26, Coursework: 26)
Assessment methods	Final written exam (compulsory), mid-term written exam and/or assignments (optional)

DECISION-MAKING THEORY AND DATA ANALYSIS	
Course number	260
URL	-
Recommended Prerequisites	• Statistics • Operations Research I
Course content	Introduction to decision analysis and game theory, decision making and decision trees, utility theory and probability, games of complete and incomplete information, zero and non-zero-sum games, applications of game theory in management science.
Expected learning outcomes and competences:	After the successful completion of the course, students will be able to: • apply the fundamentals of decision analysis • derive utility functions • construct decision trees • represent operational problems with appropriate decision theory models • solve game theory problems • plan strategies for decision making • use Bayes Theorem in decision analysis
Teaching methods	Hours of Instruction 52 (Theory: 26, Exercises: 26)

ENVIRONMENTAL TECHNOLOGY	
Course number	131
URL	http://eclass.uowm.gr/courses/MECH132/
Recommended Prerequisites	• Chemistry • Fluid Mechanics
Course content	Environmental/Air pollution, Sources of environmental pollution, Effects of environmental pollution to human health, flora, fauna and materials, Greenhouse effect, Depletion of ozone layer, Acid deposition, Photochemical smog, Atmospheric chemistry, Analysis of gaseous pollutants, Pollution control technologies for stationary and mobile sources, Particulate matter, Technologies for particulate matter control (Cyclones, Electrostatic Precipitators, Baghouses), VOCs, SOX and NOX abatement and control.
Expected learning outcomes and competences:	The course aims at enabling students to understand the impact of various human activities on the environment. More specifically, it discusses the causes, trends and technological solutions to address the environmental problems related to air pollution (gaseous and particulate pollutants) from stationary and mobile sources. Emphasis is given to the design (engineering and financial) of control pollution technology systems for the control of particulate matter and gaseous pollutants. Upon successful completion of the course students will be able to: • understand the meaning and importance of air pollution • be aware of sources of pollution and of gaseous / particulate pollutants • understand pollution phenomena, such as the greenhouse effect, photochemical smog, acid deposition (rain) and ozone layer depletion • learn about which pollutants and involved mechanisms contribute to the greenhouse effect, photochemical smog, acid rain, and depletion of ozone layer

	• be aware of the analytical techniques used to identify and quantify the concentration of gaseous pollutants, such as infrared, chemiluminescent, gas chromatography, LIDAR • understand the behaviour of particulate matter in fluids • gain knowledge of the principles of design of control pollution technologies, equipment sizing and costing, fixed and operating costs • understand the principles of operation of particulate matter control technologies, such as gravity cyclones, centrifugal cyclones, electrostatic precipitators, baghouses and scrubbers • learn about the technologies for controlling VOCs, NOX and SOX • be able to select, size, design and calculate the cost of control pollution technologies for particulate matter and gaseous pollutants.
Teaching methods	Lectures (13 weeks x 2-hour lectures and 2-hour practical session).

SUBTRACTIVE MANUFACTURING PROCESSES	
Course number	266
URL	https://eclass.uowm.gr/courses/MECH370/
Recommended Prerequisites	• Fundamentals of Machining • Materials Science and Technology I
Course content	Introduction – Main principles of subtractive manufacturing processes. Subtractive manufacturing technology . Mechanics of the cutting processes. Turning processes. Milling processes. Drilling processes. Tool wear and lifetime of uncoated and coated tools. Optimization of cutting conditions. Determination of cutting force components. Cutting tools, materials and coatings. Grinding processes, kinematics and tools. Grinding technologies. Gear manufacturing processes, gear hobbing, shaping, shaving grinding, lapping. Non-conventional methods for metal removal. Electro-erosion. Laser applications in cutting. Simulating the machining

	processes with the aid of FEM software packages. Introduction to Computer-Integrated- Manufacturing.
Expected learning outcomes and competences:	Upon successful completion of the course, students will be able to: • evaluate and choose the preferable machining process depending on the products' desirable specifications. • choose the optimal cutting tool in terms of desirable dimensional accuracy on the produced workpiece material. • select the correct workpiece material in combination with the preselected cutting tool and manufacturing process. • select the optimal cutting parameters (cutting speed, feed, cutting depth etc.) depending on the machining application. • place and mount the workpiece on the machine tool bench with criterion the stability of the device, as well as correctly define the coordinate system on it. • be able to programme a CNC machine (G- number) to perform a cutting operation. • be able to conduct all the necessary metrology measurements (roughness, tolerances etc.) on the product once the manufacturing operations are over.
Teaching methods	Lectures, laboratory experiments

TURBOMACHINERY	
Course number	205
URL	http://eclass.uowm.gr/courses/MECH158/
Recommended Prerequisites	• Mathematics I • Mathematics II • Fluid Mechanics I • Thermodynamics

	• Heat Transfer
Course content	Introduction. Applications and basic concepts of turbomachinery. Basic principles of fluid mechanics and thermodynamics. Velocity diagrams. Energy conversion in turbomachinery, efficiency, degree of reaction. Phase changes and cavitation. Characteristic curves of turbomachines and of systems, determination of operating point, connection in parallel and in series. Concepts of similarity, dimensional analysis, non-dimensional numbers, specific speed, non-dimensional cavitation numbers. Axial machines, airfoil theory, flow phenomena and forces on airfoils, non-dimensional numbers, cascade analysis, deviation angle. Radial equilibrium theory. Secondary flows and losses. Axial pumps, axial compressors and blowers, instability phenomena, supersonic flow compressors. Axial turbines, degree of reaction, types and mechanisms of aerodynamic losses in airfoils, turbine blade cooling. Hydraulic turbines. Centrifugal compressors and pumps, flow and velocity diagrams, manufacturing aspects, blade design, exhaust system.
Expected learning outcomes and competences:	The course introduces the fundamental principles of operation, analysis, and design, as well as the applications of rotating dynamic machines for energy conversion that are classified as turbomachines.
Teaching methods	Lectures, coursework, laboratory tutorials for the use of commercial software. Homework and personal assignments with the application of commercial software on real design and analysis problems. Use of information technology methods.

ENERGY DESIGN FOR BUILDINGS	
Course number	251
URL	http://eclass.uowm.gr/courses/MECH227/
Recommended Prerequisites	• Heating, Ventilation and Air-Conditioning
Course content	Objectives & Content of Energy Design of Buildings. Building uses. Building comfort requirements: Thermal comfort, ventilation, visual, acoustic comfort. Estimation of heating &

	cooling loads. System Design. Bioclimatic design of buildings. Passive solar systems for heating and cooling. Natural and forced ventilation of buildings. Conventional energy systems. Solar thermal systems. Solar air conditioning systems. RES systems in the building. Energy performance analysis of building: Energy load modeling, monthly semi-stationary method, system modeling, and energy consumption calculation. Application into optimum building design.
Expected learning outcomes and competences:	The course discusses the basic design principles for achieving the lowest possible energy consumption in buildings. After successful completion of the course, students will be able to: • understand the difference between designing a building facility and assessing its behaviour and profitability • understand the impact of the environment and the comfort requirements on the energy design of buildings • understand the objectives of energy planning at a technical, environmental and economical level • have acquired knowledge of the passive and active systems applied in a building as regards energy saving and maximum exploitation of RES systems • have gained knowledge of combining existing methods, tools and technologies for optimal design • obtain skills to apply acquired knowledge to an Energy Planning problem, according to the low / near zero energy design project (of their own choice) assigned
Teaching methods	Lectures and coursework.

FLUID MECHANICS II

Course number	249
URL	http://eclass.uowm.gr/courses/MECH137/
Recommended Prerequisites	• Fluid Mechanics I • Thermodynamics I

Course content	Review of basic principles of fluid mechanics. Mathematical description of isothermal flow, continuity and Navier-Stokes equations. Boundary layer theory and practice, flow parallel to a flat plate, velocity profile, Pandtl's analysis, Blaussius solution, momentum-integral analysis, skin friction, turbulent boundary layers, law of the wall, effect of surface roughness, boundary layers in flows with pressure gradients, flow separation. External flow over submerged bodies, drag coefficient, aero/hydrodynamic forces on submerged bodies, effect of Reynolds number, unsteady phenomena, flow over a circular cylinder, vortex shedding, Strouhal number, vortex-induced vibrations, vehicle aerodynamics, flow past airfoils, lift, drag-lift curve, dynamic stall. Transition to turbulence, types of transition, linear stability analysis, Orr-Somerfield equation, shear layers and wakes. Turbulent flows, statistical description of turbulence, integral scales, inertial subrange, Kolmogorov theory, energy dissipation, turbulence modelling, eddy viscosity, Reynolds-Averaged Navier-Stokes equations, large-eddy simulation, direct numerical simulation. Compressible flow, speed of sound, Mach number, unidirectional adiabatic and isentropic flow, normal shock waves, Fanno and Raileigh flow. Two-dimensional compressible flows, oblique shock waves.
Expected learning outcomes and competences:	The course aims at advancing students' understanding of fluid mechanics and their introduction to more advanced fluid flow problems. Students become familiar with the phenomenology of complex flows and their mathematical description so that they can solve practical fluid flow problems. Upon successful completion of the course, students will be able to: • describe flow fields using streamlines, streaklines, and particle pathlines • understand flow visualisation techniques • state, in differential form, the conservation laws for mass and momentum • simplify and solve the differential conservation laws • understand and tilize approximate solutions of the differential conservation laws • compute the skin-friction and pressure forces from their distributions around bodies • estimate the drag force using empirical relationships

	• estimate the lift on airfoils and understand stall • understand the concept of hydrodynamic instability and transition to turbulence • identify the consequences of transition in boundary layers • compute inertial and drag forces in unsteady flows around bodies • estimate the speed of sound and understand compressibility effects • calculate property changes in isentropic compressible flows • calculate property changes across normal shock waves
Teaching methods	Lectures and tutorials

