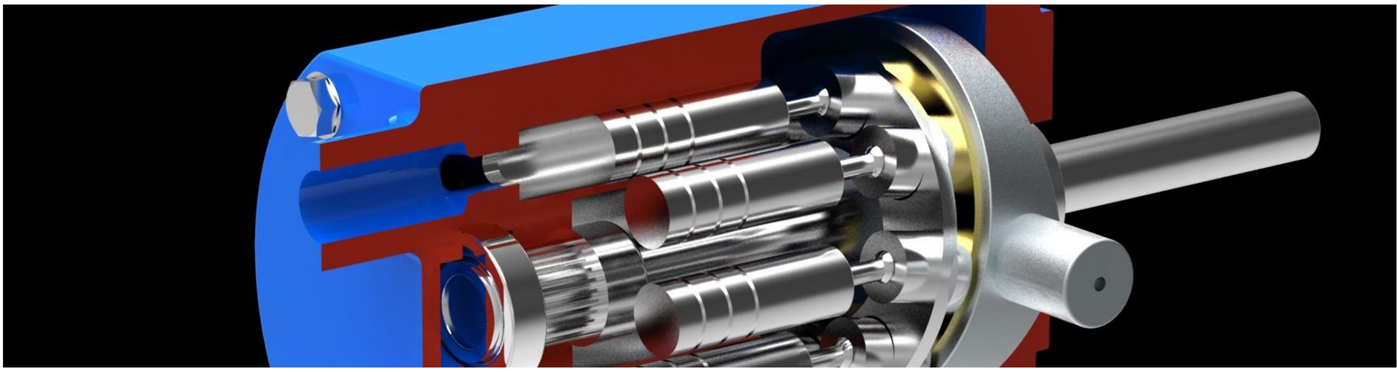
2023

School of Mechanical Engineering



Courses Guide 2023-2024

National Technical

University of Athens

COURSE DESCRIPTION

1. Συνοπτικό Περιεχόμενο Μαθημάτων

Each course code consists of four numbers (XX.YY.ZZ.UU) indicating:

1. XX: **School giving the Course**:
    - 01 School of Civil Engineering
    - 02 School of Mechanical Engineering
    - 03 School of Electrical & Computer Engineering
    - 04 School of Architecture
    - 05 School of Chemical Engineering
    - 06 School of Rural & Surveying Engineering
    - 07 School of Mining & Metallurgical Engineering
    - 08 School of Naval Architecture & Marine Engineering
    - 09 School of Applied Mathematical & Physical Sciences

2. YY: **Section giving the course**: The School of Mechanical Engineers consists of six sections:
    - 01 Industrial Management & Operational Research
    - 02 Thermal Engineering
    - 03 Mechanical Design & Automatic Control
    - 04 Nuclear Engineering
    - 05 Fluids
    - 06 Manufacturing Technology

3. ZZ: **Code of the course**.

4. UU: **Semester of the course** according to the normal studies program.

The letter C following the title of each course, indicates if it is Compulsory.

The brief summary of each course is followed by information about its laboratory exercises: these can be Compulsory (C) or Optional (O). The weight of the laboratory exercises in the calculation of the final course grade is also indicated.

The notation (GR) or (GR & EN) following the title of each course indicates whether the course is conducted in Greek only (GR) or in Greek and English (GR & EN).

** SLTS = Special Laboratory Teaching Staff*

*** STLS = Special Technical Laboratory Staff*

COURSES GIVEN BY OTHER SCHOOLS

(9.2.2008.1) Mathematics A1 (Functions of one variable) [C] (GR)

Convergence of real sequences, Cauchy sequences, completeness and Bolzano-Weierstrass theorem. Series of real numbers, convergence of series, special convergence tests (geometric series, telescopic series, ratio and root test, simple comparison test, limit comparison test, alternating series test of Leibniz, integral test). Absolute convergence. Power series, radius of convergence. Differentiation of a power series. Taylor's formula.
Real functions of one real variable. Overview of basic concepts of differential calculus. The main elementary functions (exponential, logarithmic, trigonometric and hyperbolic functions and their inverses).
The indefinite integral. Integration by parts and change of variable. Integration of rational functions- partial fraction expansion. Integrals which can be converted into rational ones by rational, trigonometric or hyperbolic substitutions.
Definite integral. Riemann sums. The fundamental theorem of Integral Calculus. Change of variable. Applications to Geometry, Physics and Mechanics (calculating of: the arclength, the area of a planar surface, the volume of a solid of revolution, the area of a surface of revolution, mass center, moment of inertia, work of a power, etc).
Integral form of Taylor remainder. Integration of a power series. Expansion of a function into Taylor and MacLaurin power series. Improper integrals. Convergence of improper integrals. Comparison convergence tests. Beta and Gamma functions. Applications.

I. Gasparis

(9.2.2143.1) Mathematics A2 (Linear Algebra & Analytic Geometry) [C] (GR)

Linear Algebra: Matrices, determinants, linear systems. Vector spaces, subspaces, basis and dimension of a vector space. Linear maps, inner product vector spaces. Orthonormal bases. Eigenvalues and eigenvectors. Matrix diagonalization. Cayley-Hamilton theorem.
Analytic Geometry: Vector calculus (inner, outer and mixed products of vectors and applications). Lines in plane and in three-dimensional space. Surfaces and curves Επιφάνειες και καμπύλες in three-dimensional space. Quadric surface.

P. Psarrakos, A. Doumas

(9.4.2170.1) Physics (Electricity and Magnetism with Optics) [C] (GR)

Properties of the Electric Charge. Coulomb's law. Electric field. Gauss's law. Electric Potential Energy and Electric Potential. Capacitors. Charged Conductors. Dielectric Materials. Electric Current. Conductivity of Metals. Magnetism. Magnetic Field. Magnetic Force. Ampere's law. Faraday's law. Magnetic Materials. Maxwell's equations. Electromagnetic waves. Nature and Propagation of Light.

Lab Work*: C*	20% of the Final Grade

M. Kokkoris, (S. Themi)

(9.1.2048.1) History of Science and Technology (GR)

The course deals with the history of science from the Renaissance until the 20th century by systematically following landmark "episodes" such as the shift of the cosmological model and the scientific revolution, the theory of evolution, genetics, nuclear physics and modern cosmology. Meanwhile, the course also focuses on a sociological discussion of the relationship of science with war, technology and gender, which are issues that are closely related to the whole evolution of modern science.

G. Mavrogonatou (SLTS)*

(9.1.2050.1) Sociology of Urban Civilization & Technology (GR)

The course investigates the societal and spatial aspects of technology as a complex phenomenon, which encompasses fundamental notions, such as social phenomena, the cultural turn, the distinction between tradition and modernity, the definition of science and technology, the relationship of technology with globalization, socio-geographical issues, as well as the technological determinism. These aspects of technology are examined along with an outline of the theories of the major Sociology contributors. The students' involvement in the discussion concerns issues of science and technology, urban space and technological parameters, as well as the ways that daily life and culture are influenced by them. The discussion that takes place during the course focuses on the ethical, political and cultural aspects of technology and science, as well as their implication in the process of collective identities' creation within the contemporary multicultural/globalized space. The course's discussions aim to a better comprehension of social exclusion within contemporary urban spaces, the relationship of environment with culture and civilization, the assessment of technology's impact on climate change, the role of communication networks in the shaping of social relations and identities, etc.

K. Theologou

(9.1.2199.1) Introduction to Philosophy (GR)

The definition of philosophy and its basic ideas. Branches and periods of Western Philosophy. Systematic presentation and analysis of its central problems, such as the validity of knowledge, science, truth, the existence of God, causality, mind and matter, the external world, universal concepts, free will, language and reality, ethics. The significance and usefulness of Philosophy today.

(S. Stelios)

(9.1.2221.1) Political Economy (GR)

The aim of the course is to introduce students to the basic concepts of economic theory, giving them a concise picture of how the Greek and international economies work. Particular emphasis is given to understanding the market processes, the factors that shape the volume, the distribution and the evolution trends of the Gross Domestic Product, the role of the state in the economy and the processes of economic globalisation with a special emphasis on the European integration.

P. Michailides

(9.3.2248.1) Mechanics A - [C] (GR)

Part I: Vectors. Forces, Moments, Distributed Loads, Centers of Mass, Kinematic Degrees of Freedom, Supports Types, Free Body Diagrams, Equilibrium Equations, 2-D and 3-D Applications, Reaction Forces and Moments, Internal Forces and Moments, Trusses, Solution Methods of Joints and Ritter Sections, Space Trusses. Load Distributions in 1-D, 2-D and 3-D, Beams and Frames, Axial Forces N, Shear Forces Q, Bending Moments M, N, Q, M Diagrams. Virtual Work Theorem.
Part II:
Stresses, Normal and Shear Stresses, The Tensor of Stresses. Equilibrium equations. Rotated Axes. Principal Axes and Principal Stresses, Hydrostatic and Divergent Stress Tensor, Plane Stress State, Mohr's Circle. Strains, Normal and Shear Strains,

Deformation Analysis. Small Strain Tensor, Small Rotation Tensor, Plane Strain State. Compatibility, Generalized Hooke Law, Axial Loads. Moments of Inertia, Principle Axes of Moments of Inertia. Simple Torsion Theory. Simple Bending Theory.

G. Exadaktilos

English Language [1st, 2nd, 3rd] (GR)

The English language course aims at familiarising students with language use in a variety of social contexts and communicative tasks (development of linguistic awareness). A range of practical activities in advanced syntactic structures are regularly provided along with activities designed to develop understanding and production of both spoken and written language in social, academic and professional settings.

M. Stathopoulou (3rd)

English Language [4th] (GR)

The aim of the course is to introduce students to technical terminology relating to the field of Mechanical Engineering through the use of texts from a variety of sources. More specifically, the course focuses on:

- Familiarising students with technical terminology specific to their discipline.
- Analysing the linguistic features of academic writing.
- Examining the structure and language of research articles and articles in popular science magazines.
- Examining the features of other academic genres, such as research abstracts and literature reviews.

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

- Understand what technical language is and how to approach academic/technical texts.
- Understand the features of academic writing.
- Extend their reading and writing skills.

G. Togia

French Language [3º] (GR)

The aim of the course is to familiarize students with the use of the French language through the study and analysis of scientific texts for academic purposes. Also, it focuses on students' exercise in scientific papers writing techniques so that they could cope to the modern scientific needs at undergraduate and postgraduate level. The course is supported by the instructor's appropriate teaching material which includes selected readings and "My Courses" NTUA platform of asynchronous tele-education.

Z. Exarchou

French Language [4º] (GR)

The course aims at introducing students to francophone scientific environments. Specifically, students are familiarized with selected Francophone bibliography, scientific readings and study material found in authentic sources (university textbooks, articles, dictionaries and other academic papers and journals). In addition, students are involved in a number of complementary activities in order to correspond to their overall academic needs (study abroad through the Erasmus program for postgraduate or doctoral studies in Francophone countries, participation in conferences, seminars and meetings conducted in French language). The course is supported by the instructor's appropriate teaching material which includes selected readings and "My Courses" NTUA platform of asynchronous tele-education.

Z. Exarchou

(9.2.2292.2) Mathematics B [C] (GR)

The n-dimensional Euclidean space. Elementary topological concepts in Euclidean space. Real and vector-valued functions. Limits and continuity.

Differential Calculus: Partial derivatives and differentiability. Tangent planes and perpendicular vectors for smooth surfaces. The directional derivative. Partial derivatives of higher order. Differential operators (gradient, divergence, curl). The differential of a vector-valued function. The chain rule. Differentials of higher order. Taylor's formula. The inverse function theorem. The implicit function theorem. Local extrema for functions of two or three real variables. Extrema under constraints. Lagrange multipliers. Applications.

Integral Calculus: The double and the triple integrals (Riemann sums, Iterated integrals, Fubini's theorem, Jordan measurability). Multiple integration techniques on elementary domains. Change of variables formula. Applications to Geometry, Physics and Mechanics (Calculating area, volume, center of mass and moments of inertia). Curves and surfaces in Euclidian space of dimension at most three. Contour (path) integrals. Green's theorem.

Path independence of a contour integral. Applications to Geometry and Physics (calculating areas, arc-lengths, center of mass, moments of inertia, work done by a force etc.). Surface integrals. Gauss Theorem (divergence). Stokes Theorem. Applications to Physics and Mechanics.

J. Gasparis

(9.03.2297.2) Mechanics B (Introduction to the Mechanics of Deformable Body, Strength of Materials) (GR)

The concept of stress, normal and shear stress. Safety factor, allowable stress. The concept of stress tensor, balance equations, stress transformations. Stress tensor invariants, Eigen values of stress tensor, principal stresses. Hydrostatic and deviatoric part of stress tensor. Plane stress, Mohr's circle. The concept of strain, normal and shear strain. The concept of strain tensor, equations of strain compatibility. Plane strain, Mohr's circle. Constitutive equations, generalized Hooke's law.

Examples: Axial loading, statically indeterminate problems, thermal loading. Pressure vessels, thin/thick walled. Simple theory of torsion, Torsion of a cylindrical shaft (statically determinate and indeterminate problems). Elastoplastic torsion. Bending theory, pure bending of a beam with an axis of symmetry. Elastoplastic bending. Bending of composite beams.

G. Tsiatas

(9.2.2283.3) Mathematics C (Ordinary and Partial Differential Equations) [C] (GR)

Ordinary Differential Equations. Introduction: Basics, Orthogonal Trajectories, Initial-Boundary Value Problems. Linearity versus Nonlinearity and Natural Phenomena. First Order Ode's: Separable Variables, Exact Equations, Integrating Factor, Linear Equations, Bernoulli and Riccati Equations, Homogeneous Equations, Lagrange and Clairaut Equations. Linear Equations: Basics, Fundamental Theorems for homogeneous equations, Homogeneous Equations with Constant Coefficients, Nonhomogeneous equations: Undetermined Coefficients Method (Euler), Variation of Parameters Method (Lagrange). Series Solutions: Series and Sequences of Functions, Series Solutions near an ordinary point, Legendre Equation, Series Solutions near a regular singular point: Fuchs and Frobenius Theory, Bessel Equation. Systems of Odes: Basics, Elimination

Method, Fundamental Theorems for Homogeneous Systems, Homogeneous Systems with Constant Coefficients, Nonhomogeneous Systems. Laplace Transform: Basics, Properties, Inverse Laplace Transform, Applications for Odes, Heaviside function, δ-Dirac Function, Convolution. Stability: Basics, Linear Systems, Almost Linear Systems-Linearization, Lyapunov Method. Partial Differential Equations: Introduction: Basic Equations of Mathematical Physics, Classification, Initial-Boundary Value Problems. D' Alembert Solution for the Wave equation. Fourier Series: Basics, Convergence theorems, Fourier Sine and Cosine Series, Bessel Inequality, Equality Parseval, Properties. Boundary Value Problems: Linear Boundary Value Problems, Eigenvalue Problems, Sturm-Liouville Problems: Properties, Regular-Periodic-Singular Eigenvalue Problems. Bounded Domain: Separation of Variables, Cartesian - Polar - Cylindrical - Spherical Coordinates for Elliptic, Parabolic, Hyperbolic Equations. Unbounded Domain: Laplace and Fourier Transforms and applications to Elliptic, Parabolic, Hyperbolic Equations.

E. Douka, N. Lambropoulos

(9.3.2010.3) Mechanics C [C] (GR)

Linear and rotational motion of a solid body, complex motion, laws of velocity and acceleration. Motion in two dimensions, instant centre of rotation. Composition of angular velocities - accelerations. Rotating reference frame, relative and absolute motion of solid bodies - Coriolis acceleration. Mass, centres of mass, moments of inertia. Dynamics of solid body and solid body systems. Theories of conservation of momentum and rotational momentum. Applications of the principle of conservation of rotational momentum. Solid body motion equations. Kinetic energy of solid body. Work - energy principle. Collisions. Lagrange equations.