COMPUTATIONAL FLUID DYNAMICS

Course number	263
URL	http://eclass.uowm.gr/courses/MECH263/
Recommended Prerequisites	• Fluid Mechanics I • Thermodynamics I • Numerical Analysis
Course content	Review of fluid motion and heat transfer principles. Differential and integral forms of the general transport equations. Classification of physical behaviours. Main elements of a computational method. Properties of numerical methods. Discretisation methods. Turbulent flow. Transition from laminar to turbulent flow. Reynolds-Averaged Navier–Stokes (RANS) equations and turbulence models. Large eddy simulation. Direct numerical simulation. Computational grids. Coordinate systems. Types of computational grids and cells. Grid quality. The Finite Volume Method. Integral form of the transport equations. Computational grid and control volumes. Discretisation of transport equations. Convective and diffusive terms. The upwind differencing scheme. False diffusion. The central differencing scheme. Hybrid scheme. The SIMPLE algorithm. Boundary conditions and wall functions. The

	algebraic equations system. Solution methods. Computational simulation of problems using software: Flow in pipes. Flow around vehicles. Heat transfer between fluid and solid. Subsonic flow through a compressor stage. Supersonic flow over wings. Transport of gaseous pollutants.
Expected learning outcomes and competences:	Upon successful completion of this course, students will be able to: • classify general transport processes and describe the forms of equations that govern them, • understand turbulent flow analysis using Reynolds-Averaged Navier-Stokes equations and turbulence models, Large Eddy Simulation and Direct Numerical Simulation, • understand and distinguish the different types of computational grids and assess their quality, • understand the finite volume method and compare the discretisation of trasnport equations with different schemes, • apply the finite volume method and model different problems by analysing their parameters and combining knowledge from different fields of fluid dynamics and engineering.
Teaching methods	Lectures, exercise tutorials, computational laboratory tutorials

UNIT OPERATIONS

Course number	210
URL	http://eclass.uowm.gr/courses/MECH180/
Recommended Prerequisites	• Thermodynamics II
Course content	Introduction – Basic Concepts (Physical processes, categorization and classification of physical processes, analysis and design of physical processes). Basic Elements of Mass and Energy Balances (Analysis of processes with mass and energy balances).

	Basic Elements of Transport Phenomena (Basic principles and applications: momentum transfer, heat transfer, mass transfer). Thermodynamics of Mixtures (Phase equilibrium in processes, vapor-liquid phase equilibrium). Distillation (Vapor-liquid equilibrium, graphical methods, computational methods, distillation of multicomponent mixtures). Absorption (Gas-liquid equilibrium, packed columns, dilute mixtures, dense mixtures, design of non-isothermal packed columns, design of tray columns). Extraction (Ternary systems, triangular diagrams, calculation of theoretical stages, extraction in packed columns). Humidification – Dehumidification (Basic definitions, wet-bulb temperature, phase equilibrium, moisture diagram, Lewis relation, cooling tower design). Adsorption (Mechanisms and isothermal adsorption with one or more components, batch separation processes, design of adsorption beds). Membrane Separations (Membrane processes for gas and liquid separations, flow models, analytical design equations, processes of reverse osmosis, ultrafiltration, and microfiltration). Mechanical Separation Processes (Sieving, mass balances and capacity of sieves, filtration, batch and continuous filtration, cyclones, centrifugation). Heat Transfer (Heat transfer by conduction, heat flow in fluids without phase change and with phase change, heat transfer by radiation, design of devices, heat exchangers, condensers, evaporators, heat transfer devices).
Expected learning outcomes and competences:	This course aims to introduce students to traditional and novel unit operation processes in industry. Students first understand the basic physiochemical mechanisms and learn to design each process using short-cut or detailed (graphical or computational) methods.
Teaching methods	Lectures (26 hours) and practical sessions (26 hours) – Coursework (3 compulsory).

TECHNOLOGICAL SYSTEMS RELIABILITY AND MAINTENANCE	
Course number	241
URL	http://elearn.materlab.eu/course/view.php?id=2
Recommended Prerequisites	• Statistics
Course content	Reliability theory, reliability distributions, exponential distribution, distribution gamma, Weibull distribution, normal distribution. Systems reliability, reliability estimation, Markov reliability chains, estimation of reliability using generic parts, fault tree analysis, Monte-Carlo Simulation, Duane model. Reliability data collection, cost estimation, maintenance policies, maintenance indices, economic implications of idle time. The theory of replacement, deterministic and stochastic replacement policies. Preventive maintenance, total productive maintenance TPM, Use of simulation in maintenance.
Expected learning outcomes and competences:	The course aims at: • introducing the concepts of reliability and maintainability of simple or complex mechanical components or devices • introducing maintenance strategies and replacement policies. • helping students to combine knowledge in statistics with solving reliability problems and applying scientific based maintenance policies in any industrial environment • training students in topics of rationally and scientifically documented maintenance policies in business and industrial environment • providing students with skills to use simulation models of maintenance and replacement • offering in-depth knowledge of using computer-based tools in maintenance management
Teaching methods	Lectures (13 weeks x 3-hour lectures and 2-hour computer-based laboratory practice) and two projects.

INVENTORY MANAGEMENT	
Course number	255
URL	http://eclass.uowm.gr/courses/MECH169/
Recommended Prerequisites	• Statistics
Course content	Introduction: The significant role of Inventory management and Logistics. Introduction to Supply Chain Management. Forecasting Methods. Deterministic systems of inventory management: (a) the case of known and constant demand (EOQ methods) and (b) the case of known and inconstant. Stochastic systems of inventory management: sQ, RS, sS, RsS systems. Seasonable and innovative products (Newsvendor problem). Introduction to Supply Chain Management and multi-echelon inventory optimization.
Expected learning outcomes and competences:	To familiarise students with the techniques and tools for organising and optimising inventory systems and supply chains in the industrial environment. After the completion of the course the students should be able to: • understand the importance of inventory management in enterprises • comprehend the economic and operational impact of inventories on businesses • model real inventory management systems • solve real inventory management problems • economically and statistically optimise design parameters
Teaching methods	Lectures (2 hours), Coursework (2 hours)

COMPUTER-AIDED MANUFACTURING IN INDUSTRIAL PRODUCTION	
Course number	252
URL	http://eclass.uowm.gr/courses/MECH252/

Recommended Prerequisites	• Fundamentals of Machining
Course content	Introduction to Computer Numerical Control (CNC) Machines, CNC Lathe, CNC Milling. CNC Programming Languages. Fundamentals of CNC programming using G- number. Rapid Prototyping, 3D Printing, Additive Manufacturing. Basic principles of 3D parametric design in CAD system, CAD/CAM interoperability. Preparation of CNC manufacturing programs and simulations with CAM systems.
Expected learning outcomes and competences:	Upon successful completion of the course students will: • have a thorough understanding of the common types of CNC machines • be introduced to the fundamental principles of Numerical Control (NC & CNC) • become familiar with fundamental programming principles of CNC machines using G- number • be able to develop programmes in G- number for CNC Lathe and / or CNC Milling • learn how to design components using CAD • develop programmes and manufacturing simulations of components using CA • perform all necessary functions / tasks to construct a three-dimensional CAD component using a Rapid Prototyping machine
Teaching methods	13 weeks of Instruction (lectures and laboratory practice on CNC and G-number programming practice (5 weeks), CAD (3 weeks), CAM (3 weeks), Rapid Prototyping (1 week)).

NONDESTRUCTIVE TESTING

Course number	256
URL	http://eclass.uowm.gr/courses/MECH171/
Recommended Prerequisites	-

Course content	Non-destructive testing of materials and structures. Radiography method, ultrasound method, electromagnetic methods (eddy currents, magnetic leakage), magnetic particle and liquid penetrant methods, visual inspection, thermography and other methods. International Standards and Specifications.
Expected learning outcomes and competences:	Upon successful completion of the course, the student will be able to: • understand the phenomenon of any recognized Non-Destructive Check method • perform simple laboratory tests with at least 4 methods (Magnetic, Penetrating, Edge, Ultrasound) • interpret industrial radiographs • evaluate applications and the expected errors in test specimens • choose appropriate Non-Destructive Check methods • interpret specifications • write simple reports of non-destructive testing • develop problem-solving abilities and evaluate numerical calculations to understand the order of magnitude
Teaching methods	Hours of Instruction 52 (Lectures: 38, Laboratory: 14)

EXPERIMENT DESIGN AND ANALYSIS	
Course number	257
URL	http://eclass.uowm.gr/courses/MECH205/
Recommended Prerequisites	-
Course content	Analysis of variance: the fixed and random effects models for one factor. Design of statistical experiments: factorial and fractional factorial experiments, design and statistical analysis. Simple and multiple linear and nonlinear regression analysis. Correlation.
Expected learning	After the successful completion of the course, students will be

outcomes and competences:	able to: • perform statistical experiments with a single factor and interpret the results • perform special types of statistical experiments with a single factor and interpret the results • perform statistical experiments with more than one factors and interpret the results • design fractional factorial experiments with several factors at two levels • use orthogonal arrays • identify the significant factor effects and interactions • perform simple and multiple linear regressions • perform significance tests of the regression variables • calculate confidence intervals and prediction intervals in regression models
Teaching methods	Lectures (26 hours), Coursework (26 hours)

BIOMEDICAL ENGINEERING	
Course number	258
URL	http://eclass.uowm.gr/courses/MECH258/
Recommended Prerequisites	• Technology of Materials I & II • Statics • Dynamics • Numerical Methods in design of mechanical structures
Course content	Basic principles of biology, biological materials and their properties (tissues, cells, proteins, amino acids, blood, etc.). Understanding biological systems and interactions between them. Mechanisms of mechanical signal transmission and its conversion into biochemical. Evolutionary mechanics and effect of daily loads on tissue morphogenesis. Techniques, biocompatibility, biodegradation and principles governing implants. Types of implants and their peculiarities based on the

	intended use. Smart / biomimetic materials and nano-materials. Implant design, material selection, clinical trials, optimization, and legislative framework for disposal. Examples of orthopedic and dental engineering and interdisciplinary benefits.
Expected learning outcomes and competences:	Upon successful completion of the course, students will: • have acquired the theoretical background in various fields of biomedical technology and knowledge for the application of engineering in medicine • be able to understand, describe and categorise key technologies used in Biomedical, with diagrams and data • be able to evaluate comparatively and substantiate the relative advantages and disadvantages of alternative technology approaches and solutions • be able to select appropriate descriptions of digital systems, based on the problem to solve • be familiar with the basic principles of material technology in all materials used in bio-medical devices • learn the basic principles of biomaterial manufacturing and their properties as well as prosthetic members
Teaching methods	Lectures (13 weeks x 2-hour lectures and 2-hour Coursework) and assignments.