Ch. Markides, P. Gourgiotis

(9.2.2246.4) Mathematics IV (Complex Functions) [C] (GR)

Complex Functions: Basics, Functions of complex variable, Differentiation, Cauchy-Riemann Equations, Harmonic Functions, Power Series and Elementary Functions, Integrals, Cauchy theorem, Laurent Series, Singular Points and Residues, Poles. Conformal Mapping and Applications.

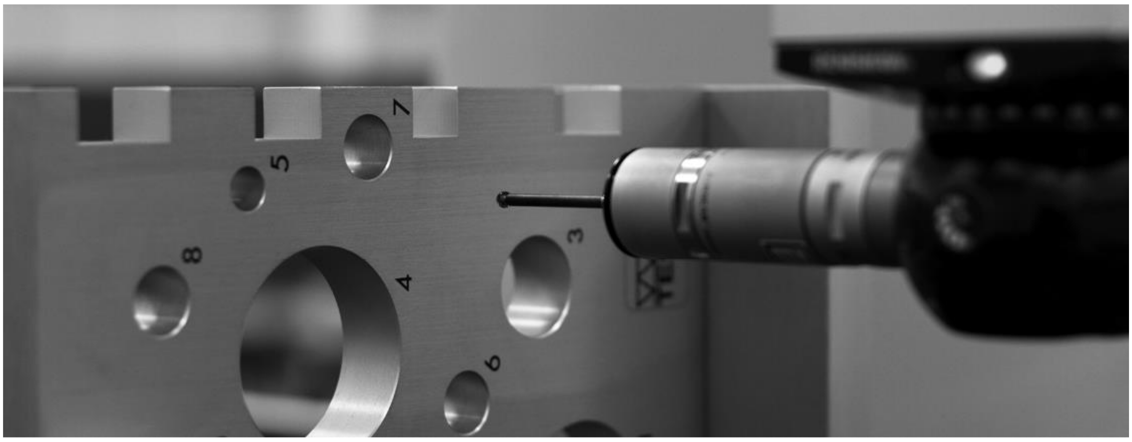
N. Lambropoulos

(9.1.2028.9) Elements of Law and Technical Legislation [9o ΜΜΠ (C)] (GR)

Fundamentals of Law. A general overview of the concept of law is followed, encompassing the explanation of the basic legal concepts and the main legal relationships that are created and included in the following branches of law: Public Law (Constitutional Law, Administrative Law). European Union law. Private law. Civil Law (General Principles, Law of Obligations, Property Law). Commercial Law (Commercial Law, Corporate Law, Securities Law). Workplace accidents / Engineer's responsibility. Technical legislation. Legislation for the Construction of Public Works (types of tendering procedures, contracting, abnormal development of the contract, contractors, etc.). European Community legislation on the construction of public works (European Union directives, adaptation decrees).

E. Tzanini

Industrial Management & Operational Research



(2.1.2160.3) Engineering Economics I [C] (GR)

Introduction to Engineering Economics. Marginal analysis of resource allocation in the production system. The value of inputs and the concept of productivity. Production costing. The value of outflows. Break-even analysis and utility theory. Financial Activity Assessment. Investment analysis. Cash flow analysis. Comparative economic assessment. Investment selection criteria. The Investment Plan: Basic concepts and definitions. Stages of investment plan preparation. The components of an Investment Plan. Planning, establishing and evaluating Investment Plans. Balance sheet and Profit & Loss account analysis. Financial Indicators..

K. Aravossis, A. Rentizelas, (V. Kapsalis)

(2.1.2072.5) Production/Operations Management & Business Administration I [C] (GR)

Introduction to Production/Operations Management & Business Administration. Work Organization. Work Study: Study of Methods, Study of Time. Quality Management and Control. Introduction to Production Planning and Control. The principles of the MRP system. Production Orders Scheduling. Inventory Management. Materials Management. Management Information Systems in Production. Supply Chain Management. Managing Health and Safety at Work. Production Cost Accounting - Break Even Analysis. Plants Capacity Planning.

Lab*: C* | *15*% of the Final Grade

N. Panayiotou, (S. Gagialis, G. Papadopoulos, G. Chatzistelios)

(2.1.2198.7) Data Bases [C] (GR & EN)

Data Base Management Systems Architecture. Management Applications and Data Bases. Elicitation of user requirements. Introduction to relational Data Base structures. Conceptual modelling with Entity Relationship diagrams (ERDs). Transforming ERDs into relational structures. Normal Forms and database schema normalization. Basics of DDL and DML SQL. Implementing Data Bases queries and user interfaces in the laboratory using commercial Data-Base management Systems. Coursework – designing and coding a specific database application.

Project/s*: C* | 30 % of the Final Grade

D. Nathanail, (G. Chatzistelios)

(2.1.2209.8) Production/ Operations Management and Business Administration II [C] (GR)

Costing terminology. Cost Flow. Cost Assignment. Full Cost Accounting. Marginal Cost Accounting. Differential Costing. Job Costing. Process Costing. Project Costing. Standard Costing & Variance Analysis. Activity-Based Costing (ABC). Budgeting. Business Process Reengineering (BPR) & Business Process Improvement (BPI). Balanced Scorecard. Introduction to Internal Audit. Individual Assignment: Obligatory (Common assignment with module 2.1.2210.8: Management Information Systems in Production).
Laboratory of Metrotechnics.

Lab*:C*	*20%* of the Final Grade

N. Panayiotou

(2.1.2030.6) Operational Research I [C] (GR)

Introduction to the scientific field of Operations Research (OR): Definitions, history of OR science, basic disciplines. Methodological approaches, taxonomy of OR problems. Mathematical modelling, Mathematical Formulation of Optimisation problems. Introduction to Linear Programming: Theory of Linear programming, solving linear problems-The simplex method, big M method, duality theory and sensitivity analysis, irregular types of linear programming models, the transportation problem, the assignment model, integer linear programming models, typical integer problems. Principles of simulation. Discrete event simulation. Network Analysis: minimum spanning tree problem, shortest path problem, maximum flow problem, traveling salesman problem. Decision Trees. Monte Carlo simulation. Dynamic programming.

Project/s: *C*	*30%* of the Final Grade

A. Tolis, A. Rentizelas, (V. Kapsalis)

(2.1.2213.7) Quality Management [C] (GR)

Quality Management Systems (QMS). Presentation of the ISO9001 standard. Document control and records management: Record management processes. Management's Responsibility: Quality Policy and Review Procedures. Resource Management: Staff training processes. Equipment capability. Design processes. Customer-Related Processes (Contract Review). Purchasing processes. Products and services processes. Identification and traceability. Customer ownership and control of monitoring and measuring devices. Product tracking and measurement, control of nonconforming products. Internal inspection procedures. Certification systems: Acquisition and retention of Quality Certification Systems.
Production statistics (position & dispersion parameters, frequency ranges, distributions, normal distribution, binomial distribution, Poisson distribution). Probability Theory Fundamentals. Quality & specifications. Quality control. Preventive control & techniques (checkpoints & tolerances). Preventive control with measurements. Min, Max & mean charts. Preventive screening. Charts of percentage and number of nonconforming products. Sample inspection by sorting. Representative samples - Sampling methods. Characteristic curve, acceptable quality level, unacceptable quality level. Shipping and Delivery Risks. Average outgoing quality, average outgoing quality limit.
Standard sampling inspection systems by sorting. ISO 2859, Dodge - Roaming, Philips. Sample acceptance inspection with measurements (sample size, acceptance criterion). Readiness, failure rate, product average lifetime, Admission Control with Lifetime Control - Organization of Quality Control in Business

Project/s*: O*	*25%* of the Final Grade

K. Kirytopoulos, (C. Tsogkas, G. Chatzistelios)

(2.1.2215.7) Introduction to Marketing (GR)

Main concepts, Marketing definitions and terminology. The Marketing environment. Marketing and Corporate Social Responsibility (CSR). Marketing and Production. Comparative advantage creation. Strategic Marketing (Vision, Mission, Objectives, PEST Analysis, SWOT Analysis, Business Model, Five Forces Analysis). 4Ps. Marketing Plan. Market Research. Industrial Marketing & Consumers Marketing. Consumers' buying behavior. Industrial buyers' buying behavior. Market segmentation in industrial markets & consumer markets and positioning. Adoption process, buying process and dissemination process of new industrial products and technological innovation. Pricing & distribution policies. Promotion techniques for consumer and industrial products. Marketing Information Systems (CRM). Marketing and New Economy.

Project/s: *C*	*30%* of the Final Grade

N. Panayiotou

(2.1.2031.7) Operational Research II [C] (GR)

Basic Probability theorems. Theorems of conditional probabilities (Bayes Theorem). Total Probability Law. Random variables – Statistical Distributions (discrete and continuous). Link with Operations Research subject (examples). Markovian processes for decision making. Markov chains. Applied Queuing Theory – Introduction. Processes of birth and death. Poisson prototypes. Other Statistical prototypes. Specific Queuing prototypes and implementation methods. Modern computational methods of Optimisation. Evolutionary algorithms. Particle Swarm Optimisation, adaptive learning and mutation. Decision analysis and decision trees. Dynamic programming.

A.Tolis, (V. Kapsalis)

(2.1.2128.8) Industrial Ergonomics [C] (GR & EN)

Introduction to Ergonomics. Generic Ergonomic Model. Ergonomic design of workplace and tools. Physical work - design to decrease physical workload. Thermal work environment (hazards, assessment and prevention measures). Psycho-acoustics and noise environment (hazards, assessment and prevention measures). Vision and lighting (designing physical and artificial lighting environment). Time and work (biological rhythms, night work, working hours and aging).

Lab: C	15% of the Final Grade	Project/s: C	25% of the Final Grade

D. Nathanail,, (S. Drivalou)

(2.1.2126.8) Production & Material Handling Systems [C] (GR)

Manufacturing / Warehousing Facilities Planning. The role of Warehouse/Distribution facilities in contemporary Supply Chain Management and Logistics. Introduction to the Facility Location problem. Plant and Warehouse Layout. Master Layout – Site and Building Parameters. Material Handling Equipment Sizing and Costing. Designing the Warehouse – Material – Equipment and Workforce Flows. Activity Relationship Analysis. Production, Warehouse and Auxiliary Space Requirements Determination. Dock and Yard Calculations. Detailed Layout. Visualizing the Layout Plan – Drawing and Simulation software. Warehouse Traditional Automations. Warehouse Information Management Systems. Introduction to Warehousing 4.0. Investment Decision Analysis.

Lab*: C*	20% of the Final Grade	Project/s: C	40% of the Final Grade

S. Ponis

(2.1.2210.8) Management Information Systems in Production [C] (GR & EN)

Introduction to Enterprise Resource Planning (ERP) systems. Business process reengineering and reorganization. Analysis & Design of Information Systems. Analysis of database schemas. Process specifications. Management of information systems projects. Business process modeling with ARIS Information Systems Architecture. Software development methodology. ERP Systems Lab (PC Lab): The functionality of the ERP Logistics Applications: Materials Management (MM), Sales and Distribution (SD), Production Planning (PP), The functionality of the ERP Financial Applications: Costing - Controlling (CO). ERP Systems of Small and Medium sized Businesses. Implementation of ERP projects.

Project/s*: C*	*30*% of the Final Grade

N. Panayiotou, (S. Gagialis, G. Papadopoulos)

(2.1.2307.8) Reverse Logistics & Circular Economy [ΜΜΠ] (GR)

Introduction of the Reverse and Green Logistics concepts. Presentation of the characteristics of Closed Loop Supply Chains and the prevailing Circular Economy models (3Rs, 6Rs etc). Trends in Circular Economy and the environmental impact of Logistics. The role of Reverse and Green Logistics in the Circular Economy and e-Business strategy and operations. Green transportation. Methods for evaluating the efficiency of Reverse Logistics Networks - Green KPIs. Product Life Cycle Analysis and the role of Reverse Logistics. Qualitative methods for the eco-design of Logistics. Quantitative methods for designing reverse Logistics networks: strategic and operational level. Decision making methods in Logistics network design / redesign problems. Industrial Symbiosis Networks. New emerging Industry 4.0 technologies (IoT: Internet of Things) to support Reverse & Green Logistics.

Project/s*: C*	*30*% of the Final Grade

S. Ponis, A Rentizelas

(2.1.2308.8) Risk management & business continuity (GR)

Notion of risk, risk management for engineering projects, enterprise risk management, business continuity, risk identification methods, risk analysis methods (qualitative - quantitative), risk evaluation, risk treatment, critical success factors and risk management culture, human biases in risk management, business impact analysis. Risk Breakdown Structure (RBS), Risk checklists, Probability - Impact matrix, Probability and impact scales, Monte Carlo simulation, Response strategies (avoid, mitigation, transfer), risk sheets, risk registers, risk perception / psychology.

Project/s*: C*	*50* % of the Final Grade

K. Kirytopoulos

(2.1.2125.9) Business Games (GR)

In this course students apply Business Administration methods, managing a hypothetical enterprise, using PC simulation. Groups of 5-6 students are managing their company, taking a series of decisions about key business operations (production, sales, marketing, financing, cooperation with banks, HR management, etc.), in conditions of uncertainty, competition and time pressure. Learning is done empirically and in a participatory way, while at the same time various related topics of theory are presented. Two games are taught in the course, one focusing on the production of a generic factory (Job-shop) and one focusing on strategic decisions. Through these games, students become familiar with all levels of management decision making, taken by an engineer.

Lab*: C*	*85*% of the Final Grade	Project/s: *C*	*15*% of the Final Grade

K. Kirytopoulos, S Ponis, (X. Tsogas, V. Bellos)

(2.1.2090.9) Decision Support Systems [C] (GR)

Introduction to contemporary Decision Support Systems. Introduction to Business and Data Analytics. Basic principles of Business Intelligence systems (structure, functionalities, interfaces). Enterprise Data Warehouses - basic concepts and functions, multidimensional business data analysis, data reporting and visualization - software tools.

Laboratory exercises (applications in case studies) supported by Solver / Optimization software (Excel add-in) to support business decisions. Solving a variety of Linear Programming, Integer Programming, Goal Seek, Investment Analysis, Supply Chain, Logistics, Network and Project Management problems.

Lab*: C*	*30%* of the Final Grade

S. Ponis, K. Kirytopoulos

(2.1.2036.9) Cognitive Ergonomics & Human-Machine Interaction [C] (GR)

Cognitive work: perception, sings categories, memory. Man-machine interface design. Human Computer Interaction and usability engineering. Complex cognitive tasks (problem solving, diagnosis, decision making). User-centered design of information technology systems supporting complex cognitive tasks. Human errors and human reliability.

Project/s*: C*	*50* % of the Final Grade

D. Nathanail

(2.1.2073.9) Production Planning and Control [C] (GR & EN)

The objectives of Production Planning and Control (PPC). Classification of production systems. Demand Management and Ordering. Aggregate Planning and Sales & Operations Planning (SOP). Master Production Schedule and Linking to the Budget (Budgeting). PPC in ERP systems. Bill of Materials and Routings. Engineering changes. Advanced topics of MRP method. Advanced topics of inventory management and purchasing. Hierarchical warehouse systems. Inventory control of slow movement materials (spare parts). Procurement management. Manufacturing planning within the supply chain. Work centers loading and capacity planning. Work orders scheduling/ Production orders sequencing. Production Control. Production Office Organization. Production data collection and evaluation. Technical management of the factory. Reverse supply chain. Production and Corporate Social Responsibility

Project/s*: C*	*30%* of the Final Grade

N. Panayiotou, (S. Gagialis, G. Papadopoulos)

(2.1.2229.9) Special Issues of Technological Economy (GR)

Introduction to green innovation, circular economy innovative models and environmental economics. Analysis of open innovation models and types, intrapreneurship, ecosystem innovation programs, startup accelerators and technology acquisitions to solve environmental challenges. Analysis of the Innovation Ecosystem and funding opportunities by Venture Capital Funds. Generation and development of new innovative ideas in the field of environment, using business planning tools and methodologies.