ADVANCED INFORMATION TECHNOLOGIES AND PROGRAMMING FOR MECHANICAL ENGINEERS

Course number	259
URL	http://eclass.uowm.gr/courses/MECH259/
Recommended Prerequisites	• Numerical Methods in design of mechanical structures • Introduction to Computing • Numerical Analysis and Simulation
Course content	Introduction to Computer Programming. Representation and processing of information, Introduction to high level programming languages (e.g., C, C++, C#, Java). Object Oriented programming and application in the analysis of

	mechanical structures. Command line and GUI applications, Programming with C++ (Selections, Loops, Arrays and Pointers, Functions, Strings, Files, Libraries), Memory and Disk management, Algorithms, Debugging, Computational Accuracy in the analysis of mechanical structures. Special issues in Algorithms and Data Structures with emphasis on the representation of mechanical systems.
Expected learning outcomes and competences:	Upon successful completion of the course, students should be able to: • appreciate the contribution of programming to the analysis and solution of mechanical engineering problems, • acquire knowledge of the fundamental principles of Object-Oriented Programming (hierarchy, polymorphism, data abstraction etc.), • formulate specifications and analyse requirements for developing engineering computer programmes, • utilise core programming techniques in the application creation process, • understand and utilise fundamental data structures (lists, trees, graphs) for the representation of technological data, • use software libraries for designing new applications, • implement programming techniques to discover possible problems and debug applications.
Teaching methods	Lectures (13 weeks x 2-hour lectures and 2-hour lab practice).

STRUCTURAL DYNAMICS	
Course number	382
URL	https://eclass.uowm.gr/courses/MECH114/
Recommended Prerequisites	• Statics • Mechanics of Materials • Dynamics • Vibrations and Machine Dynamics • Numerical Methods in Design of Mechanical Structures

Course content	Non-linear vibrations and stability of dynamic systems. Determining the dynamic behavior of multibody vehicles and other mechanical systems. Signal Analysis, Frequency Field Analysis, Frequency Response Functions and Experimental Identification of Mechanical Systems Parameters. Free vibration and forced response of single degree of freedom linear oscillators to impulsive, harmonic, periodic and transient excitation (natural frequency, damping ratio, resonance). Response of multiple degree of freedom linear vibrations (formulation of the equations of motion, determination of natural frequencies and mode shapes, modal analysis). Axial, torsional and bending vibration of bars. Applications (measurement and evaluation of vibration characteristics, vibration isolation, vibration absorption, balancing, torsional vibration). Jeffcott rotor with inelastic and flexible bearings, Damping effect, Forward and rear vortex, Critical speeds, Gyroscopic effects, Peculiarities and Peculiarities, Campbell diagram, Roller bearings, Linear and non-linear gear modeling. Introduction to rotordynamics finite element modeling.
Expected learning outcomes and competences:	Upon successful completion of this course, students will be able to: • understand the practical applications of nonlinear systems. • understand the analysis of structures in the frequency field. • analyse mechanical systems with multiple solid or flexible members. • understand the dynamic behavior of rotating systems. • use appropriate computing tools and software in typical examples. • be able to develop simplified rotor models. • develop and solve the rotation system motion equations. • develop and solve rotor system motion equations in torsional oscillations through analytical dynamics.
Teaching methods	Lectures and coursework.

STRUCTURAL OPTIMISATION	
Course number	264
URL	
Recommended Prerequisites	• Statics • Mechanics of Materials • Dynamics • Vibrations and Machine Dynamics
Course content	Plasticity: Theory of Elastoplasticity (Phenomenological approach to elastoplastic behavior, modeling of single-axial behavior in plasticity, curing laws, failure criteria, analysis of deformations/strains, perfect elastoplastic materials, curing elastoplasticity). Loading / unloading / reloading conditions. Boundary analysis method. Energy absorption. Remaining stresses and strains. Relationship of moments - curves. Effect of axial force on inelastic bending. Inelastic bending of beams and frames. Concept of plastic joint. Calculation of the plastic collapse mechanism. Inelastic torsion. Numerical solution of the problem of one-dimensional plasticity. Applications of nonlinear problems in finite element analysis software (modal time history analysis, pushover analysis). Bending of Structural Elements: Introduction to the Theory of Stability. Stability of simple elastic systems. Elastic beam with second order phenomena. Influence of border conditions. Bending and transverse loads. Influence of initial imperfections. Bending bars with numerical and approximate methods. Post-bending behavior. Simple models and columns. Introduction to Slab Theory. Elastic plates. Concept of twist. Slab analysis under specific loading and boundary conditions. Slabs under cylindrical bending.
Expected learning outcomes and competences:	Upon successful completion of the course, students will be able to: • fully understand the basic concepts of optimization. • understand the meaning and process of sensitivity analysis.

	• understand the meaning and differences between deterministic and stochastic optimization methods. • have a complete picture of the practical applications of structural optimization. • understand the concept of shape and topology optimization. • understand the concept of analysis and uncertainty quantification as well as their practical significance. • use appropriate computing tools and software in typical examples
Teaching methods	Lectures and coursework

ALTERNATIVE ENERGY SYSTEMS	
Course number	127
URL	http://eclass.uowm.gr/courses/MECH132/
Recommended Prerequisites	• Statistics • Thermodynamics • Mathematics
Course content	Introduction to energy policy issues. Energy in the European Union. The EU Green Bible for the security of the energy supply. The EU White Bible for the Renewable Energy Sources. Energy reserves and resources. The Greek energy system. Solar energy-basic principles. Solar collectors and photovoltaics. Wind energy and wind parks. Energy from biomass. Energy utilization of biomass. Hydropower and power plants – Advantages and disadvantages. Geothermal energy and geothermal fields. Tidal and wave energy. Ocean thermal energy. Energy conservation. Thermodynamic analysis of the renewable energy systems. Environmental analysis of the renewable energy systems. Social and economic impacts.
Expected learning outcomes and	The course discusses renewable energy source systems and cutting-edge developments. Upon completion of the course, students will be able to handle RES issues and design and

competences:	implementation problems effectively employing scientifically rigorous quantitative methods.
Teaching methods	Lectures (26 hours), Practical sessions (26 hours) – Coursework (3 – optional).

ENERGY ECONOMICS AND ENERGY MARKETS

Course number	EEH10
URL	https://eclass.uowm.gr/courses/ECE371/
Recommended Prerequisites	-
Course content	The theoretical part of the course provides an overview of the power systems at a national and pan-European level, while also includes lectures related to energy economics, types of electricity markets, and current challenges in the energy sector. Tutorials and exercises include representative types of problems related to the operation and the clearing of electricity markets. Laboratory courses aim to teach the GAMS (General Algebraic Modelling System) software. In the field of energy economics and energy markets, the use of optimization techniques and mathematical programming is well-established. Indicatively, mathematical models can be used to determine optimal long-term energy road maps at national and/or regional levels as well as to simulate and analyze the operation and clearing of energy markets on a daily and/or annual scale. In summary, the course aims to cover the following topics: • Energy and international relations, security of energy supply, interactions between energy sector, economy and environment. • Teaching the basic principles of energy markets by examining the Greek and the European energy market. • Unit commitment and optimal dispatch of generation units. • Power systems with high penetration levels of distributed renewable energy sources. • Long-term energy planning (current reality and future challenges).

	• Overview of the key features of Greek and European energy policies by focusing on the power systems of Greece and Southeast Europe and by presenting the main features of the most advanced power systems of Europe (most advanced in terms of high penetration levels of distributed renewable energy sources).
Expected learning outcomes and competences:	The main objective of the course is to examine and analyze concepts related to energy economics and energy markets. Upon successful completion of the course, students will be able to: • be familiar with the basic energy generation technologies and sectors of energy consumption. • understand the key challenges of the modern energy sector and the impact of energy economics on the energy environment. • understand and analyse the key economic attributes related to power systems planning and operation. • be aware of the structure and the operation of energy markets. • understand the basic features of Greek and European energy markets. • understand short-, medium-, and long-term operation of electricity markets. • model, simulate, and analyze, by using optimization tools and software, common problems related to energy economics, energy policies, and energy markets. • estimate the financial viability of energy investments. • understand current conditions and future challenges in the energy sector at a national and European level.
Teaching methods	Lectures (2 hours), Tutorials (1 hour), Practical session (1 hour)

WIND AND WATER TURBINES, HYDROELECTRIC PLANTS	
Course number	318
URL	http://eclass.uowm.gr/courses/MECH159/
Recommended Prerequisites	• Fluid Mechanics I • Turbomachinery
Course content	Wind turbines. Introduction to wind energy and wind turbines. Atmosphere and wind energy potential. Types of wind turbines and subsystems. Aerodynamic design of horizontal axis wind turbines. Aerodynamic design of vertical axis wind turbines. Static and dynamic wind loading. Selection of installation site. Wind farms. Turbine components' selection. Economics of wind energy. Water turbines and hydroelectric plants. Global and national situation, benefits, and impacts. Hydroelectric plants and their classification, advantages and disadvantages, hydrodynamic potential, hydrographs. Principles of operation and classification of water turbines, impulse turbines, reaction turbines, similarity theory, specific speed, cavitation phenomena.
Expected learning outcomes and competences:	The course mainly aims to introduce students to the principles of the operation of wind generators and water turbines. Students will gain an in-depth knowledge and understanding of the principles of operation, flow phenomena, and design characteristics. They will also gain experience in using specific techniques for the analysis, design, and selection of various classes of wind and water turbines. During the course, the development and use of computational methods are encouraged; experimental activities and a group project are also required. Students will be able to assess the wind potential of an area, select installation sites for wind turbines, and perform economic and technical evaluations. In addition, they will be able to assess the hydrological potential of a region, select the appropriate type of turbines, and assess the expected power output.
Teaching methods	Lectures, exercises, and laboratory tutorials for the use of open-source software. Coursework and personal assignments with the application of software on real design and analysis

	problems.