Exercise: students collect real data and develop in groups a solid business plan for a green innovative company, operating in the Environment and Energy sectors. The business plan will be presented to the class.

Project/s*: C*	*75%* of the Final Grade

K. Aravossis, N. Panayiotou

(2.1.2260.7) Supply Chain Management & Logistics (Transportation - Distribution) [C] (GR & EN)

Introduction to contemporary Supply Chain Management (SCM) principles. Supply Chain performance management – key drivers and metrics. Supply Chain network design and planning. The facility location problem. The capacity allocation problem. Demand forecasting. Time series forecasting. Measures of forecast Error. Inventory management. Statistical Inventory Control – deterministic and stochastic inventory models. The role of transportation in the supply chain. Vehicle routing & scheduling. Distribution Channels & processes. Purchasing decisions in SCM. Third Party logistics. The role of Information technology in SCM. Traceability (Bar Codes – Radio Frequency Identification principles and applications. Sustainability and the Supply Chain, Logistics 4.0: The future of logistics.

Project/s*: C* | *40*% of the Final Grade

S. Ponis

(2.1.2269.7) Project Management (GR & EN)

Project management concepts and definitions, project management processes. National & International PM standards. Project management cycle – projects and business strategy. Organisational structures. Project Manager – Project Management Office. Staff motivation. Scope management – Work Breakdown Structure. Time management – Gantt - CPM – total and free slack – uncertainty in estimations – PERT. Cost management – Cash flows – Time phased budget - Earned Value Management (EVM). Resource management – resource allocation – Project risk management. Stakeholder & communication management – RACI – responsibility assignment matrix.

Laboratory / PM software: Introduction to project management software. Define activities. Enter activities, durations, dependencies. Calculate project duration, structure the project in phases, milestones, critical path. Resource loading. Costs. Baseline schedule – monitor actual progress. Types of activities, Person-hours. Resource availability, resource allocation, resource leveling. Reporting. Network diagram. Calendars. Lead/lag times. Earned Value Management..

Lab*:* C | *35* % of the Final Grade

K. Kirytopoulos, (E Bellos)

(2.1.2268.8) Occupational Safety and Health (GR & EN)

Historical background, Ethics. Safety & Health and organizational efficiency. Technical, Behavioral and Systemic approaches to the problem of Occupational Safety and Health (OSH). Statistical analysis of occupational accidents and work related diseases. Proactive OSH metrics. OSH Accident analysis methods (cause-effect, event trees, fish-bone & bow-tie diagrams). Industrial occupational risk assessment methods. Basic OSH legislative & regulatory issues. The cost/ benefit of OSH. OSH management systems at the enterprise (OHSAS 18001, ISO 45001). System safety and resilience. Elements on human error and procedure deviation/ violation. Analysis of large scale industrial and transportation accidents. Swiss Cheese model and Sociotechnical intervention methods.

Project/s*: C* | *40* % of the Final Grade

D. Nathanail, (S. Drivalou)

(2.1.2279.9) Digital Transformation & Electronic Business [C] (GR)

Main concepts, E-Business & E-Commerce Definitions. E-Business Strategy Implementation. E-business models analysis with the use of the Internet. E-Retailing. E-Learning. Collaborative Commerce and Management of E-Supply Chains. Content Management Systems. Infrastructure and Software for the Implementation of E-Business Applications. Security and E-Payments. M-Commerce. E-Business Evaluation & Key Performance Indicators (KPIs). Considerations about E-Business applications and future trends. The course includes a ten-week assignment concerning the development of an e-business plan of a new or existing enterprise with an emphasis on the innovation of the offered products and/or services.

Project/s*: C* *10* % of the Final Grade

N. Panayiotou, S. Ponis

Thermal Engineering

(2.2.2097.2) Applied Thermodynamics of Pure Substances [C] (GR)

Basic concepts and definitions. First Law of Thermodynamics, Ideal Gas, Cyclical processes, Carnot Cycle of an ideal gas, Reversible and irreversible processes, Second Law of Thermodynamics, Carnot Circle of any working fluid. Thermodynamic temperature scale, Entropy, T-S and H-S charts (Mollier), Thermodynamic probability, Entropy of mixing. Entropy of irreversible processes, Maxwell and Tds relations, Two-Phase Thermodynamics, Evaporation, Charts, Steam tables, Real gases, Thermodynamic analysis of reversible processes, Joule-Thomson effect, Equations of Stage (VDW Equation), Heat capacities of Real Gases, Thermodynamic cycles, One-dimensional flow. Nozzles.

E. Koronaki, (N. Komninos)

(2.2.2043.7) Applied Thermodynamics of Mixtures [C] (GR)

Ideal and non-ideal mixtures. Partial molar properties. Thermodynamic classification of mixtures. Dilute solutions. Mixture and solution activities and activity factors. Methods for determining the activity factors of dilute solutions. Free enthalpy equations. Mixing of two mixtures. Latent heat of mixtures. Isenthalpic throttling of mixtures. Equation of state of mutual actions of gas mixtures. Azeotropic mixtures. Normal solutions. Absorption of gases. Absorption towers. Separation methods of binary mixtures. Enhancement - exhaustion units. McCabe-Thiele and Ponchon methods. Batch-process columns. Fully and partially miscible liquid mixtures. Liquid / solid phase dimer mixture equilibrium. Fundamentals of Statistical Thermodynamics. Maxwell-Boltzmann, Fermi-Dirac, Bose-Einstein distributions. Entropy and temperature. Applications of Statistical Thermodynamics.

(N. Komninos), (N. Komninos)

(2.2.2284.8) Environment and Development (Interdepartmental Course) (GR)

Development and Environment (legal, social, economic, political and cultural aspects). Sustainable development and critical analysis. Environmental and developmental aspects. Managerial and Technological Tools (potential and challenges). Analysis of specific areas - developmental incidents - environment - practices. Technological and ethical obligations of the engineer.

Obligatory projects assigned to interdisciplinary groups of students related to the specific material presented in the lectures. Lectures in the form of controversy on relevant environmental issues (eg climate change, renewable energy sources, fossil fuel use, nuclear energy use, maritime environmental impact, water resources management, natural disasters, zero energy and positive energy balance buildings, smart cities, recycling and energy recovery solid waste, etc.)

Project/s*: C* | *100%* of the Final Grade

S. Karellas, M. I. Anagnostakis, (S. Ch. Chatzilaou)

(2.2.2132.4) Heat Transfer [C] (GR)

An elementary treatment of the principles of heat transfer for a one semester course with a separate discussion of heat conduction and convection - Steady-state and unsteady-state conduction in one- and multiple dimensions is treated from both the analytical and the numerical viewpoint and a similar procedure is followed in the presentation of convection heat transfer. Analytically: Conduction; the Conduction Rate Equation, the Thermal Properties of Matter. One-Dimensional, Steady-State Conduction: the Plane Wall, Radial Systems (the Cylinder, the Sphere), Composite Structures, Critical Thickness of Insulation, Conduction with Thermal Energy Generation, Application of Resistance Concepts, Heat Transfer from Extended Surfaces. Two-Dimensional, Steady-State Conduction: Finite Difference Equations and Solutions. Transient Conduction. Convection: The Convection Transfer Problem and Equations, The Convection Boundary Layers, Boundary Layer Analogies, The Convection Coefficients. Convection and Internal Flow: Hydrodynamic and Thermal Considerations, The Energy Balance, Laminar and Turbulent Flow in Circular Tubes and Convection Correlations, Noncircular Tubes, Heat Transfer Enhancement. External Flow and Convection (The Flat Plate in Parallel Flow, The Cylinder in Cross Flow, The Sphere, Flow Across Bank of Tubes). Free Convection: The Governing Equations, Empirical Correlations. Boiling and Condensation. Heat Exchangers: Heat Exchanger Types, Heat Exchanger Analysis; Use of the Log Mean Temperature Difference, NTU-Method. Radiation: Fundamental Concepts, Blackbody Radiation (The Planck Distribution, Wien's Displacement Law, The Stefan-Boltzmann Law), Surface Emission, Absorption, Reflection, Transmission. Kirchhoff's Law.

S. Karellas, (A. Nikoglou)

(2.2.2032.6) Internal Combustion Engines [C] (GR)

General principles of operation, and configuration of modern spark ignition (SI) and diesel engines; Slider-crank mechanism; Two-stroke and four-stroke operation; Forces of the slider-crank mechanism; Dual fuel engines and gasoline direct injection (GDI) SI engines; Electronically controlled fuel injection in Diesel and SI engines; Engine ancillary systems (valve operation, cooling, lubrication, starting); Cylinder arrangements; Mechanical supercharging, and turbocharging; Wankel rotary engine; Combined cycle plants with internal combustion (IC) engines; Applications of IC engines; Outlook and challenges of IC engines; Modern diesel engines with electronic control; Thermodynamics fundamentals; Combustion of ideal air mixtures with temperature dependent specific heat capacities; Ideal engine cycles (Otto, Diesel, dual, Atkinson); Real operation/cycle of IC engines; Cylinder pressure recording with conventional and modern techniques; Work, mean effective pressure, torque, power, specific fuel consumption, mechanical losses and mechanical efficiency, similarity, power density; Energy balance; Combustion issues in SI and Diesel engines; Conventional and alternative fuels; Mixture preparation and formation; Combustion chamber design, power control, operation curves; Emission of pollutants and CO_2; Antipollution techniques (internal measures and after-treatment devices).

Lab*: C* | *10* % of the Final Grade

D. Hountalas, E. Giakoumis, (N. Komninos, A. Doukelis)

(2.2.2162.8) Combustion Theory, Combustion Systems [C] (GR)

Introductory notions. Characteristics, classification and physical mechanisms of combustion phenomena. Combustion thermo-chemistry. Laminar and turbulent diffusion and premixed flames. Mathematical modeling of gas-combustion phenomena. Evaporation-combustion of liquid fuels. Combustors and conventional combustion systems for gas and liquid fuels. Contemporary combustion and thermo-chemical conversion technologies (e.g. gasification, fuel cells). Measuring Systems. Emissions from combustion systems. Laboratory sessions accompany the lectures.

Lab*: C* | 30 % of the Final Grade | Project/s: O

(D. Kolaitis, D. Katsourinis, G. Zannis, D. Giannopoulos)

(2.2.2293.9) Principles of Fire Engineering (GR & EN)

Introduction to combustion. Fires, compartment fires, wild land fires. Industrial accidents. Explosions. Combustion thermo-chemistry. Heating value. Adiabatic flame temperature. Free radicals. Toxicity of combustion products. Ignition requirements. Fire tetrahedron. Ignition and auto-ignition temperatures. Flammability limits. Fire suppression concepts. Fire suppression agents. Fire initiation and fire spreading mechanisms. Mass, momentum and energy transport phenomena. Combustion stages for liquid and solid fuels. Fundamental physical phenomena governing the combustion of solid fuels. Pyrolysis reactions. Main fire stages: Ignition, growth, development, decay. General characteristics of compartment fires. Fire stages. Ventilation effects. Flashover. Backdraft. Main characteristics of the developing flow- and thermal-field. Fire risk analysis. Estimation of main quantities. Heat release rate. Fire load. Standard gas temperature curves. Numerical simulation methodologies. Main equations. Fluid flow. Conjugate heat transfer. Chemical reactions. Two-phase flows. Fires in means of transportation. Aircraft-, ship- and train-fires. Fires in road and rail tunnels. Human behavior during a fire. Behavior of materials exposed to fire. Reaction to fire tests. Fire resistance tests. Temperature-dependent thermo-physical properties. Fire behavior of common construction materials. Fire legislation and legal requirements. Passive and active fire safety protection.

Lab*: C* | *30* % of the Final Grade

(D. Kolaitis, J. Zannis)

(2.2.2086.5) Thermal Energy Conversion in Power Plants [C] (GR)

Global energy demand - consumption. General description of thermal energy conversion systems. Thermodynamic properties of water-steam. Preliminary introduction/review to thermodynamics. Historical evolution of the construction of steam boilers. Design criteria for contemporary steam boilers. Classification of modern steam boilers. Working fluid circulation types (natural, artificial, forced). Feed water quality. Pumps, Fans. Thermodynamic cycles of Steam Power Plants - Clausius Rankine Cycle efficiency. Specific Heat Consumption. Efficiency improvement concepts. Mass and energy balance in thermal networks. Condensation, Cooling water. Energy flow in steam boilers, Losses, Gross and net efficiency of steam boiler, self-consumption. Physico-chemical composition and fuel properties. Stoichiometric combustion. Air-fuel ratio. Combustion calculations. Co-firing. Evolution of Thermal Power Plants. Combined Cycle Steam

Power Plants, Cogeneration of heat and power, Thermal Power Plants with renewable fuels, Hybrid Thermal Power Plants with various renewable energy sources. Economics of electricity generation. Exhaust emissions, Environmental Impact. Introduction to large-scale energy storage.

Lab: C | Project: C

E. Kakaras, S. Karellas, (A. Doukelis,, P. Vourliotis, P. Pallis)

(2.2.2191.7) Thermal Radiation and Applications (GR)

General principles of heat Transfer. Transient conduction. Analytical methods for transient phenomena – Periodic conduction. Nature of thermal radiation - Basic principles of thermal radiation - Blackbody radiation – Wien's displacement law – The Stefan-Boltzmann law – Exchange of radiation between real surfaces – Kirchoff's law – Radiation exchange between two or more surfaces – Electrical analogy – Shape factors – Gas radiation – Infrared thermography.

Lab*:* O | Project/s C

D. Hountalas, (D. Katsourinis, D. Giannakopoulos)

(2.2.2091.7) Dynamics of Reciprocating Internal Combustion Engines (GR)

Kinematic analysis of reciprocating engine mechanism. Analysis of forces (gas, inertial, gravitational), and their transmission through the various parts of the mechanism. Bearing stress - polar diagrams. Ignition order (various examples for in-line and V-type engines). Crankshaft torque. Non-uniform rotation of the crankshaft. Balancing – examples (in-line, V-type and radial engines), counterbalance systems, partial balancing, symmetrical / anti-symmetrical crankshaft, practical applications. Crankshaft torsional vibrations – Applications, calculation, methods of mitigation.

Project/s*: O* | 15% of the Final Grade

D. Hountalas, E. Giakoumis, (D. Giannopoulos)

(2.2.2081.7) Transport Phenomena (GR)

Introduction to transport phenomena – transport rates. Conservation equations with emphasis on non-dimensionalised equations. Velocity – temperature – concentration boundary layer equations. Flow over a horizontal flat plate. Turbulent transport analogy. Heat – mass transfer analogy for the flow over a horizontal plate. Introduction to mass transport in laminar and turbulent flows. Fick's law of diffusion – steady state mass diffusion. Mass diffusion without homogeneous chemical reactions. Catalytic reactions. Mass diffusion in homogeneous chemical reactions. Evaporation of liquid droplets. Introduction to combustion – mass conservation of a single droplet – droplet combustion.

Lab: O

D. Hountalas, (D. Kolaitis, D. Katsourinis)

(2.2.2195.8) Basic Principles of Refrigeration [C] (GR)

Introduction to industrial cooling applications. Vapour compression cooling systems. Basic cooling cycle. Cooling cycle with subcooling and superheating. Real cooling cycle. Multi-stage vapour compression systems. Refrigerants. Calculation of cooling capacity. Gas compression cooling cycle. Stirling Circle. Basic air humidification cycle. High / low-pressure air humidification cycle. Air humidification with partial expansion. Minimum work required for gas liquefaction. Ejector compression systems. Thermoelectric cooling. Magnetic cooling. Absorption cooling. NH3/H2O and H2O/LiBr refrigeration systems. Adsorption/desorption cooling. Psychrometrics. Sensible heating. Cooling and dehumidification. Bypass factor.

Lab: O | Project/s: O

X. Tzivanidis, K. Braimakis, (G. Zannis)

(2.2.2236.7) Combustion/Pollution of Internal Combustion Engines [C] (GR)

General principles of the combustion chemistry. Dissociation of combustion products. General overview of engine types, Diesel and Spark Ignition. Combustion in spark ignition engines, lean-burn and direct injection engines. Design of spark ignition engine combustion chambers with emphasis on the reduction of pollutants and fuel consumption. Engine knocking and auto-ignition, octane number. Fuel injection and ignition systems. Thermodynamic analysis of spark ignition engine combustion. Description of combustion in Diesel engines. Engine knocking, cetane number. Diesel engines combustion chambers. Fuel injection in Diesel engines, conventional and state-of-the-art common rail systems. Fuel distribution and evaporation, Fuel jet penetration, Air-fuel mixing, Ignition delay. European emission ("Euro") standards, Driving cycles and certification procedure. Mechanisms of pollutants formation (CO, HC, NOx, particulate matter) from internal combustion engines - influence of engine operating parameters on the formation of pollutants. Pollutants control: Exhaust gas after-treatment systems (three-way catalytic converter, diesel oxidation catalyst, diesel and gasoline particulate filter, selective catalytic reduction (SCR), lean NO_X trap, scrubber) and internal measures (exhaust gas recirculation (EGR), water injection, etc.). Internal combustion engines fuels and biofuels. CO_2 emissions from engines (legislation, standards, methods of reduction).

D. Hountalas, E. Giakoumis, (N. Komninos, D. Giannopoulos)

(2.2.2042.9) Energy Storage Systems [C] (GR & EN)

Central and decentralized energy systems, energy storage needs and framework, overview and analysis of energy storage technologies and applications. Power-to-X, Power - to - Fuel, Power - to - Power, Power - to - Heat. Thermal Energy Storage processes (sensible, latent). Renewable CO2 capture/sequestration for use in energy storage applications. Thermochemical energy storage for hydrogen, methane, methanol and hydrocarbons production. Biomethane production technologies. Carnot Batteries and Thermal Energy Storage. Energy Storage Applications and Cross-sectoral integration.
Teaching will include simulation of presented processes in ASPEN+.

Project/s: C | 80 % of the Final Grade

S. Karellas, K. Braimakis, (A. Nikoglou)

(2.2.2025.8) Decentralized Thermal Energy Systems (GR & EN)

Energy utilization of biomass and residues. The properties of biomass as a fuel and its energy upgrade. Biomass combustion systems (grate, fluidized bed, pulverized fuel, other technologies), Gasification (autothermal - allothermic) of solid biomass, biogas production and direct use or upgrade. Operation of decentralized thermal systems for biomass and other thermal renewable energy sources. Combined heat, power, cooling generation and multi-generation. CHP legislation. Economic evaluation of decentralized thermal systems. Small-scale energy storage systems. Utilization of waste heat from thermal processes, Industry.

- Laboratory exercises (Fluidized bed, Rankine Organic Cycle installation function),

- Semester project on thermodynamic development, selection of appropriate components (piping, pumps, expanders), design (alternator, frame and unit sizing) and financial evaluation of an integrated decentralized thermal system.

Lab: O	Project/s: O	10% of the Final Grade
Subject: C	50% of the Final Grade	

E. Kakaras, S. Karellas, (P. Vourliotis, A. Doukelis, P. Pallis)

(2.2.2186.8) Computational Methods for Transport Phenomena (GR)

Transport by molecular motion, transport in laminar or turbulent flow - Hyperbolic, parabolic and elliptic equations - Variational methods for steady-state and time-dependent transport phenomena (weak formulation, functionals, the Ritz method, the method of weighted residuals). Finite difference method (discretization, steady-state and transient diffusion, Steady-state and transient transport by diffusion and convection) - Finite element method (physical or direct approach, variational formulation, steady-state and transient transport phenomena) - Boundary element method - Errors, convergence and stability of numerical methods - Computer programs for each method - Applications.

Project/s*: C*	*20* % of the Final Grade

Ch. Tzivanidis (G. Zannis)

(2.2.2182.9) Solar Energy (GR)

Solar radiation (basic concepts, angles, direct and diffuse radiation, spectral distribution, attenuation by the atmosphere, tilted and tracking systems, correlations, measurement of solar radiation, values in the Athens area) - Theory of flat-plate collectors (heat transfer analysis, temperature distribution on the absorber plate, collector efficiency factor, heat removal factor and flow factor, collector efficiency, measurement of collector performance, various designs of flat plate collectors) - Concentrating collectors - Solar systems for space and service water heating (design methods, the f-chart method) - Design methods for thermal solar systems (Utilizability, the f-chart method) - Energy storage - Other applications (Solar cooling, conversion to mechanical energy, solar ponds, passive systems, economics).

Lab: C	10% % of the Final Grade	Project/s: C	10% of the Final Grade

Ch. Tzivanidis, K. Braimakis, (G. Zannis)

(2.2.2183.9) Air-Conditioning [C] (GR)

Thermal comfort - Psychrometrics (thermodynamic properties of moist air, humidity parameters, psychrometric charts, typical air-conditioning processes) – Air duct design (frictional losses, dynamic losses, duct design methods) - Climatic conditions - Solar heat gain - Air-conditioning loads (heat gain, cooling load, heat extraction rate, ASHRAE load calculation method, loads from walls - fenestration - lighting - people - appliances - ventilation and infiltration, transfer function method) - Air-conditioning systems: direct expansion, all-water (fan-coil units), all-air (variable volume or variable temperature, dual conduit, multi-zone systems), air-water (induction unit), heat pump – Applications (design of installations) – Laboratory.

Lab *:C*	*10* % of the Final Grade	Project/s: C	10% of the Final Grade

Ch. Tzivanidis, K. Braimakis, (G. Zannis)

(2.2.2009.9) Industrial Refrigeration Systems-(GR)

E. Koronaki, (G. Antonakos)

(2.2.2044.7) Thermodynamics Software-(GR)

Project/s*: C* | *100* % of the Final Grade

E. Koronaki, (N. Komninos, G. Antonakos)

(2.2.2285.8) Gas Exchange & Supercharging of Internal Combustion Engines (GR)

Gas exchange in four-stroke engines. Volumetric efficiency, influence of various parameters (fuel type, heat losses, friction, valve timing, injection timing, residual exhaust gas, exhaust gas recirculation). Exhaust gas and exhaust emissions, silencers, exhaust gas recirculation. Gas exchange in two-stroke engines - performance parameters and scavenge models. Supercharging and turbocharging Intercooling. Compressor and turbine operating maps (variable geometry compressors and turbines, waste-gate valves). Supercharging system selection for different applications. Matching examples (mechanical supercharger, turbocharger). High-performance - assisted turbocharging). Exhaust manifold configuration. Efficiency/CO_2 emissions, mechanical and thermal stress, and supercharged engines torque curves. Gasoline engine supercharging problems. Transient response of turbocharged engines and methods to improve it.

Lab*: O* | *15* % of the Final Grade

D. Hountalas, E. Giakoumis, (A. Doukelis)

(2.2.2272.9) Thermal Energy in Buildings (GR)

External and internal boundary conditions: climate data, indoor and outdoor temperature, solar radiation, ground temperature, etc. Thermal properties of building materials. Insulation materials. Convection heat transfer coefficients of external and internal structural surfaces. Analytical, numerical and experimental methods of thermal analysis of buildings. Transfer functions. Thermal resistance circuit methods. Steady state and transient heat transfer to the building shell. Periodic heat transfer. Conduction and convection heat transfer. Radiation heat transfer. Air penetration. Thermal behaviour of glass panes. Thermal bridges. Steady state and transient heat transfer in the interior of buildings. Convection. Radiation. Thermal effect of indoor mass of buildings. Thermal characteristics of buildings and their individual structural components. Thermal loss coefficient, effective and apparent heat capacity, time-constant, thermal lag, etc. Thermal storage capacity of building elements and the whole building. Bioclimatic design of buildings. Passive thermal systems. Night cooling and thermal mass of buildings. Thermal response of buildings to typical external disturbances. Reverse thermal building problem: Identification of building materials given the thermal behavior of buildings. Dynamic indoor thermal response to internal thermal load fluctuations. Internal building surface heat capacity. Dynamic models of the thermal behavior of buildings. Building shell models and indoor models. Thermal mass models (inertia). Thermal resistance circuit modelling. Energy savings. Thermal control of buildings.

Project/s*: C* *30* % of the Final Grade

Ch. Tzivanidis, K. Braimakis, (G. Zannis)

(2.2.2212.9) Pollution Abatement Technology for Thermal Plants [C] (GR & EN)

Energy and environment. Environmental impact of thermal plants. Energy technologies and measures for reducing the environmental impact, Climate change. International

Environmental Policy. European Environmental Policy & Objectives. Environmental legislation. Emissions Trading System (ETS). Particles from combustion in thermal stations and pollution abatement systems (electrostatic precipitators, bag filters, cyclones). Mechanisms of formation and capture capabilities of main gas pollutants (NO_x, SO_2). Acid dew point and factors that affect it. CO_2 emissions and the greenhouse effect. CO_2 emissions reduction studies in different countries. CO_2 emissions reduction in electricity generation. CO_2 capture and storage technologies in thermal power plants. Large-scale energy storage systems (Power-to-X) that include the reuse of CO_2. Energy recovery of waste and residues. Operation and pollution abatement technology of thermal power plants for waste utilization or production of secondary fuels from recovered waste materials. Life cycle analysis. Measurement techniques for gas pollutants (O_2, CO_2, O, SO_2, N_2O), C_xH_y, NO_x) and particles. Laboratory exercises focusing on measurement of gas pollutant concentration.

Lab*: O* | Project/s*: O* | *10* % of the Final Grade

S. Karellas, (P. Vourliotis, S.Ch. Chatzilaou)

Mechanical Design & Automatic Control

(2.3.2238.1) Introduction to Computing [C] (GR)

Introduction to Computing. Numbering Systems. Binary arithmetic and coding. Computer Architecture. Microprocessor architecture and operation. Typical microprocessors. Peripheral Devices. Computer communications & Networks. Introduction to scientific computations using the MATLABTM environment. Computing applications in Mechanical Engineering. Laboratory sessions: Introduction to MATLAB™.

Lab: C | *25* % of the Final Grade

L. Alexopoulos, (A. Kotsirea)

(2.3.2219.3) Kinematics and Dynamics of Mechanisms [C] (GR)

Kinematics of the rigid body: translational motion, rotation around a fixed axis, general plane motion, calculation of velocity and acceleration, instantaneous pole of rotation, rotation around fixed point (spherical motion), angular speed and acceleration, derivative of a vector with respect to a rotating cartesian frame, general space motion, relative motion of point, Euler angles.

Dynamics (kinetics) of a rigid body: Euler equations for rigid bodies, angular momentum and inertia tensor, motion equations for rigid body, principle of impulse-momentum, principle of work-energy. Analytical dynamics: Lagrange equations, integrals of motion, Hamilton’s principle. Introduction to the kinematic and dynamic analysis in planar mechanisms, design steps and iterations in mechanisms, constraint requirements, kinematic link-chains-mechanisms and machines, mobility of mechanisms, kinematic inversion, kinematic pairs and joints. Groups of Mechanisms according to their operating principle and application: 4-bar linkage (parallel and non-parallel, drag link, crank and rocker), slider crank mechanism, scotch yoke mechanism, quick return mechanisms, straight line mechanisms, parallel mechanisms (pantograph), toggle mechanisms, Oldham coupling, universal joints (Kardan joints), intermittent motion mechanisms (Geneva wheel-Malta cross), ratchets, elliptic trammel. Kinematic analysis of mechanisms applying vector analysis using the loop closure equation, for position analysis - velocity analysis - acceleration analysis. Application in slider crank mechanism - 4/5-bar mechanism - mechanisms with sliding links - compound mechanisms. Dynamic analysis of mechanisms applying D' Alembert principle (converting dynamic problem to static). Application in slider crank mechanism - 4/5-bar mechanism - mechanisms with sliding links - compound mechanisms. Synthesis of mechanisms: Freudenstein's method and application in 4-bar mechanism. Gyroscopes and Gyroscopic coupling: Calculation of the gyroscopic coupling moment in rotating elements, mechanisms based on gyroscopic phenomena. Flywheels: the problem of instantaneous fluctuation of speed - energy considerations and energy flow in mechanisms (energy balance) - design of flywheels. Design of Cams: Cam profiles and follower motions (linear, harmonic, cycloidal), the challenge for jerk-free motion- cam design using polynomials. Balancing of mechanisms: static and dynamic balancing of mechanisms and of the 'rigid' machine.

Lab: 2 Optional PC Lab using MATLAB | 2 Optional Projects, 20% of the Final Grade each.

A. Chasalevris

(2.3.2167.4) Machine Elements I [C] (GR)

Introduction to mathematical modeling of mechanical parts and assemblies. Engineering materials and their selection methods. Loading and failure models on machine elements. Design for life and Fail safe engineering design approaches. Calculation of static and fatigue loading. Calculation of the fatigue strength of parts using Woehler, Soderberg and Goodman-Smith diagrams. Elements of fracture mechanics and Paris charts. Stress intensity and stress concentration coefficients in machine elements. Cumulative effect of fatigue and Palmgren-Miner rule. Strength calculation for combined loading. Shafts and axles. Calculation of wended joints and adhesive layers. Mechanics and calculation of threads and bolted connections. Shaft-hub connections (keys, splines, friction elements, press-fits). Couplings, cluthes and brakes. Ball-roller bearings and dry sliding bushings. Rotary seals for shafts. Springs and other flexible machine elements. Wire ropes and linear flexible machine elements and their applications. Protective coatings for machine elements.

Lab*: C* | *70* % of the Final Grade

V. Spitas, (G. Kaisarlis)

(2.3.2078.5) Machine Elements II [C] (GR)

Introduction to motion and power transmission systems. Power flow in mechanical systems and efficiency. Belt drives and friction drives. Law of gearing and matrix equations of gear meshing. Contact surfaces, rolling curves and meshing gear tooth profiles. Contact ratio and stages of tooth meshing. Kinematical Analysis and calculation of sliding velocity and efficiency. Gear types (cylindrical spur-helical gears, bevel and spiral bevel gears, worm-gear sets, hypoids, spiroids etc) and their calculation under common loading types (bending strength, pitting, scoring etc). Compliance, profile modifications and load distribution on gear teeth. Transmission errors and gear tolerances. Gear manufacture. Gear failure and inspection. Chain drives. Speed reducers and gearboxes. Planetary mechanisms and differentials. Special drives (harmonic, cyclo-drive etc). Lubrication and introduction to tribology. Journal Bearings and air bearings.

Lab*: C* | *70* % of the Final Grade

V. Spitas, (G. Kaisarlis)

(2.3.2089.4) Dynamics and Vibrations [C] (GR)

Linear Dynamic Systems with a Single Degree of Freedom

Structure and Basic Components. Free vibrations. Response to harmonic, periodic and transient excitations. Response to general and random vibrations (*)

Linear Dynamic Systems with Multiple Degrees of Freedom

Natural Frequencies and natural modes. Modal analysis and transformation. Transfer Functions. Laplace transform (*). Numerical approaches. Applications in mechanical engineering systems.

Modelling of Dynamic Systems
Lagrangian Energy Principle and applications in discrete mechanical systems, continuous mechanical systems and dynamic systems with various physical components (mechanical. hydraulic, pneumatic, electrical).
Basic principles for vibration control
Concepts for vibration isolation. Transmissibility functions. Damping and damper technology. Vibration absorption and tunned mass absorbers. Application examples.