SOLAR TECHNOLOGY/PHOTOVOLTAICS	
Course number	316
URL	http://eclass.uowm.gr/courses/MECH197/
Recommended Prerequisites	• Heat Transfer
Course content	Solar Radiation. Parameters and Calculation of the Incoming Solar Radiation on horizontal and Inclined Surface. Calculation of the Energy Needs in Space Heating and Domestic Water Heating. Flat Plate Solar Thermal Collectors. Concentrating Solar Thermal Collectors. Storage of Solar Energy in Heating Processes. Integrated Solar Energy Systems for Heating Processes. F-Chart Method. Technology of the Photovoltaics. Photovoltaic Panels. Photovoltaic Systems. Dimension Process in Photovoltaic Systems.
Expected learning outcomes and competences:	The course discusses basic principles of Solar Energy exploitation. After the completion of the course, students should be able to: • calculate the potential of Solar Energy • calculate the components of solar radiation falling on a flat plane • calculate thermal efficiency and productive thermal energy of a solar thermal collector • calculate thermal efficiency of solar thermal systems combined with collectors and storage tanks • insert dimensions of solar thermal systems • understand photovoltaic conversion of solar energy • calculate the maximum electrical efficiency of a photovoltaic module • insert dimensions of photovoltaic systems
Teaching methods	Lectures (13 weeks x 2-hour lectures and 2-hour practical session).

AIR POLLUTION	
Course number	391
URL	http://eclass.uowm.gr/courses/MECH239/
Recommended Prerequisites	-
Course content	The atmosphere: Origins - Structure – Composition. Key features and principles of the atmosphere - The Boundary layer. Atmospheric pollutants and their sources. Basic principles of air pollution. Air pollution meteorology. Atmospheric stability. Basic atmospheric diffusion principles. Effective emission height. Atmospheric diffusion modeling. Scalar transport theory. Pollutants deposition. Instrumentation - Measurement of Meteorological Parameters.
Expected learning outcomes and competences:	The course aims to provide students with the basic principles of physics and atmospheric dynamics, the sources of pollution, the life cycle of atmospheric pollutants, from emissions or formation to final removal from the atmosphere, and the environmental burden mechanisms and impacts on health and ecosystems. The course is especially focused on industrial processes and plants. Students will also be introduced to the European legislative framework concerning air quality and international conventions. The course will enable students to apply integrated approaches towards environmental impact assessment. Specific objectives are listed below: • gaining an understanding of the basic concepts of air pollution and its effects on human health and the ecosystem • exploring how atmospheric chemical composition both drives and responds to changes in the earth system, including climate change • learning about major air pollutants, sources, chemical transformations in the atmosphere and impacts • articulating current air pollution policies applied in Europe for criteria pollutants

	• learning how to interpret meteorological data for atmospheric stability and air pollutant transport and dispersion • getting an insight into the fundamentals of air quality models
Teaching methods	Lectures (34 hours), Lab - Coursework (18 hours)

SPECIAL TOPICS ON POWER GENERATION	
Course number	349
URL	http://eclass.uowm.gr/courses/MECH173/
Recommended Prerequisites	• Heat Transfer • Fluid Mechanics • Thermodynamics • Steam Generators
Course content	Introduction to energy systems, Global, European, and National energy balance, Fossil Fuels, Conventional power generation, Wind Power, Biomass & Synthetic Fuels (thermochemical and biological methods of biomass conversion to gaseous, liquid, and solid biofuels), Hydrogen production, storage, energy fuel cells, Technoeconomic evaluation, Kwh cost calculation.
Expected learning outcomes and competences:	The course is focused on a number of special topics related to energy production: (a) conventional & alternative energy conversion technologies; (b) cogeneration; (c) levelized cost estimation of kWh Upon successful completion of the course, students will be able to: • acquire a general overview of the energy forms and their share in the global, European, and national energy balance. • be aware of the modern trends in energy balances at a global level. • understand the origin, types, and energy flows of

	conventional forms of energy (coal, oil, natural gas). • identify the corresponding shares for RES and nuclear energy. • understand conventional fossil fuel power technologies and the corresponding environmental impacts. • understand RES usefulness (wind, solar, biomass, geothermal). • understand the principle of operation of energy conversion technologies for converting wind, solar power and bioenergy into electricity, heat, and biofuels. • understand wind turbines, sizing, and theoretical performances. • calculate which part of the wind power potential can be converted into electrical power. • design and estimate the cost of wind farms in a given area with a given wind potential. • understand biomass potential, biomass types, physicochemical characteristics, and conversion technologies (gasification, pyrolysis, anaerobic digestion) into biofuels and energy. • understand thermochemical principles (combustion, gasification, pyrolysis) and biological (anaerobic digestion) processes for converting biomass to biofuels. • design, size, and estimate the cost for biomass conversion to bioenergy in conventional thermal and alternative energy conversion devices. • understand fuel cell operating principles, types, and operating curves. • understand hydrogen economy. • size and estimate the performance of low- and high-temperature fuel cells and planar and tubular geometry fuel cells. • understand hydrogen production technologies by reforming hydrocarbons and water electrolysis.
Teaching methods	Lectures (13 weeks x 2-hour lectures and 2-hour practical session)

APPLIED AERODYNAMICS

Course number	397
URL	http://eclass.uowm.gr/courses/MECH397/
Recommended Prerequisites	• Fluid Mechanics I • Fluid Mechanics II
Course content	Fundamental principles and equations. Two-dimensional flow around airfoils. Incompressible flow. Circulation and dynamic lift. Thin airfoil theory. Stall. High-lift devices. Aerodynamic performance of airfoils. Airfoil analysis methods. Flow around finite length wings. Velocity and pressure distribution around wings. Wing geometry. Lifting line theory. Induced drag. Three-dimensional incompressible flow. Tip vortex and induced drag. Compressible subsonic, transonic and supersonic flow around airfoils and wings. Shock waves in external flows and Prandtl-Meyer compression and expansion waves. Drag coefficient in transonic flows. Basic principles and real flow equations. Turbulent flow around aerodynamic bodies. Laminar to turbulent flow transition models. Impact of shock waves on the development of boundary layers. Aircraft aerodynamics. Flight at sonic, transonic and supersonic speeds. Aerodynamics of ground vehicles. Developing forces and performance. Noise. Conventional vehicles. High performance vehicles.
Expected learning outcomes and competences:	Upon successful completion of this course, students will be able to: • describe the development of aerodynamic forces on airfoils, understand the stall of an airfoil and evaluate the aerodynamic performance of an airfoil, • apply airfoil analysis methods, • apply the lifting line theory and describe the development of wing tip vortex and the induced drag, • understand the principles governing subsonic, transonic and supersonic flow around airfoils and wings, • describe the development of shock waves and Prandtl-

	Meyer compression and expansion waves, • analyze the effect of shock waves on the development of boundary layers, • understand how turbulent flow develops around aerodynamic bodies and apply appropriate transition models, • analyse and compare the effect of flight speed on the aerodynamics of the aircraft, • identify and analyze the factors influencing the aerodynamic behavior of ground vehicles.
Teaching methods	Lectures, exercise tutorials, laboratory tutorials.

DESIGN OF WELDED STRUCTURES	
Course number	398
URL	
Recommended Prerequisites	• Computer Machining for industrial production
Course content	Introduction to welding, welding methods, welding materials, welding calculation, welded component configurations, symbolic and schematic representation of welded components, design of welded structures with CAD environment and item catalogs, cutting lists.
Expected learning outcomes and competences:	Upon successful completion of this course, students will be able to: • acquire a thorough understanding of welding methods used in industry • calculate the strength of welds • prepare mechanical drawings of welded structures and machinery • manage the structure of welded parts and machines in CAD system design welded structures (frames) from structural

	elements • design parts using sheets of metal parts • manage cutting lists and item lists
Teaching methods	Lectures and laboratory exercises

VEHICLE DESIGN METHODS	
Course number	371
URL	http://eclass.uowm.gr/courses/MECH143
Recommended Prerequisites	• Dynamics • Machine Elements I • Mechanical Vibration and Machine Dynamics • Internal Combustion Engines
Course content	VEHICLE TECHNOLOGY: Introduction: Definitions, historical development, vehicle classification, basic technical characteristics, one- two-three-wheeled vehicles. Power unit systems: Internal combustion engines, electric motors, accumulators, gearboxes. Frames-Subframes: Technology, manufacturing methods, materials, loads. Wheels and Tires: Dynamic wheel behavior, tire types, friction, wear. Brake system: Brake types, braking assist systems (ABS). Suspension-steering systems: Suspension types, passive-active suspensions, driving behavior, handling. VEHICLE MOTION MODELING: Kinetic / Kinematics: motion in straight line, motion in curve, accelerations, steering behavior, handling, vibrations, kinetic / kinematics study of the front and rear suspension system and the steering system. VEHICLE DESIGN: Basic design principles, implementation of CAD / CAE techniques for the design of vehicle components
Expected learning outcomes and competences:	Upon successful completion of the course, students will be able to: • clearly define a motor vehicle and identify the individual categories according to geometry, road type and speed. In addition, they will be able to identify and describe the

	individual mechanical, electrical and electronic systems of which they are composed, as well as to understand their organisational structure • implement basic parametric 3D CAD and strength analysis techniques for the development of the main structural subsystems of vehicles, such as frame. • apply skills to analyse the performance of the power transmission system of a vehicle using both qualitative and quantitative criteria and to propose design improvements or even its complete redesign • perform kinetics and kinetic analysis of subsystems related to suspension and steering mechanism as well as dynamic analysis of the overall vehicle in various driving scenarios • understand the basic concepts of the vehicle design procedure. In particular, they will be able to methodically develop a new vehicle by defining the basic technical specifications, creating and implementing a structured work plan with clear work packages, timetables and deliverables
Teaching methods	Lectures (13 weeks x 2-hour Lectures and 2-hours coursework).