Lab*: C*

I. Antoniadis, A. Chasalevris, (Ch. Giakopoulos)

(2.3.2007.6) Modelling and Automatic Control of Systems [C] (GR)

Introduction, brief history, control system principles, mathematical models of physical systems, transfer functions, state equations, functional block diagrams, properties of feedback control systems, transient response, basic feedback controllers, root locus, methods for control system design, frequency response, compensator design, applications.

To attend this course, sufficient knowledge of the material of the following courses is strongly recommended: Electric Circuits & Systems, Mathematics IV (Complex Functions), Introduction to Electronics.

Lab*: O* | Project/s*: O*

E. Papadopoulos, (I. Davliakos, M. Drosakis)

(2.3.2029.6) Analysis of Mechanical Structures I [C] (GR)

The meaning of Static and Dynamic Analysis of Structures. Idealization of structural members (bar, beam, plane stress, plate in bending, shell, string and membrane). Related theory of elasticity. Torsion of solid sections (Prandtl stress function solution), the membrane analogy, St Venant warping function. Stiffness matrix of bars and beams. Plane trusses and frames. Triangular elements in plane stress Elasticity (isotropic and anisotropic, stress concentration problem), in Heat transfer, and in Acoustics. Solution of Laplace-Poisson problems in mechanical engineering. Boundary conditions of the third type. Axisymmetric problems. Mass matrix and time integration. Three-dimensional problems. Coupled problems. Rectangular elements. Isoparametric elements and Gauss integration. Application in Navier-Stokes problems. Fundamentals of automatic mesh generation. Architecture of finite element codes and programming. Demonstration of commercial software.

Project/s*: O* | *15* % of the Final Grade

Ch. Provatidis

(2.3.2169.8) Transport and lifting machines [C] (GR & EN)

Basic technologies of conveying and lifting systems and machines. Structure, technologies and calculation of wire ropes and cables. Horizontal and inclined conveyor belts (modeling of operation, transient phenomena, design and calculation). Ancillary equipment and supporting structures for conveyor belts and conveyor systems in general. Angle of repose / surcharge and modeling of the behavior of granular materials in industrial conveying systems. Calculation of transient (dynamic) phenomena and selection of motors / speed reducers. Roller conveying systems and cableways. Pretensioning systems and their calculation. Pneumatic conveying systems. Modelling and design of positive or negative (vacuum) pressure systems including selection and design of fans/ blowers, bag-filters, cyclone dust collectors, silos, air-gliders, feeders and other ancillary equipment. Conveyor screws (horizontal – inclined – vertical) and their calculation – design. Bagging machines. Basic technologies of lifting machines and systems. Calculation and design for lifts and escalators. Lifting platforms and mechanisms. Safety regulations and handling of loads. Traction and lifting winches. Design of cranes and gantry cranes. Chain bucket elevators.

80% of the Final Grade

V. Spitas, (G. Kaisarlis)

2.3.2306.7) Dynamics of Rotating Machines (GR)

Dynamics of flexible bodies in rotation, gyroscopic phenomena. Bending and torsional vibrations of rotors. Linear harmonic analysis (eigenvalues, eigenmodes in rotating machines, critical speeds), Campbell diagrams, application of Finite Element Method in rotors, dynamic analysis of multiple body systems with local nonlinearities, application of Model Order Reduction techniques, stability criteria in multiple DOF systems, damping models, characteristics of trajectories and response time series (periodicity, quasi-periodicity, chaos) in rotating machines, tribology in sliding bearings (Reynolds equation), design of sliding bearings and gas foil bearings, squeeze film dampers, base excitation in machines, parametric excitation (anisotropic rotors in generators), self-excited vibrations from fluid and gas flow (oil whirl/whip, Thomas/Alford forces) and dynamic stability. Standards and templates in dynamic analysis of turbomachines. Simulation of rotating machines. Projects: Basic rotor dynamic calculations for turbomachinery design, e.g. turbine-generator for power generation, turbopump for rocket propulsion, turbochargers in internal combustion engines, gear boxes, power transmission layouts.

Lab: 3 Optional PC Lab using MATLAB	Projects: 3 Optional Projects, 15% of the Final Grade each

A. Chasalevris

(2.3.2304.9) Hydraulic and Pneumatic Systems [KMM (Y)] (GR)

Introduction to hydraulic-pneumatic motion and power transmissions. Mass and energy flow in power hydraulics. Hydraulic fluids (properties and selection). Transient phenomena and water hammer effect. Hydraulic power generation using positive displacement pumps. Geometry and flow calculations (including flow ripple) and volumetric efficiency for gear, vane and piston pumps (swash-plate and bent-axis). Piping and fittings. Flow and pressure control valves (check valves, pressure reliefs, flow control valves etc.) Ancillary equipment of hydraulic systems (tanks, filters, heat exchangers etc.) Design and selection of hydraulic actuators (cylinders and hydraulic motors). Hydraulic accumulators and their use in power circuits. Control of hydraulic power and actuators (analog and servo-valves), meter-in / meter –out configurations. Piston, rod and static seals for high pressure hydraulics. Hi-lo arrangements and synchronization of motions. Pneumatic compressors. Air reservoirs and air-conditioning systems for industrial pneumatics. Pneumatic cylinders and motors. Valves and pneumatic automation. Design of pneumatic circuits.

Εργαστήρια: Κατ' επιλογήν υποχρεωτικά	Βαρύτητα: 60% (Άσκηση 1: 30% Άσκηση 2: 30%)

V. Spitas, (G. Kaisarlis)

(2.3.2299.7) Introduction to Biological Engineering (GR & EN)

Introduction to organ and cell functions in the human body. Introduction to biology. Coding DNA-> RNA ->protein. In-vivo and in-vitro models of biological systems. Cell structure and function. Fundamentals of Anatomy and organ functions. Cell signaling and decision making. Systems Biology. Bioinformatics. Problem solving in Medicine and Biology in terms of Mechanical Engineering principles and practices. Introduction to applications: Tissue Engineering, Biomechanics, Biomaterials, Biomedical Devices.

To attend this course, sufficient knowledge of the material of the following courses is strongly recommended: Operating Systems and Programming Languages.

L. Alexopoulos

(2.3.2300.8) Biodesign (GR & EN)

Introduction to medical devices. Medical Devices (MDs) and In vitro Diagnostic Products (IVDs). Micro/Nano technologies for MDs and IVDs. Biosensors. Single & Multiplex measurements for DNA, RNA, and proteins. Regulatory Framework. Quality Management Systems (QMS) for MDs and IVDs. ISO13485. The course is project-based and include the research and development of an IVD or MD starting from the idea, brainstorming, concept, market analysis, need identification, intellectual property (IP) search, product design, and business plan.

L. Alexopoulos

(2.3.2305.9) Hybrid-Electric Vehicles [MMEEMM] (GR)

Sustainable Transportation. Introduction to the architecture of hybrid and electric vehicle powertrain. Calculation of basic components (power, torque, etc.). Engine-transmission systems. Energy storage systems (batteries, high speed flywheels, supercapacitors, etc.). Systematic energy management planning for the movement of the vehicle. Degree of hybridization. Energy recovery systems. Modeling - component analysis of hybrid - electric vehicles. Current technologies of hybrid vehicles.

Project (1): C 50%

D. Koulocheris

(2.3.2289.7) Design for Manufacturing & Cost [C] (GR)

Product design specification. Conceptual, embodiment and detail design. Design principles. Principal design guidelines. Variant design. Value engineering analysis. Mechanical engineering design in conjunction with the technical characteristics of the manufacturing processes. Industrial Materials and Processes – selection and costing. Design for the Environment/DFE, Design for Manufacturing and Assembly/DFMA. Product documentation and Quality Control. Design for accuracy and interchangeability. Geometric dimensioning and tolerancing. Design for Manufacturing/Assembly cost reduction. DFC indices. Tolerance analysis and synthesis. Tolerances and machining accuracy. Tolerancing methods. Product testing. Prototyping. Additive Manufacturing/Rapid Prototyping & Tooling/3D Printing. Modern practices and information systems for product design, development, production and PLM. Reverse Engineering. Industrial Property, Patents.

Project/s*: O* *25* % of the Final Grade

Ch. Provatidis, V. Spitas, (G. Kaisarlis, S. Polydoras)

(2.3.2023.7) Advanced Control Systems [C] (GR)

Modeling of dynamical systems, power state variables, bond graphs, derivation of state space equations, linear systems analysis, solution of state space equations, controllability and observability, classical and modern control, state feedback control, optimal control & the general optimal control problem, linear-quadratic optimal control problem, optimal regulator, relation to classical control, optimal control and reference input tracking systems, state reconstruction – observers, applications.

K. Kyriakopoulos, (M. Drosakis)

(2.3.2192.8) Analysis of Mechanical Structures II [C] (GR)

Plane load carriers (membrane, thin plate, laminate plate, shell). Partial differential equations of stress equilibrium for thin plates in bending, torsion and in-plane loading. Analytical solutions for typical boundary conditions. The finite element method. Buckling of columns and plates. Large-displacement analysis. Contact analysis. Elastoplastic analysis. Time integration. Adaptive finite elements. Isogeometric Analysis and CAD-based macroelements. The Boundary Element Method in elasticity and potential problems. Bending, shear and torsion of open and closed, thin-walled beams. Stress analysis of aircraft components. Shear stress distribution at a built-in end of a closed section beam. Structural Optimization under stress-, displacement-, eigenvalue- and buckling- constraints. Fully stressed design. Optimality criteria in trusses and frames. Non-linear mathematical programming methods. Stochastic optimization methods. Shape optimization. Topology optimization. General rules in FEM modeling. Hands on commercial codes in the PC-lab (practice, two- out of the four hours, weekly). Optional homework, either using commercial FEM codes (SolidWorks, ANSYS) or programming via MATLAB and other computer languages.

Project/s: *O* *40%-50 % of the Final Grade*

Ch. Provatidis

(2.3.2039.4) Introduction to Electronics [C] (GR)

Analog Circuits: Diodes (Zener, Photo-diodes, applications: inversion). Bipolar Transistor (CB, CC, CE). Low frequency Amplifiers. Operational Amplifiers (Applications to signal conditioning and control). Digital Circuits: Gates (hardware realization, Boolean Algebra). Medium Scale Integration Circuits (decoders, multiplexers, adders, ROM, PLAs). FLIP-FLOP. Sequential Circuits (Introduction, counters). Applications: Signal Conditioning & Transmission, TRIAC & Thyristors. Industrial control systems. Laboratory sessions: a) Operational Amplifiers in control b) Inversion.

K. Kyriakopoulos, (M. Drosakis, A. Triantis)

(2.3.2232.9) Flight Dynamics [C] (GR)

Basic Aerodynamics: aerodynamic surfaces, flight control surfaces and systems of typical aircrafts. Static stability and trim. General Dynamic Equations (3D solid body in space). Linear simplification of longitudinal dynamics: solution, oscillation types, longitudinal dynamic stability. Linear simplification of lateral dynamics: solution, oscillation types, lateral dynamic stability. Aerodynamic stability derivatives. Stabilization and longitudinal dynamics control, automatic pilots. Stabilization and lateral dynamics control, automatic pilots. Special cases (e.g. handling quality).

To attend this course, sufficient knowledge of the material of the following courses is strongly recommended: Introduction to the Aircraft.

Project/s*: C* *50* % of the Final Grade

I. Antoniadis, Sp. Voutsinas

(2.3.2242.2) Electric Circuits & Systems [C] (GR)

Models of circuit discrete elements. Resistors and energy storage elements. Sources. Systems of elements. Transformers. Linear circuit analysis via the linear graph method. Voltage division. Kirchhoff laws. Thevenin and Norton theorems. Linear system properties. Superposition. Stability. Circuit time response and sinusoidal steady state response. Frequency response. Transfer functions, filters. Three-phase networks. Average and reactive power. Balanced and unbalanced loads. Lab exercises: circuit time and frequency response, parameter identification.

To attend this course, sufficient knowledge of the material of the following courses is strongly recommended: Mathermatics A1 (Functions of one variable), Mathematics A2 (Linear Algebra & Analytic Geometry), Physics (Electricity and Magnetism with Optics).

Lab*: O* | *Project/s: O*

I. Poulakakis, (I. Davliakos, A. Triantis))

(2.3.2245.3) Electromechanical Power Conversion Systems [C] (GR)

Fundamental principles of electromagnetism. Magnetic circuits and permanent magnets circuits. Electromechanical power conversion, development of torque and voltage. Electromagnetic actuators, electromagnets, voice coils. Generators, motors and loads. Torque-speed characteristics. Basic equations, equivalent circuits, characteristic curves, power flow, efficiency and losses in electric machines. DC generators and motors. Synchronous generators and motors. Three-phase and single-phase induction motors. Stepper, universal, and brushless motors. Introduction to drives and motor control. Lab exercises: motor response, parameter identification and characteristics of motors/generators.

To attend this course, sufficient knowledge of the material of the following courses is strongly recommended: Electric Circuits & Systems.

Lab*: O*

I. Poulakakis, (I. Davliakos, A. Triantis)

(2.3.2174.7) Theory of Ground Vehicles [C] (GR & EN)

Vehicle definition, vehicle classification, European Directives, International Regulations. Analysis of the subsystems of a vehicle (chassis, transmission, braking systems, suspension, steering, etc.). Introduction to tire mechanics (basic equations). Equations of planar motion of the vehicle motion, calculation of required torque / power on the axles. Vehicle performance (calculation of maximum speed values, acceleration, inclination, traction, etc.). Calculation - Selection of vehicle transmission system (gearbox - differential ratios). Optimization of vehicle transmission system (drive axles). Calculation of maximum braking force and deceleration. Critical braking speed. Optimal braking - Distribution of total braking force on the axles of the vehicle. Use of specialized software for calculation / selection of vehicle subsystems. Introduction to hybrid vehicles (Architecture & Basic subsystems) - new driving technologies. Heavy vehicle superstructures (examples from the automotive industry - case studies).

Lab exercises (3): C 20% | Project (1): C 30%

D. Koulocheris

(2.3.2244.8) Dynamics and Design of Vehicles [C] (GR & EN)

Tire mechanics (basic theory - equations). Tire models (analytical, semi-analytical, Pacejka). Equations of vehicle motion in 3D space. Modeling of vehicle steering system, optimization. Calculation of vehicle stability (longitudinal, transverse). Modeling of vehicle suspension systems (passive, active, semi-active). Vehicle's handling. Ride comfort optimization. Dynamic behavior vehicle models (quarter / half / full car). Field measurements of characteristic quantities & estimation of the dynamic behavior of the vehicle. Introduction to traffic accident reconstruction. Use of dynamic simulation computer software. Applications - Case studies from the Greek construction industry of special vehicles (optimal design of dynamic behavior of a complete vehicle).

Lab Exercises (3): C 20%	Project (1): C 30%

D. Koulocheris

(2.3.2220.7) Signal Processing at Mechanical Systems [C] (GR)

Fundamentals of Signal Processing

Basic concepts and examples. Fourier analysis, spectra, windows. Digital signals and sampling theorem. Correlation and modulation. Time-frequency analysis and wavelets.

Vibration Measurement and processing

Sensors and processing architectures. International standards for measurement and analysis. Laboratory and industrial applications.

Sound and Noise Measurement and Analysis

Sound and Noise features and characteristic variables. International standards for measurement and analysis. Laboratory and industrial applications.

Diagnosis of mechanical faults

Basic concepts. International standards and empirical approaches. Dynamic models of machines under faults and response analysis. Typical faults of rotating machines. Unbalance, misalignment, loose supports. Bearing and gear faults. Faults in electrical motors.