TECHNOLOGY, RESEARCH & INNOVATION POLICIES	
Course number	356
URL	http://elearn.materlab.eu/
Recommended Prerequisites	• Technology and Innovation-Economic Science and Entrepreneurship
Course content	Innovation and competitiveness, Innovation as a management process, Innovation Systems, Technological entrepreneurship, Entrepreneurship and innovation practices, Research, Technology and Innovation Policies in America, Europe and Greece, Indicators of innovation measurement, Drafting and Developing a Business Plan
Expected learning outcomes and competences:	Upon successful completion of the course, students will be able to: • list innovation types

	• describe the concepts of posture, propensity and innovation performance • identify the difference between innovation and invention • describe the types and characteristics of innovation • apply the standards of the innovation process • identify innovation systems • identify types of entrepreneurship • choose appropriate financial tools for entrepreneurship • compare innovation policies • draw up a business plan
Teaching methods	Lectures

RISK MANAGEMENT AND SAFETY OF LARGE INDUSTRIAL SYSTEMS	
Course number	389
URL	-
Recommended Prerequisites	-
Course content	The course discusses Risk Management and Safety of Large Industrial Systems with emphasis on Petroleum Industry. The following subjects are included: Safety and loss prevention, definition of hazard, risk and risk assessment, scope and outline of risk management, frequency and severity, intrinsic and extrinsic safety, risk balance, Pareto principle, epidemiological approach, hazard warning. Identification of hazards and basic definitions: toxicity, flammability, sources of ignition, fires, explosions, ionizing radiation, noise pollution, temperature and pressure deviations. Fire protection: classification of fires, fundamentals of fire suppression, fire protection systems and facilities, thermal radiation. Hazard and operability studies (HAZOP): basic principles, explanation of guide, procedures, critical examination of flow sheets. Risk analysis; acceptable risks and safety priorities, frequency of accidents, safety checklists and fault trees, assessment of risks

	from complex plants. Strengths and limitations of quantitative risk assessment, modeling, a systematic approach to risk reduction, human factors, and management of process safety, insurance. Industrial hygiene, identification MSDS, evaluating exposure to volatile toxicants. Flow of fluids through a pipe, liquids through pipes Toxic release and dispersion models, parameters affecting dispersion.
Expected learning outcomes and competences:	The course aims at enabling students to: • understand the fundamental principles of safety and risk management • learn about the practical applications of safety and risk management issues • gain an in-depth understanding of topics related to the practical implementation of security management • explore topics related to risk management development skills related to the design, development and submission of written reports • develop an understanding of professional obligations associated with the discipline of security and risk management • become familiar with personal protective equipment measures • learn about labour and industrial hygiene and safety signals
Teaching methods	Lectures, Course material, Practical Guides, Internet Sources, (13 weeks x 3-hour lectures and 1-hour computer-based laboratory practice), and two projects.

ENGINEERING AND ENERGY LEGISLATION

Course number	376
URL	http://eclass.uowm.gr/courses/MECH128
Recommended Prerequisites	-

Course content	General principles of law. The basic legal concepts are discussed and explained. The various branches of law are presented and briefly analysed. “Engineering & Energy legislation” includes “Construction works”, “Environmental legislation”, “Energy legislation”, “Energy market deregulation”, “Health and safety legislation”.
Expected learning outcomes and competences:	The course discusses engineering and energy legislation issues. It provides fundamental information in the context of the EU and Greek legislation with respect to energy, environment, construction works, health and safety, and energy market liberalisation. After the completion of the course, the students will be able to approach effectively the issues of licensing industrial plants and energy markets, and to handle establishment and operation of construction works, energy generation, distribution and services, by means of scientifically rigorous methods.
Teaching methods	Lectures (27 hours), Coursework (12 hours) & Three assignments (3)

SUPPLY CHAIN MANAGEMENT	
Course number	393
URL	-
Recommended Prerequisites	• Statistics • Operations Research I • Inventory Management
Course content	Introduction. Management methods, challenges and decision-making analysis through every aspect of the process flow, from the raw material procurement to final product delivery to the customer. Customer service. Procurement. Inventory management. Warehousing. Transportation. Information in supply chain and Bullwhip effect. Contemporary product traceability methods. Information systems in supply chains. Supply chain integration strategies: Push-Pull strategy, Risk Pooling, Transshipment etc. Special topics in supply chain management: Reverse Supply Chains, Closed Loop Supply Chains and Humanitarian Logistics.

Expected learning outcomes and competences:	Upon successful completion of the course, students will be able to: • define the basic principles in supply chain management, • evaluate the importance of customer service in supply chain, • describe principles and techniques in procurement, • describe principles and techniques in inventory management, • describe principles and techniques in warehousing, • organize and conduct the proceedings related to the product transportation and distribution, • solve travelling salesman problem, find a minimum spanning tree and solve maximum flow problems, • evaluate the importance of information flow in supply chain, • measure supply chain performance through specific metrics
Teaching methods	Lectures (26 hours), Practical sessions (26 hours).

ADVANCED ROBOTICS TECHNOLOGY IN MANUFACTURING	
Course number	394
URL	http://eclass.uowm.gr/courses/MECH394
Hours per week	4
Recommended Prerequisites	• Statics • Dynamics • Automatic Control Systems
Course content	Industrial robots. Structural analysis of spatial mechanisms. Special Mechanisms. The kinematic problem. Robotic problems in the mechanical engineering industries. Transformations in space. Kinetic equations. Identification of a Jacobian registry. Solutions to the inverse kinematic problem. Speeds and static forces. Calculation of track in Cartesian space. Interference in the field of joint variables. Robot position control with one and many degrees of freedom. Control systems referenced in the

	Cartesian coordinate system. Implementation of computer and mechanical CAD technologies in the study of robotic systems. Movement with compassion. Power sensors. Power control algorithms. Natural and artificial constraints with emphasis on mechanical applications. Hybrid position / power control - Programming and languages of industrial robots. Applications of industrial robots. Special machining and welding issues. Sensors & actuators (conventional and non-conventional), microprocessors and external communication, signal converters from analog to digital and vice versa, digital signal processing. Mechanical study of the robotic system. Application to robotic machining and welding systems. Machining robot simulation with Mechanical CAD system.
Expected learning outcomes and competences:	Upon successful completion of the course, students will be able to: • analyse, design, and implement robotics applications. • understand the basic principles of operation of Robotic Systems • understand, identify, formulate, and analyse industrial robotic systems • prepare and present examples of integrated robotics with sensors, action instruments, control unit • identify kinematic and dynamic analysis of industrial robots, arm structure, and geometry • study and optimise a robot workspace • understand the contribution of industrial robots to machining
Teaching methods	Lectures (13 weeks x 2-hour lectures and 2-hour coursework) and assignments.

PRODUCT DESIGN AND DEVELOPMENT

Course number	396
URL	http://eclass.uowm.gr/courses/MECH396
Recommended	• Machine Elements I

Prerequisites	• Mechanical Design I • Mechanical Design II • Mechanics of Materials.
Course content	Introduction to Product Engineering Design Methods. Customer needs acquisition and Product Design Specifications (PDS). Translating customer needs into product specifications, the Quality Function Deployment method (QFD). Developing alternative product concept designs Evaluation of alternative product concepts and optimal idea selection. The Controlled Convergence method. Design for Manufacturability (DFM), essential design principles for reducing component manufacturing costs, essential principles of Design For Machining and Design For Sheetmetal. Design for Assembly / Disassembly, essential design principles for reducing assembly costs. The methods: Hitachi Assemblability Method (AEM), Lucas Design For Assembly (DFA / MA), Bothroyd & Dewhurst Design for Manufacturing and Assembly (DFMA). Failure Mode and Effects analysis methods (FMEA & FMECA). Concurrent Engineering. Essential principles of Virtual Prorotyping: Detailed design, product modeling and simulation with CAD / CAM / CAE systems.
Expected learning outcomes and competences:	Upon successful completion of this course, students will be able to: • draft Product Design Specifications (PDS), based on customer needs, • transform customer needs into product quality features, • manage and systematically evaluate alternative product design ideas, • systematically assess design solutions based on ease of fabrication and/or ease of assembly, • systematically study the possible product faults and their consequences, • have a full understanding of the principles of modular design and product design (Modular Design), • have a good understanding of the principles of Concurrent Engineering, • demonstrate knowledge of the use of CAD / CAM / CAE systems in the design and development of engineering products

Teaching methods	Lectures (13 weeks x 2-hour lectures and 2-hour coursework) and assignments.

PRODUCTION OF ENVIRONMENTALLY FRIENDLY FUELS	
Course number	399
URL	-
Recommended Prerequisites	• Chemistry • Thermodynamics I • Environmental Technology
Course content	The current status in fuel markets for the energy and transport sectors. The necessity to develop environmentally friendly fuels. Production of environmentally friendly fuels. Crude oil (extraction, types, properties). Brief presentation of an oil refinery and produced fuels/chemicals. Catalytic reforming Isomerization. Fluid catalytic cracking of heavy oil fractions. Hydro-processing of oil products. Modifications and fuel additives. Natural gas (production, types, properties, treatment and uses). Overview of alternative fuels and prospects in the future fuel market. CO2 capture and utilization.
Expected learning outcomes and competences:	Upon successful completion of this course, students will be able to: be aware of the world fuel market, the trends and prospects for a sustainable energy future, • learn the crude oil types, characteristics, and properties, • be familiar with the different processes occurring in an oil refinery to cover the market requirements and to produce environmentally friendly fuels, • learn the processes (thermodynamics, operational conditions, catalysts) of catalytic reforming, isomerization, fluid catalytic cracking, and hydro-processing, • be aware of the processes to improve the energy and environmental efficiency of generated fuels, • learn the natural gas production processes, types, and

	properties, • be familiar with the treatment processes of natural gas to be delivered in the gas pipe network. • learn the production processes of alternative fuels for the energy and transport sectors, such as the liquid biofuels of 1st, 2nd and 3rd generation, ammonia and methanol • learn the processes to capture and utilize CO_2 emissions for the production of synthetic natural gas and synthetic liquid fuels through the Fischer-Tropsch process.
Teaching methods	Lectures, tutorials

SOLID WASTE MANAGEMENT	
Course number	405
URL	-
Recommended Prerequisites	-
Course content	Classification and Characterization of Solid Waste (Properties and characteristics, principles of integrated solid waste management based on their characteristics, basic stages of solid waste management: collection, transport, storage, recycling, processing, final disposal). Available Methods for Solid Waste Treatment Based on Characteristics (Composting, thermal treatment, sanitary landfill), advantages and disadvantages, and criteria for selecting available methods. Energy from Waste Analysis of Solid Waste Collection Systems (Temporary storage system, design factors such as bins, selection of total bin and garbage truck capacity, collection and transport system, route design, evaluation and selection of garbage trucks, capacity, design parameters, equivalent annual collection and transport costs, design examples). Municipal Solid Waste (MSW) Transfer Station (Structure and operation of systems, sizing, selection criteria, and technology compatibility, location, annual expenses,

	economic evaluation of garbage trucks with transfer stations). Methods for Calculating the Required Number of Sanitary Landfills (SLs) or Integrated Waste Management Facilities (IWMFs) (for a study area), criteria for selecting SL locations, selection of site from alternative candidates. Biological and Chemical Decomposition Processes of Waste (Quantitative and qualitative characterization of decomposition products such as leachate and biogas). Landfill Design (Development phases and capacities, earthworks and sealing, collection and management of leachate and biogas, technical infrastructure: fencing, gates, weighbridge, access roads, etc.), mechanical equipment, operation organization, control and monitoring, final restoration, and future monitoring.
Expected learning outcomes and competences:	The course aims at familiarizing students with the fundamental concepts of single-variable function analysis, basic concepts of linear algebra, and analytical geometry. Upon completion of the course, students will be able to understand and solve engineering application problems related to the Analytical Geometry of the Plane, Complex Numbers, Matrix Algebra, Systems of Linear Equations, Vector Spaces, Linear Mappings, Inverse Trigonometric and Hyperbolic Functions, Indefinite Integrals, and more. The student will become proficient in all mathematical processes related to the optimization of scientific processes and situations. Additional Skills: • search, analyze, and compose data and information using the necessary technologies • decision making • creative and inductive thinking • independent and teamwork skills
Teaching methods	Lectures, Tutorials

ADDITIVE MANUFACTURING PROCESSES

Course number	406
URL	
Recommended Prerequisites	• Fundamentals of Machining • Materials Science and Technology I • Mechanical Drawing I & II
Course content	The course consists of 12 sections, covering all basic definitions and advanced concepts of additive manufacturing (from a theoretical and applied perspective): **1.** Introduction to geometry acquisition and reverse engineering (different techniques, accuracy, and file types). **2.** From topography to geometry (conventional errors, correction and simplification of data). **3.** Historical background and evolution of additive manufacturing and its industrial applications. **4.** Classification of different techniques based on employed material and their advantages & disadvantages. **5.** Material properties of components produced with additive manufacturing and how they differ compared to conventional fabrication techniques. **6.** From geometry to production file (supporting structures, object orientation, workspace optimization etc.) **7.** Advanced applications of additive manufacturing (in aeronautics, biomedical engineering etc.). **8.** Transition from macro- to micro-fabrication and future trends of additive manufacturing in the nanoscale. **9.** Surface-initiated assembly (SIA) for engineering extracellular matrix (ECM) protein nanofibers and nanostructures. **10.** Surface and mechanical characterization of Polydimethylsiloxane (PDMS) substrates with tunable mechanical properties. **11.** Fabrication of ECM-based nanomechanical biosensors (NMBS). **12.** Validation of the NMBS to track strains using biologically relevant test strips and finite element analysis.
Expected learning outxomes and competences:	Upon successful completion of the course, students will be able to: • identify the criteria (both technical and cost related), based on which additive manufacturing may serve as an alternative to conventional manufacturing processes. • conceptually understand and apply, the required

	processes for the production of components, via additive manufacturing. • correlate the mechanical properties of the produced components to the fabrication technique and its parameters. • understand the use of biocompatible / biologically relevant materials in additive manufacturing applications in biomedical engineering.
Teaching methods	Lectures [13 weeks x 4 hours], including laboratory.

GAS TURBINE TECHNOLOGY	
Course number	385
URL	http://eclass.uowm.gr/courses/MECH265/
Recommended Prerequisites	• Fluid Mechanics I • Thermodynamics I • Turbomachinery
Course content	Introduction and applications of gas turbines. Open cycle configurations. Closed cycle configurations. Aircraft Propulsion. Industrial applications. Environmental issues. Power Cycles. Ideal cycles. Gas turbine component losses. Operation at the nominal operating point. Combined cycle and cogeneration schemes. Gas turbine cycles for aircraft propulsion. Simple Turbojet engine. The Turbofan engine. The Turboprop engine. The Turboshaft engine. Auxiliary power units. Axial and radial flow Compressors. Principles of operation. Work done and pressure rise. Dimensional flow. Compressor performance characteristics and design processes. Combustion systems. Types of combustion systems. The combustion process. Emissions. Coal gasification. Axial and radial flow Turbines. Basic theory. Selection of aerodynamic parameters. Blade cooling. Performance prediction of simple gas turbines. Components characteristics. Operation at off-design conditions.

Expected learning outcomes and competences:	The course aims to introduce the basic operating principles, components and applications of gas turbines. During the course, the student will be able to: • acquire state-of-the-art knowledge in the operation and thermodynamics of modern gas-turbine engines • analyse thermodynamic cycles of various types of gas turbine engines for aircraft propulsion and industrial applications • calculate the thrust and specific consumption of various types of aircraft engines such as turbojet, turbofan, and turboprop, and assess the effects of speed and altitude on performance characteristics • select the main operating parametres of industrial gas turbines and calculate the effect of the characteristics of individual components on the overall engine performance such as power output and specific consumption • use specialised software for the preliminary design and analysis of the operation of gas turbines
Teaching methods	Lectures, coursework, and laboratory tutorials for the use of commercial software. Homework and individual work assignments with commercial software applications on real design and analysis problems. Use of information technology for course management.

UNSTEADY FLOWS	
Course number	404
URL	
Recommended Prerequisites	• Calculus • Vactor calculus • Fluid Mechanics I • Fluid Mechanics II
Course content	Classification of unsteady flows. Review of basic principles of fluid dynamics. Unsteady flows without separation. Rigid-column theory in internal flows. Rayleigh and Stokes solutions. Flow instability and separation. Unsteady flows with separation.

	Quasi-steady external flows. Oscillatory flow around a cylinder. Hydrodynamic inertia and damping coefficients. Flow-induced vibration due to cross flow. Vortex-induced vibration. Galloping. Flow-induced vibration in tube arrays. Externally induced vibration by unsteady flows. Turbulence buffeting. Flow-induced vibration due to internal flow. Water hammer. Two-way coupling of internal flow and tube deformation. Flow diagnostics of unsteady flows and data analysis.
Expected learning outcomes and competences:	Upon successful completion of the course, students will be able to • identify and classify unsteady flows • recognize the dimensionless parameters that govern unsteady flow problems and problems involving dynamic flow-structure interactions • estimate the forces due to external unsteady flows • predict possible flow-induced vibrations and their characteristics • suggest countermeasures for reduction/suppression of unwanted flow-induced vibrations in the design stage or during operation
Teaching methods	Lectures, practical sessions, tutorials