Applications of pattern analysis and machine learning in machine fault identification

Feature selection and extraction and extraction (CDET, PCA, ICA). Fundamentals of machine learning (K-means Clustering, Support Vector Machines, Neural Networks) and anomaly detection. Applications in machine fault identification.

Lab*: C*	*30* % of the Final Grade

I. Antoniadis, (Ch. Giakopoulos)

(2.3.2310) NOISE AND VIBRATIONS [C] (GR)

Fundamental Principles and Technologies of Anti-vibration Mounts. Basic concepts of Acoustics. Measurement and Analysis of Sound. Wave Phenomena and Wave Theory. Subjective Perception of Sound. Processing of Acoustic Signals. Passive Noise Control/Reduction. Noise Isolation (Soundproof Panels, Sandwich Panels, Elastic Mounts). Noise Absorption (Sound-absorbing Materials, Meta-materials, etc.). Acoustics of Rooms and Buildings. Sound from Structural Elements (Sound Scattering from Structural Elements, Acoustic-Structural Interaction). Active Noise Control (ANC)/Reduction (Linear and Non-linear ANC Methods, Local and Global ANC methods, Equipment, sensors, etc.).

Microphones and Loudspeakers. Noise Pollution - Legislation (permissible limits, units of noise pollution measurement, human impacts, environmental noise, etc.).

- Laboratory Application/Demonstration of Active Noise Control
- Development of Simulation Models for evaluating various Active Noise Control (ANC) Methods in the Matlab/COMSOL computing environment.

I. Antoniadis, (Ch. Giakopoulos)

(2.3.2249.8) Microprocessors Based Control [C] (GR)

Introduction to control systems using microprocessors -μP and microcontrollers –μC (ADC, DAC, Sampling & Hold–S/H). Introduction to microprocessor and microcontroller architecture and programming. Assembly and interfacing of MC86HC11. Signal representation in digital systems, Z-transform, frequency domain analysis, state equations of sampled systems, time domain analysis. Stability, Controllability & Observability. Design and Implementation of Sampled Data control systems. State observation (observers – Kalman filtering) Model Identification. Introduction to Adaptive Control. Laboratory sessions: a) design and simulation of a digital control system for a medium scale plant (e.g. aircraft), b) assembly programming for μP & μC and simple controller implementation (e.g. alarm, servo-motor control), c) on-line identification of the dynamic parameters of 2-DOF manipulator.

k. Kyriakopoulos, (M. Drosakis, A. Triantis)

(2.3.2274.9) Robotics [C] (GR)

Advanced analysis and design techniques of automatic control systems for nonlinear engineering systems. Parameter identification and adaptive control. Neural networks. Robotic systems (manipulators, vehicles, underwater and aerial vehicles): Analysis, Control, Programming & Integration. Laboratory exercises: System simulation, robotic manipulator control, navigation and control of mobile robots, navigation and control of an underwater vehicle.

To attend this course, sufficient knowledge of the material of the following courses is strongly recommended: Modelling and Automatic Control of Systems.

Lab*: O*

K. Kyriakopoulos, I. Poulakakis, (I. Davliakos)

(2.3.2276.9) Biomechanics and Biomedical Engineering [C] (GR)

Introduction. Current and future potential of Biomedical Engineering. Biomechanics. Tissue Engineering. Elementary gait analysis and rehabilitation principles. Mechanical behavior of bones and soft tissues. Mechanical behavior of muscles and tendons. Biological system analysis. Biomedical devices for protein and DNA measurements. Methods to obtain medical images from a CT scanner (raw data, DICOM, etc.). Development of a 3D-CAD model. Development of finite element models.

Project/s*: C* *50* % of the Final Grade

L. Alexopoulos

(2.3.2311.9) Design for Additive Manufacturing and Applications [C] (GR)

Review of the basic additive manufacturing (AM)/ rapid prototyping (RP) techniques, printing heads and 3D-printing machines. AM materials (polymers, elastomers, ceramics, metals, mortars etc.) and methods for finishing coarsely manufactured surfaces. Selection of suitable AM method and material. Introduction to rapid tooling (RT). Elements of reverse engineering (RE) and basic RE technologies and machines (touchprobe, laserscanner), accuracy and repeatability of the measurements, measuring techniques on CMMs. Postprocesssing of the obtained point-cloud, triangle model and grid repairing techniques, development of CAD models and parametric surface models. Design for AM. Identification of the critical functional tolerances and calculation of fits on functional assemblies. Design simplification and adaptation to the available RP technologies / machines. Placement and support of the objects on AM machines. Techniques for avoiding part warping during and after AM, design of part supports and selection of infill pattern and density. Numerical modeling of RP parts using FEM and assessment of residual stresses-strains and strength. Design assessment.

Ch. Provatidis, V. Spitas, (G. Kaisarlis, S. Polydoras)

Nuclear Engineering

(2.4.2241.3) Operating Systems and Programming Languages [C] (GR)

The software of digital computers. The role and structure of operating systems. Categories of operating systems, real-time operating systems, multi-processing systems. General characteristics and components of UNIX and LINUX, user interface, utilities, editors and Word Processors, file management services. Language processors, assemblers, compilers, interpreters. Programming languages, data structures, basic operations and flow control. Source code, object code, libraries, executable program. Application: statements of Fortran, editing and execution of simple numerical algorithm programs.

Lab*: O* | *100* % of the Final Grade

N. Petropoulos

(2.4.2079.5) Statistics and Measurement in Engineering [C] (GR)

(a) Theory: Introduction to Statistics. Descriptive statistics. Probability theory. Probability distributions. Measurement statistics and statistical tests. Error analysis and error propagation. Linear regression and correlation. Multiple regression. Planning and conducting experiments. Comparative experiments. Factorial experiments. Simulation - Computer simulation techniques. On-line measurements and real-time data acquisition, processing and control. (b) Laboratory work: Application of the laws of statistics in engineering measurements - Comparative and factorial experiments - Real-time computer based measuring systems.

Lab*: O* | *20* % of the Final Grade

M. Anagnostakis, P. Rouni

(2.4.2075.7) Physical Principles of Nuclear Power Reactor Plants [C] (GR)

Basic atomic and nuclear physics concepts. Nuclear reactions. Fission and Fusion. Fission Nuclear Reactors. Neutron population physics. Diffusion of monoenergetic neutrons. Neutron moderation. Neutron thermalization. Thermal neutron diffusion.
To attend this course, sufficient knowledge of the material of the following courses is strongly recommended: Mathematics C (Ordinary and Partial Differential Equations).

N. Petropoulos, D. Mitrakos

(2.4.2298.7) Interactions of Ionizing Radiation with Matter, Radiation Protection – Dosimetry (GR & EN)

Radioactive decay. Sources of radiation. X-Ray production. Interaction of α-particles, β-particles, photons, neutrons and fission fragments with matter. Energy absorption in matter. Radiation damage. Monte-Carlo simulation of the interaction of radiation with matter. Introduction to radiation biology. Dosimetry and dosimetric units (Air Kerma, Exposure, Absorbed Dose, Equivalent Dose). Internal and external dosimetry, dosimetric calculations and portable instruments. Principles of radiation protection, dose limits and relevant legislation. Radiation shielding calculations. Safe use of radioactive sources. Laboratory Training.

Lab: O

M. Anagnostakis, P. Rouni

(2.4.2001.8) Nuclear Power Reactor Set-up and Operation [C] (GR)

Nuclear Power Reactor (NPR) types. NPR components and set-up. Criticality and geometry calculations of Nuclear Reactors. NPR heat transfer calculations. Site selection. Nuclear accidents. Fourth Generation Nuclear Power Reactors. Basic principles and operation of fusion nuclear reactors.

To attend this course, sufficient knowledge of the material of the following courses is strongly recommended: Mathematics C (Ordinary and Partial Differential Equations).

N. P. Petropoulos, D. Mitrakos

(2.4.2262.9) Nuclear power reactors thermal-hydraulics and multiphase flows (GR & EN)

Principal characteristics of power reactors (power cycles, coolant systems, reactor cores, fuel assemblies, reactor types, principles of reactor thermal design and performance). Heat generation and distribution in the core of nuclear reactors. Heat removal from the core. Thermal-hydraulic response and feedback mechanisms. Inadequate heat removal and associated phenomena. Reactor emergency cooling systems. Boiling on heated surfaces, heterogeneous nucleation, bubble generation and departure, wall boiling models. Flow boiling analysis, mixture models, two-fluid models. Aerosol flows and dynamics in reactor containment. Basic principles of nuclear safety. Laboratory exercise.

Lab: O | *20* % of the Final Grade | Project/s: O | *30* % of the Final Grade

D. Mitrakos

(2.4.2263.8) Medical Imaging and radiation therapy (GR)

Introduction to radiation physics, radiobiology and medical imaging. X-ray tube: principles of operation and applications. Radiographic image: film, image intensifier, digital imaging, image quality. Medical radiography units: fluoroscopy, mammography, bone densitometry. Tomography: principles of tomography, tomography units, image reconstruction.

Medical accelerators: principles of operation, applications, Cyclotron, Linear Accelerator (LINAC).

Radiopharmaceuticals: production, use and radiation protection. Gamma-camera. Imaging techniques: PET and SPECT. Nuclear Magnetic Resonance (NMR), Magnetic Resonance imaging (MRI). PET-CT and PET-MRI systems. Ultra-sound imaging.

Radiotherapy: principles, radiotherapy with X-rays, β-particles, heavy particles, radiotherapy planning. Brachytherapy. Radiopharmaceuticals for radiotherapy. Radiation protection in radiotherapy.
Laboratory training

Lab: O

M. Anagnostakis

(2.4.2275.9) Radioactivity in the environment (GR & EN)

Natural radioactivity, artificial radioactivity and technologically enhanced natural radioactivity. Nuclear and radiological accidents. Radioactive contamination from the operation of Nuclear Power Plants and of non-nuclear installations. Enhancement of natural radioactivity due to industrial processes (NORM). Radioactive contamination from the use of radioactive materials. Radioactive effluents. Dispersion and kinetics of natural and artificial radionuclides in the environment. Radionuclides as tracers of atmospheric and other processes. Radioenvironmental surveys. High background areas. Statistical analysis and mapping of radioenvironmental measurements. Radioactivity of building materials. Radon in the living environment, radon indoors and remediation techniques. Radioactive aerosols. Nuclear analytical techniques for the determination of trace elements in the environment. Laboratory training.

M. I. Anagnostakis, P. K. Rouni, D. Mitrakos

(2.4.2287.8) Nuclear Measurement Systems (GR & EN)

Nuclear radiation detectors. Radiation measurement statistics and detection limits. Gas detectors. Scintillation detectors. Semiconductor detectors. Neutron detectors. Radon measurement instrumentation. Portable Instruments for radiation detection. Radionuclide determination techniques: α-spectrometry, γ-spectrometry. Total-α and total-β measurements. Liquid scintillation. Radiochemical methods. Radon concentration measurement techniques and radon exhalation measurements. Nuclear related techniques for trace elements determination: Instrumental Neutron Activation Analysis (INAA), X-ray fluorescence (XRF). Laboratory Exercises.

To attend this course, sufficient knowledge of the material of the following courses is strongly recommended: Interactions of Ionizing Radiation with Matter, Radiation Protection – Dosimetry.

Lab*: C* | *40* % of the Final Grade

N. P. Petropoulos, M. I. Anagostakis

Fluids

(2.5.2110.4) Fluid Mechanics I [C] (GR)

Historical review, achievements – Physics and Chemistry of fluids – Continuum Mechanics – Kinematics – Basic laws in integral and differential form: conservation laws of mass, momentum, moment of momentum, energy (1st and 2nd law) – Constitutive relations – Newtonian and non-Newtonian fluids – Applications, simplifications: Euler and Bernoulli equations – Navier-Stokes equations – Analytic solutions of Navier-Stokes equations – Irrotational flow of incompressible fluids – Superposition of simple potential flow fields - Similarity laws – Flow stability – Turbulent flows – The boundary layer concept – Laminar boundary layer over a flat plate (theory of Blasius) – Turbulent flow in pipes – Forces on moving bodies – Moving frames of reference – Discontinuities – One dimensional isentropic flow of compressible fluid and Laval nozzle.

To attend this course, sufficient knowledge of the material of the following courses is strongly recommended: Mathematics A1, Mathematics A2, Mathematics B, Mathematics C.

D. Mathioulakis, M. Manolesos, D. Bouris, V. Riziotis, Ch. Manopoulos, (I. Prospathopoulos)

(2.5.2016.7) Fluid Mechanics II [C] (GR)

Laminar and turbulent boundary layers. Stability and transition to turbulence. Applications of turbulent flows in jets and wakes of bodies. Boundary layer control. Flow separation phenomenon. Low Reynolds number flows with applications on hydrodynamic lubrication. Buoyant flows. Natural convection flows. Unsteady boundary layers.

To attend this course, sufficient knowledge of the material of the following courses is strongly recommended: Fluid Mechanics I, Numerical Analysis.

D. Mathioulakis

(2.5.2131.5) Hydraulic Turbomachines [C] (GR)

Introduction to Hydraulic Turbomachines: Historical review, modern types and principles of operation. The fundamental equations for incompressible fluid. Energy flow and torque development. Relative motion in rotating impeller, relative flow equations, velocity triangles. Basic equations, operation principles, performance and efficiency, and

characteristic operation curves of centrifugal pumps. Geometric and dynamic similarity in pumps. Dimensionless parameters. Selection of motor and rotation speed. Calculation of main dimensions of a centrifugal pump. Design of the impeller and of the inlet and outer sections.
The pumping installation. Pump selection and operation point. Pump co-operation in parallel and in series connection. Cavitation in pumps: analysis, criteria and calculations. Pump station configuration and operation - Automations. Transient phenomena and hydraulic hammer.
Description of a typical hydroelectric installation and of various hydro turbine types. Performance and efficiency, characteristic operation curves, similarity, dimensionless parameters and cavitation in hydro turbines. Automations and control. Design principles and calculation of main dimensions of hydro turbines. Reversible pump-turbine machines. Hydrodynamic torque converter and hydraulic brake.

Team project (3-5 students, weight 20%): Calculation and design of a hydrodynamic machine (centrifugal pump / fan, or crossflow pump / fan or Pelton, or Francis hydro turbine, or hydraulic wheel) using literature and software.
Individual project, weight 10%: Pump selection and pumping station configuration.
Laboratory exercise, weight 10%. Measurements and construction of the characteristic operation curves of a centrifugal pump.

To attend this course, sufficient knowledge of the material of the following courses is strongly recommended: Mathematics A1, Mathermatics A2, Mathematics B, Mechanics A, Mechanical Design I, Mechanical Design II, Fluid Mechanics I, Electromechanical Power Conversion Systems.

Lab: C	10%: of the Final Grade	Project/s: C	10%: of the Final Grade	Team Project/s: C	30% of the Final Grade

I. Anagnostopoulos, Ch. Manopoulos, (P. Chasapogiannis, A. Raptis)

(2.5.2045.6) Thermal Turbomachines [C] (GR)

Introduction to the morphology, operation and aerothermal analysis of thermal turbomachines. Types of thermal turbomachines, compressor, turbine, steam-turbine. Fundamental governing equations. One-dimensional flow in thermal turbomachines. Flow analysis in two-dimensional cascades. One-dimensional flow analysis in axial and radial compressors. One-dimensional flow analysis in axial and radial turbines. Single- and multi-stage turbomachines. Turbine and compressor similarity. Basic mechanical features. Experiment in the Lab: Experimental determination of a compressor characteristic curve. Project on turbomachinery computations.

To attend this course, sufficient knowledge of the material of the following courses is strongly recommended: Fluid Mechanics I, Applied Thermodynamics of Pure Substances.