COMBUSTION PHENOMENA	
Course number	348
URL	http://eclass.uowm.gr/courses/MECH144/
Recommended Prerequisites	• Thermodynamics I • Thermodynamics II • Fluid Mechanics I
Course content	Kinetic theory of gases, transport phenomena, chemical thermodynamics. Reaction speed, steady state phenomena, chemical equilibrium. Overview of chemical kinetics: order of reaction, chain reactions. Detonation limits and oxidizing

	characteristics of fuels (hydrogen, carbon monoxide, methane, paraffins, aromatic hydrocarbons). Premixed flames: 1-D flow, laminar flame structure, flame speed (Mallard and Le Chatelier), ignition limits, quenching distance, flashback and blowoff, and flame stability limits. Turbulent flows with flames, turbulent flame structure, turbulent flame speed, flame stabilisation in high velocity flow, Diffusion flames: Phenomenology, 1-D flame balances, turbulent fuel jets. Ignition: chain ignition, forced thermal ignition. Optical experimental techniques for the investigation of combustion phenomena.
Expected learning outcomes and competences:	Upon successful completion of the course, students will be able to: • understand basic combustion characteristics, related to thermodynamic or fluid dynamic parameters, and the differences between laminar and turbulent combustion. Students will also understand turbulent combustion areas as well as basic combustion chemical kinetics • learn about technological tools used for the study of fundamental combustion • distinguish combustion types • use acquired knowledge to design combustors or to optimise their operation • combine the operating data of combustion applications and predict operating stability • evaluate combustor operation
Teaching methods	Lectures and coursework

RENEWABLE ENERGY SOURCES LABORATORY

Course number	390
URL	http://eclass.uowm.gr/courses/MECH231/
Recommended Prerequisites	• Alternative & Renewable Energy Sources • Energy Design for Buildings
Course content	Introduction to Renewable Energy Sources (RES), RES in

	buildings. Laboratory exercise: Measurements, quality of measurements, and uncertainties. Laboratory exercise: Instrument calibration. Application in liquid flowmeter. Laboratory exercise: Meteorological station. Measurement of ambient temperature, Use of pyranometers for measuring solar radiation. Measurement of wind velocity and direction. Measurement of humidity. Laboratory exercise: Photovoltaic systems. Study of a photovoltaic panel. Measurement of the I-V characteristic, Measurement and estimation of the characteristic electrical parameters. Design of a PV system. Laboratory exercise: Solar thermal energy. Study of a flat plate solar collector. Estimation of optical efficiency and thermal losses. Study of thermal solar system performance. Heating storage thermal losses. Complete system estimation of performance.
Expected learning outcomes and competences:	Students perform lab tests on the operation and efficiency of RES systems, focusing on systems applied to buildings. Upon completion of the course, students will have: • understood the importance of applying accurate measurements to determine and evaluate the efficiency of an RES system • identified analysis particularities in a laboratory environment, in terms of infrastructure (including measuring instruments) and methods • acquired knowledge about quantification of measurement quality through the concept of uncertainty • gained knowledge on experimental methods of assessing RES systems performance • learned about the actual operation of RES systems.
Teaching methods	Laboratory practice (including lectures)

SPECIAL TOPICS ON POLLUTION CONTROL TECHNOLOGIES

Course number	350
URL	http://eclass.uowm.gr/courses/MECH131/

Recommended Prerequisites	• Chemistry • Environmental Technology
Course content	Introduction, Wastewater (Physicochemical Properties, Quantities), Wastewater Treatment Technologies, Pretreatment, Primary, Secondary, Advanced Wastewater Treatment, Solid Waste, Integrated Solid Waste Management, Thermochemical and Biological methods for the energy exploitation of waste (Gasification, Pyrolysis, Anaerobic Digestion), Mobile Sources of Pollution, Pollution control technologies in Otto and Diesel Engines, Otto Cycle, Three-way Catalytic Converters, λ sensors, Control pollution technologies in Diesel engines, Diesel Cycle, Formation of soot particles, Soot traps, Control pollution technologies in air transport, Brayton cycle, Catalytic ozone abatement, Hybrid vehicles, Fuel cell vehicles, Alternative fuels.
Expected learning outcomes and competences:	The course focuses on the methods of pollution control technologies used in the case of wastewater and solid waste and mobile sources. Through lectures and dedicated exercises, the students are introduced to wastewater treatment technologies and learn how to design such plants. The students are also introduced to the concept of integrated solid waste management. Finally, emphasis is given to pollution control technologies employed in Otto and Diesel cars (three-way catalytic converters, soot traps) and hybrid and fuel cells. Upon completion of the course, students will be able to: • understand the origin of wastewater (sources, categories, quantities) • understand the physicochemical (solids, gases, BOD, COD, TOC) and biological (microorganisms) characteristics of wastewater, and methods of measurement/estimation. • understand the technologies employed in wastewater treatment plants • design screens, aerators, primary sedimentation tanks, aerobic reactors, and anaerobic tanks for biogas production • recognize the types of solid waste and physicochemical characteristics • be aware of methods of waste collection • understand the use and operation of landfills. • understand which processing technologies should be used

	depending on the physicochemical characteristics of the waste, • recognize combustion and composting technologies • understand the thermochemical (combustion, gasification, pyrolysis) and biological (anaerobic digestion) processes of the organic fraction of waste. • be aware of the contribution of transport to air pollution and the significance of pollution control technologies. • understand the principle of operation of three-way catalytic converters • understand the principle of soot traps in diesel engines • distinguish hybrid and hydrogen-powered vehicles. • calculate the equivalent air/fuel ratio • calculate exhaust amounts in terms of employed air/fuel ratio.
Teaching methods	Lectures (13 weeks x 2-hour lectures and 2-hour practical session)

MATERIALS FOR ENERGY AND ENVIRONMENTAL APPLICATIONS

Course number	379
URL	http://eclass.uowm.gr/courses/MECH233/
Recommended Prerequisites	• Chemistry • Physics • Thermodynamics • Materials Science and Technology I & II
Course content	Physicochemical and surface characterization of catalysts - Morphology and physicochemical properties of catalysts – Active sites – Explanation of catalyst action – Comparison of catalytic activity & Catalyst selection – Compensation phenomenon – Deactivation and regeneration – Applications of catalytic processes in energy (hydrogen production) and in

	the environment (catalysis of exhaust gases from mobile & stationary sources - three-way catalytic converter - decomposition/reduction of nitrogen oxides, destruction of volatile organic compounds, photocatalysis) – Materials for fuel cells - Basic principles of electrochemistry, Membrane and solid electrolyte fuel cells - Photovoltaic systems – operation – material categories – inorganic and organic PV systems – p- and n- semiconductors - Dye-sensitized PVs. Selection of materials for energy and environmental applications – Ashby diagrams. Special topics - use of waste/by-products from industries as raw materials for the synthesis of new products (circular economy - special applications – examples) - advanced materials for energy & environmental applications (nanomaterials – nanocomposites).
Expected learning outcomes and competences:	Upon successful completion of the course, students will be able to: • understand the specific characteristics of catalytic and electrochemical processes in energy and environmental applications. • comprehend the impact of material synthesis methods on their structure and properties. • grasp the influence of the physicochemical properties of selected materials on the performance of processes. • explain the role of active sites according to material type and reaction. • explain the behavior of inorganic and organic materials in photovoltaic systems. • select the appropriate material for a specific application. • recognise the concept of sustainability in materials used in catalytic and electrochemical processes in energy and environmental applications.
Teaching methods	Lectures. Exercises (on paper and using computational programmes for material selection – Ansys Granta EduPack). Demonstration of "green" processes (hydrogen production through water electrolysis – hydrogen as a car fuel).

SIMULATION AND SYSTEM DYNAMICS

Course number	367
URL	http://eclass.uowm.gr/courses/MECH168/
Recommended Prerequisites	• Statistics
Course content	Design, analysis, and development of simulation, random numbers, random numbers and generators, simulation sampling, and statistical analysis of simulation results. Applications in industrial management and operations research. Practice on specialised simulation software. Fundamental system concepts, the object of a system dynamics analysis.
Expected learning outcomes and competences:	To familiarise students with decision-making techniques and tools using simulation methods in the complex industrial environment when analytical methods cannot be utilised. Upon completion of the course, students should be able to: • understand the importance and usefulness of mathematical simulation • understand the importance and usefulness of dynamic systems • comprehend the need for mathematical simulation in problems where the analytical solution is either impossible or very difficult • develop simulation models for real problems • solve problems and find optimal solutions using simulation • use statistical analysis of simulation results
Teaching methods	Lectures (13 weeks x 2-hour lectures and 2-hour practical session) and 4 assignments (compulsory).

EXPERT SYSTEMS FOR ENGINEERS AND DESIGN AUTOMATION FOR ENGINEERING PRODUCTS

Course number	400

URL	
Recommended Prerequisites	• Product Design and Development
Course content	Introduction to Knowledge-Based Engineering Systems for Engineers (KBE), Expert Systems and Rule-Based Programming. Basic models Expert Systems development: MOKA, KNOMAD, CommonKADS. Design Automation (DA), CAD systems programming, Design Rules using the VB.NET language and the iLogic tool. Differences between: Parametric Design, Design Automation via CAD customization and Expert Systems. Essential principles of Knowledge Engineering using Rules, developing Expert Systems with CLIPS, complexity management for Design Automation in mechanical systems. Connecting Expert Systems to other systems such as: CAD / CAM / CAE, PLM, ERP etc.
Expected learning outcomes and competences:	Upon successful completion of the course, students will be able to: • acquire the essential principles of Knowledge-Based Systems for Engineers. • be familiar with the basic principles of Knowledge Engineering using rules. • gain knowledge of the basic models for development of Expert Systems: MOKA, KNOMAD, CommonKADS. • develop design rules. • customise a CAD system to automate parts, assemblies, and two-dimensional construction drawings. • extend the capabilities of a CAD system through API programming. • create custom interfaces that extend the functionality of the CAD system. • understand how an Expert System can be connected to other systems such as PLM, ERP, CAD / CAM / CAE, etc.
Teaching methods	Lectures

THERMAL PROCESS EQUIPMENT	
Course number	401
URL	
Recommended Prerequisites	• Heat Transfer • Thermodynamics I • Thermodynamics II
Course content	Preliminary thermal design of heat exchangers. Scale formation problem. Basic exchanger types. Design of double-pipe exchangers. Construction details, TEMA classification and design of shell-and-tube exchangers. Design of compact heat exchangers, tube-and-fin, plate-and-fin and plate-and-frame. Two-phase pressure drop and heat transfer computations. Physics of condensation and design of condensers. Nucleate and film boiling. Critical boiling, convective boiling. Subcooling boiling. Design of evaporators. Condensers and vacuum technology. Cooling towers-energy analysis. Design and construction.
Expected learning outcomes and competences:	Upon successful completion of the course, students will be able to: • select among different types of heat exchangers based on the thermo-physical properties and process characteristics of the streams, • perform preliminary calculations of heat transfer area, taking into account scale formation, • perform detailed calculations of shell-and-tube exchangers, • perform detailed calculations of the most popular compact exchangers (tube-and-fin, plate-and-fin, plate-and-frame), • calculate pressure drop and heat transfer coefficients in gas/liquid two-phase flow, • design various types of condensers and evaporators
Teaching methods	Lectures, tutorials

PROJECT MANAGEMENT	
Course number	392
URL	-
Recommended Prerequisites	• Statistics • Operational Research I
Course content	Project Overview: Definition, characteristics, and types of projects. Key factors and variables affecting project operation, implementation, and success. Environment and teams affecting project implementation. Project life cycle. Interrelation between cost, quality, added value, and project life cycle. Criteria for project selection and evaluation. Organisation, administration, and project management. Project resources. Work, Product, Cost, and Organisation Breakdown Structure. Activities, milestones, and scheduling. Network analysis: AOA and AON, CPM and PERT. Project time, cost, and compression. Economic aspects of projects.
Expected learning outcomes and competences:	The course aims at enabling students to: • develop an effective project plan and decompose complex projects using hierarchy diagramming • optimise the duration of a project and the sequence of tasks using CPM • control project uncertainties using stochastic estimating techniques • use the earned-value management method to track project status • apply and control changes to the project management plan • apply detailed cost estimating techniques, identifying, and quantifying project risks Upon completion of the course, students will be able to: • understand the concept of a project, characteristics, and importance to businesses and organisations. • comprehend the complexity and variability of the project implementation environment, including the role of stakeholders, and how these factors contribute to initiation, execution, and completion of a project. • recognize the interplay between cost, time, and

	quality. • identify the key factors and variables affecting the completion of a project. • apply techniques and methodologies for evaluating, selecting, and potentially rejecting a project. • understand the significance of project life cycle and its role in effective project monitoring and implementation. • use tools and methods to organise, schedule, monitor, and manage project activities. • prepare, track, and analyse project budgets, and also understand the broader financial considerations involved in project management.
Teaching methods	Lectures (26 hours), Coursework (26 hours)

TOTAL QUALITY MANAGEMENT

Course number	395
URL	-
Recommended Prerequisites	• Statistics • Operations Research I • Quality Control
Course content	The concept of quality, objectives, reasons for adopting Total Quality and obstacles to achievement. Principles of Total Quality Management, quality planning, Quality financial model differences between Total Quality Management and traditional management approach. Quality measurement, control and improvement tools, capability analysis. Quality assurance, Common Assessment Framework and Quality Awards. The Taguchi approach, Taguchi loss function, 6σ methodology (Six Sigma) and DMAIC, Total Quality Management and Business Process Reengineering (BPR).
Expected learning outcomes and competences:	Upon successful completion of this course the student will be able to: • understand the main principles of quality,

	• employ tools for measurement, control and improvement of quality, • define cost of quality, • evaluate the advantages of TQM, • identify obstacles to TQM implementation • manage practical approaches of TQM implementation, • evaluate importance and demands of quality standard certification
Teaching methods	Lectures (13 weeks x 2-hour lectures and 2-hour coursework).

TECHNO-ECONOMIC ASSESSMENT	
Course number	352
URL	http://eclass.uowm.gr/courses/MECH163/
Recommended Prerequisites	• Thermodynamics • Statistics • Unit Operations • Fluid Mechanics I
Course content	Principles and methodology of financial analysis of industrial plants. Design and optimisation methodology. Evaluation indices. Engineering and financial evaluation of investment plans. Design and time scheduling. Methodology of feasibility studies and financial analysis of investments.
Expected learning outcomes and competences:	The course involves a systematic analysis of the design and optimisation of industrial plants, as well as feasibility studies. It enables students to become familiar with issues of financial and engineering evaluation of industrial plants and handle design and optimisation problems, using scientific rigorous quantitative methods.
Teaching methods	Lectures (26 hours), Coursework (26 hours) & Assignments (1-3 compulsory) – Homework (optional)

AIRCRAFT AERODYNAMIC DESIGN AND CONTROL	
Course number	403
URL	http://eclass.uowm.gr/courses/MECH403/
Recommended Prerequisites	• Fluid Mechanics I • Fluid Mechanics II • Applied Aerodynamics
Course content	Introduction. Elements of aerodynamics. Aircraft airfoils and wings. Dynamic lift, drag, and aerodynamic moments. Three-dimensional flow over wings and compressibility effects. Dynamics and flight parameters. Special aircraft cases. Atmosphere. Aircraft aerodynamic design process and selection of aerodynamic parameters. Computational methods for aerodynamic aircraft design. Aerodynamic design of wings, winglets, flight control surfaces, and engine inlets. Feedback control of dynamic systems principles. Time domain, frequency domain, and state-space analysis. Stability of dynamic systems. Design of controllers in time domain, frequency domain, and state-space. Aircraft stability and control. Static and dynamic stability. Equations of motion. Longitudinal and lateral motion control. Optimal control techniques. Design of control surfaces.
Expected learning outcomes and competences:	Upon successful completion of the course, students will be able to: • describe the development of aerodynamic forces on an aircraft, aircraft dynamics, and the correlation of flight and flow field parameters, • apply design methods by selecting the appropriate aerodynamic parameters, • apply computational methods of analysis and design of aircraft and individual aerodynamic components, • understand and determine the appropriate aircraft dynamics control systems, • apply aircraft motion control methods and design appropriate control surfaces.

Teaching methods	Lectures, tutorials, laboratory sessions.

CONVENTIONAL & ADVANCED ENERGY STORAGE SYSTEMS	
Course number	402
URL	
Recommended Prerequisites	• Chemistry • Heat Transfer • Fluid Mechanics • Thermodynamics I
Course content	Current status of the energy sector, Trends and prospects toward a zero-carbon economy, Need for energy storage systems, Energy storage technologies (power to power and power to fuels), Mechanical methods (flywheels, hydroelectric storage, compressed air storage, cryogenic energy storage), Thermal methods (thermochemical heat storage, sensible heat storage, heat storage through phase transition, thermoelectric materials), Electrochemical methods (batteries, electrolysis), Electrical methods (supercapacitors). Chemical energy storage to hydrogen, syngas, ammonia, methanol, synthetic methane and liquid fuels, Smart grids, Examples - Applications
Expected learning outcomes and competences	Upon successful completion of the course, students will be able to: • understand the current status of the energy sector, • understand the necessity for the transition to a zero-carbon economy and the role of energy storage technologies toward increasing intermittent RES share in the energy mix, • identify the different energy storage methods and technologies, • distinguish the mechanical (flywheels, hydroelectric storage, compressed air storage, cryogenic energy storage), thermal (thermochemical heat storage, sensible heat storage, heat storage through phase transition,

	thermoelectric materials), electrochemical (batteries, electrolysis), and electrical (supercapacitors) methods for the development of conventional and advanced energy storage systems, • comprehend the chemical energy storage technologies to hydrogen, syngas, ammonia, methanol, synthetic methane, and liquid fuels.
Teaching methods	Lectures, tutorials

ENGINEERING APPLICATIONS OF MACHINE LEARNING AND ARTIFICIAL INTELLIGENCE	
Course number	407
URL	
Recommended Prerequisites	• Introduction to Computing • Mathematics • Numerical Analysis
Course content	The course introduces students to the fundamental principles of Python and data processing, progressing to machine learning and its applications in mechanical engineering. Students become familiar with tools and data analysis methods, predictive models, and neural network applications. Special emphasis is placed on algorithms for the prediction and optimisation of engineering systems, as well as on practical implementation through experimentation and simulations.
Expected learning outcomes and competences	Upon successful completion of the course, students will be able to: • Use Python for data analysis and processing, employing basic data structures, loops, functions, and the pandas library for analysing and managing CSV files. • Understand the fundamental concepts of machine learning, including supervised and unsupervised learning methods, as well as the appropriate algorithms for each case. • Develop predictive models using Scikit- learn by selecting appropriate algorithms, training models, and evaluating their performance through cross-validation. • Use libraries, such as TensorFlow or PyTorch, to build and train

	basic neural networks, and demonstrate an understanding of CNN and RNN architectures. • Analyze mechanical engineering data and develop predictive models for material degradation, system dynamics, and production performance, to enhance functionality and reduce maintenance costs. • Apply simulation and system- identification methods to optimise engineering processes and support experimental design. • Evaluate successful implementations of artificial intelligence in mechanical engineering by examining real application scenarios, the challenges involved, and outcomes. The course combines theoretical knowledge with practical application, enabling students to gain substantial experience with modern machine learning and artificial intelligence technologies in mechanical engineering.
Teaching methods	Lectures, laboratory sessions

DIPLOMA THESIS	
Course number	-
Semester	9-10
URL	-
Recommended Prerequisites	-
Course content	Students can choose a thesis topic to develop their thesis. The thesis should be relevant to (at least) a taught course included in the desired Specialisation.
Expected learning outcomes and competences	It is a full-length written project on a relevant Engineering topic as specified in the course curriculum. It aims at demonstrating students' ability to pursue and investigate specific scientific issues.
Teaching methods	-
Assessment	-

University of Western Macedonia
Department of Mechanical Engineering
Faculty of Engineering

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