Lab: C	5% of the Final Grade	Project/s: C	5% of the Final Grade

K. Giannakoglou, (Ch. Romesis)

(2.5.2111.7) Computational Fluid Dynamics [C] (GR)

Numerical solution of flow fields. Methods of numerical solution of algebraic equations and systems of equations; solution of ordinary differential equations, Runge-Kutta methods. Classification of partial differential equations into elliptic, parabolic and hyperbolic type and corresponding methods of discretization into finite difference equations. The methodology of finite difference and finite volume in potential flow fields (Laplace equation), in frictionless fluid flows (Euler equations) and in viscous flow fields

(Navier-Stokes equations). Examples. Mathematical methods of turbulent flows. The nature of turbulence and the cascade mechanism of turbulent energy, turbulent spectra. Discontinuities and numerical solution of one-dimensional aerodynamic problem Laboratory exercises: Computational simulation topics 1. Numerical solution of a flow field having analytic solution; 2. Numerical solution of parabolic flow fields; 3. Numerical solution of elliptic flow fields; 4. Numerical solution of hyperbolic flow fields.

To attend this course, sufficient knowledge of the material of the following courses is strongly recommended: Fluid Mechanics I, Numerical Analysis.

Project/s*: C* *30* % of the Final Grade

Sp. Voutsinas, (I. Prospathopoulos)

(2.5.2303.7) Aerodynamics (GR & EN)

Introduction to the aerodynamics of the subsonic airplane (dynamic lift and resistance). Simple calculations of lift and drag. The unsteady subsonic three dimensional flow of an inviscid flow: a) Flow around the fuselage, b) Flow around the wing (lifting line theory, monoplane equation, calculation of aerodynamic coefficients, compressibility effects), c) Flow around the propeller (momentum theory, blade element theory, lifting line theory, design and performance of the airplane propeller). d) Flow around the airplane (panel theory). Static theory flight and stability. Modern numerical methods for aerodynamic problems and their applications.

To attend this course, sufficient knowledge of the material of the following courses is strongly recommended: Mathematics B, Fluid Mechanics I.

Project/s: *C* *50* % of the Final Grade

V. Riziotis

(2.5.2189.7) Experimental Fluid Mechanics (GR)

Basic characteristics of measuring instruments. Measurement errors. Signal digitization. Fourier analysis. Operation principles of various measuring techniques like Hot wire anemometry, Laser Doppler anemometry, Particle Image Velocimetry, Pitot and Pitot Static tubes, tubes of many holes, flow rate meters, viscometers, ultra sound, shear stress measurement, pressure measurement, flow visualization. In the context of this course, 6 exercises are carried out, applying some of the above techniques.

To attend this course, sufficient knowledge of the material of the following courses is strongly recommended: Fluid Mechanics I.

Project/s*:C* *25* % of the Final Grade

D. Mathioulakis, D. Bouris, N. Aretakis, Ch. Manopoulos, M. Manolesos
(P. Chasapogiannis)

(2.5.2202.8) Principles of Jet Propulsion [C] (GR)

Thrust generation, equations for thrust calculation, factors influencing thrust. Comparative presentation of different jet-engine layouts. Description of the main parts of a jet engine. Cycle analysis and performance calculations. Parametric design studies. Inlets analysis, design principles, subsonic, supersonic. Exhaust nozzles, operational principles, convergent, convergent divergent. Mixers. Layout and operational principles of compressors, burners and turbines. Blade cooling. Component matching for equilibrium operation. Cycle analysis and performance calculations for different operating conditions, reduced performance parameters. On-aircraft engine operation for different flight conditions.

To attend this course, sufficient knowledge of the material of the following courses is strongly recommended: Applied Thermodynamics of Pure Substances, Thermal Turbomachines, Fluid Mechanics I.

Project/s*: C* *20* % of the Final Grade

K. Mathioudakis, N. Aretakis, (Ch. Romesis)

(2.5.2100.8) Design of Thermal Turbomachines (GR)

Basic principles of compressor and turbine design. Selection of rotational speed and annulus dimensions. Determination of number of stages. Flow angle calculation across blade height (quasi-three-dimensional flow). Radial equilibrium equation. Comparison of different radial distributions of peripheral velocity. Investigation of compressibility effects. Blade profile selection using cascade experimental data. Blade design. Calculation of efficiency using empirical loss equations and experimental data. Calculation of performance maps. Laboratory exercise: measuring the flow field inside an axial compressor stage. Computational project: design of an axial compressor or turbine.

To attend this course, sufficient knowledge of the material of the following courses is strongly recommended: Thermal Turbomachines.

Lab: C | 10% of the Final Grade | Project/s: O | 30% of the Final Grade

K. Mathioudakis, N. Aretakis, (Ch. Romesis)

(2.5.2194.9) Multi-phase Flows (GR & EN)

Introduction to multiphase flow: description, categorization and application examples. Dispersed phase: properties, characterisation, coupling with carrier phase. Statistical characteristics of dispersed phase distributions. Particles in a continuous phase: dynamics, thermodynamics, interactions with fluids, particles and solid boundaries (erosion, deposition). Carrier phase: equations, integration methods. Numerical simulation: Lagrange-Euler. Continuous phase equations (coupling with dispersed phase). Dispersion mechanisms: molecular and turbulent diffusion, numerical simulation. Measurement methods.
Project 1 : Statistical processing of dispersed phase measurements.
Project 2: Numerical simulation of particle motion in basic flow fields of incompressible fluids.

To attend this course, sufficient knowledge of the material of the following courses is strongly recommended: Fluid Mechanics I, Computational Fluid Dynamics.

Project/s*: C* | *50* % of the Final Grade

D. Bouris

(2.5.2178.8) Wind Energy [C] (GR & EN)

Introduction to Wind Energy Technology, current status and Prospects of Wind energy Market in Europe and in the world. Meteorological elements of wind. Wind energy potential. Types and subsystems of wind turbines. Aerodynamic design of horizontal and vertical axis wind turbines. Static and dynamic loading of wind turbines. Electrical motors for wind turbines and their cooperation with the grid. Site selection of wind turbine installations. Analysis of aerodynamic performance and optimized design of wind farms. Practical elements for wind turbine selection. Applications. Economics of wind turbines.

Project/s*: C* *60* % of the Final Grade

V. Riziotis, M. Manolesos, (G. Caralis, P. Chasapogiannis)

(2.5.2218.9) Aeroelasticity and Aeroacoustics [C] (GR & EN)

Mathematical formulation of acoustic and dynamic physical problems: Analytic methods, asymptotic methods, approximations theory. Linear problems analysis: a) elliptic problems (integral equations, boundary element methods, variational methods and finite element methods). Applications to the aerodynamic (dynamic flows, Stokes flows, least squares method, penalty method, dual variational formulations b) Unsteady problems: the diffusions equation, the wave equation. Finite difference method, finite element method, vortex method. Analytical methods: Smooth and eigenvalue asymptotic problems. Applications to the flow around airfoils and wings.

To attend this course, sufficient knowledge of the material of the following courses is strongly recommended: Fluid Mechanics I, Dynamics and Vibrations.

V. Riziotis, (I. Prospathopoulos)

(2.5.2216.9) Gas and Steam Turbine Operation [C] (GR)

Gas Turbines: Types and layout of gas turbines. Cycle analysis, performance parameters. Features of compressors and turbines. Blade cooling. Combustion, combustion chambers, fuels. Operation under varying loads, control methods. Performance simulation. Gas turbine set up, subsystems.

Steam turbine: Steam cycles and steam turbine. Stage analysis, types, operation. Performance parameters, losses, efficiency. Operation under varying loads, control. Performance simulation. Wet steam turbine features.

Principles of maintenance, condition monitoring and fault diagnosis of gas and steam turbines. Performance diagnostics. Aerothermodynamic diagnostics and vibration diagnostics.

To attend this course, sufficient knowledge of the material of the following courses is strongly recommended: Applied Thermodynamics of Pure Substances, Fluid Mechanics I, Thermal Turbomachines.

N. Aretakis, K. Mathioudakis, (Ch. Romesis)

(2.5.2217.9) Aircraft Engine Operation 90 [C] (GR)

Operation analysis of turbo combustion engines and calculation methods of the operation performance. Computational models of aircraft engines, modeling of engine components, determination of engine characteristics and methods for developing computer models of the operation of aircraft engines.Principles of operation and types of auxiliary systems for aircraft engines. Engine use in relation to a specific aircraft, according to its mission analysis. Environmental impact of engines by emissions of gas pollutants as well as noise emissions. Engine certification.

To attend this course, sufficient knowledge of the material of the following courses is strongly recommended: Principles of Jet Propulsion.

Project/s*: C* | *10* % of the Final Grade

N. Aretakis, K. Mathioudakis, (Ch. Romesis)

(2.5.2185.9) Computational Methods in Turbomachinery (GR)

Boundary layer and viscous flow theory. Incompressible and compressible viscous layers in compressor and turbine bladings. Differential and integral methods for viscous flow modeling in turbomachines. Grid generation. Viscous-inviscid interaction methods in turbomachinery. Turbulence and transition modeling in turbomachines. Secondary flows and relevant computational methods. Tip-clearance flows in turbomachines and their modeling. Advanced case studies. Demonstration in OpenFOAM.

To attend this course, sufficient knowledge of the material of the following courses is strongly recommended: Computational Fluid Dynamics.

K. Giannakoglou

(2.5.2231.9) Biofluid Mechanics and Biomedical Engineering (GR)

Biofluid-Mechanics. Elements of Anatomy and Physiology of the circulatory system. Blood rheology. Structure and mechanical properties of the blood vessel wall. Wave propagation in arteries. Pulsating blood flow in arteries. The circulatory system, regulation, modeling. The heart as a pump. Microcirculation. Fluid mechanics of thrombogenesis and atherogenesis. Measurement in circulatory system. Urodynamics. Bio-fluid Mechanics of respiration and voice. Bio-fluid mechanics of hearing and smelling. Bio-fluid mechanics of other biological fluids. Diagnostics and Bio-fluid Mechanics.

Devices and equipment of Biomedical Fluid mechanics. Respiratory ventilators. Haemodialysers (artificial kidney). Peristaltic and infusion pumps. Biomedical measurements (stethoscopes, pressure recording, flowmeters, ultrasonics). Cardiac artificial valves, artificial grafts, replacements, biocompatibility. Artificial organs. Assist devices. Extracorporeal equipment. Devices and equipment of urodynamics. Lithotripters – Suction and drainage technology.

To attend this course, sufficient knowledge of the material of the following courses is strongly recommended: Mathematics A1, Mathematics B, Mechanics B, Mechanics C, Fluid Mechanics I.

Project/s*: O* | *30* % of the Final Grade

Ch. Manopoulos, (A. Raptis)

(2.5.2013.1) Introduction to Mechanical Engineering [C] (GR)

Content of the studies of Mechanical Engineering. Mechanical Engineers' knowledge and skills. Modelling: basic principles and theories. Elements of systems theory and thinking. Basic functions of mechanical products and installations. Elementary assessment tools. Basic physical lows used in Mechanical Engineering and application examples. Lessons learned from successful and unsuccessful examples mechanical constructions.

Project/s & Subjects: O | *40* % of the Final Grade

N. Marmaras, D. Bouris, (S. Drivalou)

(2.5.2148.4) Numerical Analysis [C] (GR)

Systems of linear equations: Direct (Gauss elimination, factorization) and iterative (Jacobi, Gauss-Seidel, SOR) solution methods. Eigenproblems and the power method. Interpolation and polynomial regression: Taylor, Lagrange, Newton and Hermite polynomials. Spline interpolation. Nonlinear equations: bisection, regula-falsi, fixed-point iterative methods, Newton-Raphson, the secant and Schroder methods. The Newton's method for systems of nonlinear equations. Numerical differentiation and integration. Approximation of derivatives. Simple rules for numerical integration. Gaussian quadrature. Integration of improper integrals. Differential equations. The Initial-value problem, Numerical errors. One-step methods (Taylor, Runge-Kutta). Multistep methods (Adams, prediction-correction). Regression theory. Least-squares regression (polynomial, exponential). Least-squares with orthogonal polynomials. Boundary-value problems. Partial derivatives approximation. The linear shooting method. Finite difference methods.

To attend this course, sufficient knowledge of the material of the following courses is strongly recommended: Operating Systems and Programming Languages

Project/s & Subjects: O | *30* % of the Final Grade

K. Giannakoglou

(2.5.2021.5) Applied Fluid Mechanics [C] (GR)

Steady incompressible pipe flow (laminar and turbulent). Pressure-drop in closed channels. Flow calculation in pipe network and pipe network design. Numerical methods in pipe network flow calculation (Handy-Cross, Newton Raphson). Steady compressible pipe flow (adiabatic-isothermal). Fanno curves. Application in natural gas transportation networks. Natural gas transportation network design. Flow in open channels and applications. Ventilation in road tunnels. Natural ventilation of buildings.

To attend this course, sufficient knowledge of the material of the following courses is strongly recommended: Fluid Mechanics I.

D Mathioulakis, V. Riziotis

(2.5.2187.6) Environmental Technology [C] (GR)

Current environmental problems, causes and sources of pollution. Air pollution (emission limits and concentrations, law, effects on health, primary and secondary pollutants, meteorology, atmospheric dispersion). Indoor air quality (concentration levels, ventilation). Air pollution control equipment. Equipment and methods for measuring air pollutant concentrations. Molecular and turbulent diffusion. Plumes and jets. Flow past buildings – infiltration and ventilation mechanisms and requirements. Design of intake and exhaust devices. Filters (HEPA-ULPA-MERV).

To attend this course, sufficient knowledge of the material of the following courses is strongly recommended: Fluid Mechanics I, Applied Thermodynamics of Pure Substances.

Lab*: C* | Project/s: O | *35*% of the Final Grade

D. Bouris

(2.5.2253.7) Optimization Methods in Aerodynamics (GR)

Inverse design and optimization problems in aerodynamics. Objectives in design problems. Shape optimization problems with inviscid and viscous flow considerations. Numerical optimization: mathematical background, optimization without or with constraints, single- and multi-variate optimization, single- and multi-objective optimization, iterative optimization methods (sequel to methods known from the Numerical Analysis course), existence and uniqueness of the optimal solution, advantages and limits of numerical optimization methods. Automatic differentiations, direct differentiation, the complex variable method, the continuous and discrete adjoint method. Applications. Stochastic optimization methods based on evolutionary algorithms and artificial intelligence. Advantages and disadvantages. Applications.

To attend this course, sufficient knowledge of the material of the following courses is strongly recommended: Operating Systems and Programming Languages.

Project/s*: O* | *50* % of the Final Grade

K. Giannakoglou

(2.5.2252.7) New and Renewable Energy Sources (RES) (GR)

Introduction: RES and the energy problem - Historical evolution of energy technologies – The present situation: energy sources and energy consumption (worldwide, in Europe, in Greece) – Towards a sustainable energy future- The development of RES in Europe and in the world – RES in Greece – Short and long term perspectives of RES (worldwide, in Europe, in Greece). The potential of RES- Methods of analysis and estimation: wind potential – solar radiation – biomass – hydroelectric potential – geothermal resources – ocean waves/ ocean currents. Technologies - applications – systems of RES: Wind turbines- Passive solar systems – Bioclimatic architecture – Active solar thermal systems – Photovoltaic systems – Bioenergy – Small hydro – Marine energy systems – Geothermal energy– Hydrogen – Fuel cells. Techno-economic analysis of RES systems: Energy costs (conventional, environmental, external) – Environmental impacts and their economic evaluation - Avoided costs of conventional fuels – Analysis of investments and their application in energy systems – Management of energy systems including RES.

Project/s*: O* | *40* % of the Final Grade

(G. Caralis)

(2.5.2251.8) Hydroelectric Power [C] (GR)

Hydroelectric energy: current conditions and prospects for further development. Advantages and disadvantages of its utilization. Hydraulic potential of rivers, lakes and oceans.

Basic configurations and categorization of conventional hydroelectric plants, based on size (power), type (with or without reservoir), usage (e.g. pumped storage), type of hydro turbines. Civil engineering: dams, water intake, penstocks, surge tank, hydroelectric power station.

Hydro Turbines: Types, operation range and limitations, standardization for Small Hydropower Plants. Electrical and electronic equipment: generators, transformers, power factor, measuring equipment, automation and control. Auxiliary equipment of hydroelectric power station. Main hydrodynamic installations. Transient flow phenomena. Hydraulic hammer and protection.

Hydrological analysis: Hydrological cycle, hydrological data and models, flow duration curve, drainage measurement. Techno-economic analysis of hydroelectric plants / units and Levelised Cost of produced Energy. Methodology of planning and optimal sizing of small hydropower plants.

Sea wave energy. Hydrodynamics and energy content of marine waves, wave databases. Recommended devices and wave energy conversion units. Analysis of hydrodynamic performance. Examples of units in pilot and normal operation. Duration curve and estimation of the energy utilization (capacity) factor.

Tidal energy and sea currents. Global potential and basic configuration of electricity production plants. Technical and operational characteristics of hydrodynamic machines. Examples of units in pilot and normal operation. Duration curve and estimation of the energy utilization (capacity) factor.

Innovative hydrokinetic devices producing small scale electric energy (low flow rate and/or low to ultra low hydraulc head). Operation principles, areas of application and technical characteristics.

Integration and operation of hydroelectric power plants into electricity systems: Main and auxiliary services. Cooperation with intermittent RES units, energy storage, hybrid RES-hydro power stations.

Environmental impacts of hydroelectric projects and power production plants. Protection and mitigation measures, depending on the units type and size.

Team project (3-5 students, weight 40%). Energy production and techno-economic evaluation / Optimal selection and dimensioning / Modeling, of hydroelectric units of various types, using literature, databases and software.

To attend this course, sufficient knowledge of the material of the following courses is strongly recommended: Hydraulic Turbomachines.

Team Project/s: C | *40* % of the Final Grade

I. Anagnostopoulos, (G. Caralis)

(2.5.2280.9) Gas Turbine Diagnostics (GR)

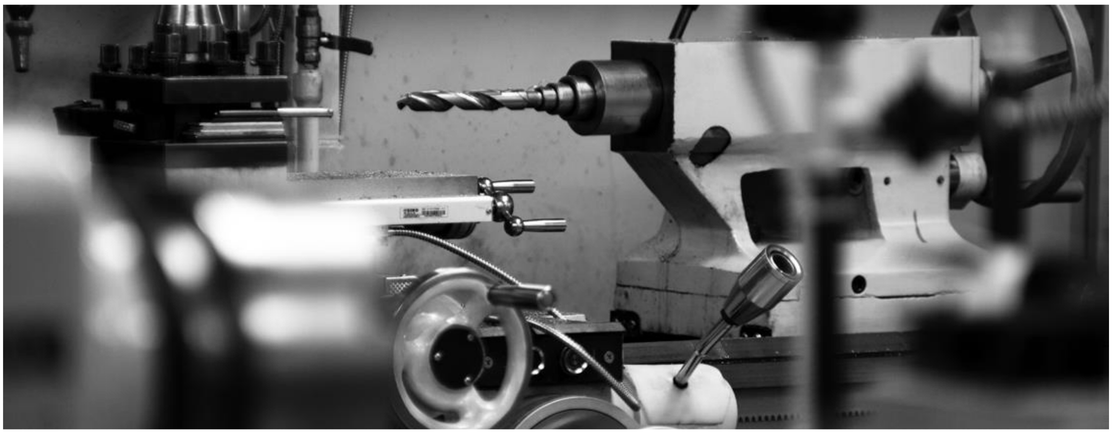
The need and importance for gas turbine engine condition monitoring. Relation to on-condition maintenance. Measured quantities and methods, data collection for monitoring. Systems and methods for condition assessment and fault diagnosis. Gas path analysis: direct methods, estimation methods, linear, non-linear. Trending. Use of fast response measurements (sound, vibration). Elements of life assessment methods. Data evaluation, artificial intelligence methods. Jet engine testing, testing procedure, parameter corrections. The use of computers for monitoring methods support.

To attend this course, sufficient knowledge of the material of the following courses is strongly recommended: Mathematics A2, Statistics and Measurement in Engineering, Thermal Turbomachines, Dynamics and Vibrations.

Lab*: C* | *10* % of the Final Grade

N. Aretakis, K. Mathioudakis, (Ch. Romesis)

Manufacturing Technology



(2.6.2105.2) Metallic Technical Materials [C] (GR)

Classification of materials. Crystalline structure of metals. Imperfections of crystal structure. Main physical properties of metallic materials. Mechanical properties and mechanical testing of metallic materials. Fracture of metals (ductile and brittle fracture and their characteristics). Equilibrium phase diagrams (binary and ternary). Study of the binary alloy Fe-C. Solid state phase transformations. Materials hardening mechanisms. Surface hardening processes for metallic materials (mechanical, thermal and thermo-mechanical). Industrial alloys (steels, cast irons, copper alloys, aluminium alloys, magnesium alloys, titanium alloys, super-alloys).

Lab*: C*

D. Manolakos, A. Markopoulos, (P. Kostazos)

(2.6.2296.3) Non Metallic Technical Materials [C] (GR)

Polymers (Structure, properties, processing methods, 3D printing, applications). Ceramics and glasses (Structure, properties, processing methods, applications). Composites. Electrical and magnetic properties of materials (Semiconductors, Magnetic materials, Superconductors). Biomaterials / Nanomaterials / Smart Materials. Basic principles of design and selection of materials.

Experimental Laboratory exercises:

1. Structure characterisation of ferrous and non-ferrous alloys
2. Thermal processing of steels
3. Mechanical behaviour and properties of materials.

Lab*: C*

D. Manolakos, G. Ch. Vosniakos, P. Benardos, (P. Kostazos)

(2.6.2200.4) Manufacturing Processes: Casting, Welding, Powder Metallurgy [C] (GR)

Manufacturing process types ("primitive", material forming, material removal, surface processes, joining). Manufacturing system structuring based on product quantity and variety. Welding: phenomena, weldability, metallurgy, technology (methods and equipment). Welded part defects. Destructive and non-destructive tests of welded parts.

Casting: phenomena during solidification-crystallization, castability, casting methods with consumable and permanent mold. Feeding system design. Casting defects. Casting equipment. Die casting presses. Casting tools. Rapid tooling. Powder metallurgy: static pressing and sintering, Tools. Solid state diffusion and applications in surface modification processes. Coatings: methods, properties, characterization. Laboratory exercises: 1. Experimental metal casting 2. Metal welding.

To attend this course, sufficient knowledge of the material of the following courses is strongly recommended: Metallic Technical Materials.

Lab*: C* *20* % of the Final Grade

G-C Vosniakos, (P. Kostazos)

(2.6.2156.5) Manufacturing Processes: Plastic Deformation Processes [C] (GR)

Overview of manufacturing processes. Fundamentals of Plasticity and applications on the manufacturing processes. Mechanics of forming processes / Formability. Bulk deformation processes (rolling, forging, extrusion, rod-, wire- and tube-drawing). Sheet-metal forming processes (bending, deep-drawing, stretch forming, bulge forming). Forming Limit Diagrams (FLDs). Friction / Lubrication. Residual stresses. Defects.

Laboratory exercises: 1. Slab rolling. 2. Closed-die forging. 3. Extrusion. 4. Deep-drawing. 5. Bulge test.

Lab*: C*

D. Manolakos, G. Ch. Vosniakos,, (P. Kostazos)

(2.6.2093.6) Manufacturing Processes: Material Removal Processes [C] (GR)

Overview of conventional (mechanical) material-removal processes Cutting with single-point and multipoint cutting tools of clearly defined geometry. Mechanics of chip formation. Cutting tools and tool wear. Machinability. Abrasive processes. Mechanics of grinding. Grinding wheels and grinding wheel wear. Finishing operations. Friction / Lubrication. Cutting fluids. Residual stresses. Quality and integrity of machined surfaces. Fundamentals of programming of CNC turning and milling centers (G-code).

Laboratory exercises: 1. Metal cutting in turning: Mechanics of cutting. 2. Metal cutting in turning: Tool wear. 3. Metal cutting in milling. 4. Metal cutting in drilling. 5. Surface grinding.

Lab*: C*

D. Manolakos, A. Markopoulos

(2.6.2222.8) Manufacturing Systems (GR)

Manufacturing System types, structure and operation. Equipment layout, product-, work- and information flow. Control levels. Cellular production: Group Technology, coding systems, Computer Aided Process Planning systems. Flexible Manufacturing Systems: flexibility types. Operations assignment and scheduling. Controller design based on Petri Nets. System Monitoring. Robotic Manufacturing Cells: industrial robot types, integration interfaces, on and off-line robot programming for machine tool tending and manufacturing processing. Analysis and Design of Manufacturing Systems using discrete event simulation. Computer Integrated Manufacturing: information integration,

interfaces in Computer-Aided-X software systems, databases and local area communication networks. Optional assignments in four major topics of the syllabus.
Laboratory exercises: 1- Manufacturing System Simulation using specialised discrete event software. 2- Industrial robot programming for machine tool tending

Lab: C	30 % of the Final Grade	Project/s: O	10-70% of the Final Grade

G-X. Vosniakos

(2.6.2309.7) Additive Manufacturing Processes [O] (GR)

- History-development and typology.
- Material Extrusion (FDM, FFF): Material flow mechanics through a nozzle. Printing of polymers, biopolymers and polymer matrix composites. 3D printer configuration and motion control. Robotic arms as 3D printers. Process parameters, 3D printer parameters and connection to part quality.
- Selective laser sintering and melting (SLS/SLM): Laser-matter interaction during sintering and melting. Melt pool, solidification, transformations of metallic materials. Sintering of non-metallic materials. SLS/SLM machines: configuration and control based on melt pool characteristics. Process parameters, machine parameters and connection to part quality.
- VAT polymerisation (SLA): Resin polymerisation using monochromatic light and other sources. SLA machines and control of layer thickness. Process parameters, printing parameters and connection to part quality.
- Other methods (direct energy deposition-DED, material jetting, binder jetting, sheet lamination): Physics of material joining. Functional principles of pertinent machines. Process parameters, constraints and part quality.
- Process selection – case studies: Comparison to conventional processes and to the rest of AM processes. Post-processing. Survey of the range of materials that can be processed in general applications. Special applications of materials and methods in biomechanics, biomedicine, aerodynamics. Future applications and new materials outlook.
- CAD/CAM Interfaces: Layer design, path design, pertinent constraints and optimization. CAM systems and slicers for layer and path definition. Relevant standards (STL, AMF etc).

To attend this course, sufficient knowledge of the material of the following courses is strongly recommended: Metallic Technical Materials, Non Metallic Technical Materials.

Lab: C	15 % of the Final Grade	Project/s: C,O	20-20% of the Final Grade

G-X. Vosniakos

(2.6.2035.7) Machine Tools [C] (GR)

Machine tool types and kinematics. Technological evolution and impact to manufacturing. Machine tool structure: body, spindles, motors, guideways, sensors, position encoders, transmission. Fixtures and workholding elements. Computer numerical control of machine tools: structure and functions of CNC systems. Interpolation methods and types. Motion control. Adaptive control for manufacturing processes. Selection of CNC system main characteristics. CNC machine tool programming: parametric programming and programming using CAM systems. Machine tool dynamics: machining force variation. Frequency response function. Forced vibrations. Chattering. Stability regions. Experimental determination of machine tool dynamic characteristics. Machine tool metrology using lasers: CNC axis positional

accuracy. Angular errors. Composite errors. Volumetric error. Error analysis/budgeting. Thermal errors. Use of metrology equipment.
Laboratory exercises: 1- Machine tool programming using a CAM system. 2-Machine tool dynamics.

To attend this course, sufficient knowledge of the material of the following courses is strongly recommended: Manufacturing Processes: Material Removal Processes, Mechanical Design II.

Lab: C	20 % of the Final Grade	Project/s: O	10-30% of the Final Grade

P. Benardos

(2.6.2060.8) Non Conventional Manufacturing Processes [C] (GR)

Fundamentals of dynamic plasticity applied in bulk and porous materials. Non-conventional forming techniques of bulk material (ring-rolling, impact and rotary forging, hydrostatic extrusion). Non-conventional sheet-metal forming techniques (hydroforming, high energy rate forming, shot-peening, superplasticity, punching). Non-conventional material removal processes (machining/Grinding) (Abrasive jet machining, Explosive cutting, Ultra-sonic machining, Electro-discharge machining (EDM), electrochemical grinding (ECG), electrochemical machining (ECM), chemical cutting). Non-conventional welding techniques (explosive cladding/welding, laser welding). Powder compaction (powder metallurgy, dynamic powder compaction, elastic and plastic waves in porous materials) Defects.
Laboratories: 1. Open-die impact forging 2. Explosive sheet metal forming. 3. Electro-discharge machining (EDM). 4. Powder metallurgy: Static and dynamic compaction of metal powders.

To attend this course, sufficient knowledge of the material of the following courses is strongly recommended: Manufacturing Processes: Material Removal Processes, Manufacturing Processes: Plastic Deformation Processes.

Lab*: C*

A. Markopoulos

(2.6.2267.9) Technology and Mechanics of Composite Materials [C] (GR)

A. Fabrication of composite materials: Classification and terminology. Matrix and fibre materials. Fabricating processes. Advantages and limitations of composites. Industrial applications.
B. Mechanical behaviour of composite materials: Elastic constants of an orthotropic lamina, stress-strain relations of anisotropic materials, failure criteria of orthotropic materials. Lamination theory for laminated composites (coding, stress-strain relations, equilibrium equations, combined stresses of composite plates and shells, failure criteria). Sandwich hybrid structures. Fatigue, impact, delamination. Environmental effects (temperature/fire/moisture) on the degradation of composites. Experimental characterization of composite materials.

(P. Kostazos)

(2.6.2207.8) Crash Analysis of Structures [C] (GR)

Fundamentals of Structural Plasticity. Theorems of Limit Analysis. Limit analysis of bar structures. Limit analysis of plates and shells. Residual strength of structures in the plastic domain. Strain-rate effects. Crashworthiness of thin-walled structures. Impact energy-absorbing systems. Design and construction of active and passive safety

systems. Crash tests. Introduction to fracture mechanics (basic principles, applications in materials failure).
Laboratory exercises: 1. Static collapse of thin-walled structures. 2. Dynamic collapse of thin-walled structures.

Lab: C

(P. Kostazos)

(2.6.2277.9) Intelligent Manufacturing Systems (GR & EN)

Problem solving in modern manufacturing systems using computational intelligence and other IT techniques. The students are introduced to advanced IT tools, such as: expert systems, artificial neural networks, evolutionary algorithms and fuzzy logic. Practical problem solving is emphasized through assigned coursework based on software development and use rather than in theoretical foundations of relevant tools and techniques. Standard topics dealt with are: Process Plan development. Definition and recognition of morphological features connected to particular manufacturing process types (material removal, sheet forming). Process parameter selection. Path planning, tool selection and feed scheduling in high speed milling. Machining time and surface quality criteria in machining operations. Manufacturing process control using quantitative and qualitative models. Transition from process parameter selection to process control. Manufacturing cell control: operation dispatching criteria (lead time, resource utilization etc.) Links to discrete event simulation. Manufacturing system design. Simplified process plans. Virtual Manufacturing Systems and case-based structure optimization. Manufacturing system diagnostics. Sensor based individual manufacturing process monitoring. Discrete state change monitoring in manufacturing systems.

To attend this course, sufficient knowledge of the material of the following courses is strongly recommended: Manufacturing Systems.

Lab: C	30 % of the Final Grade	Project/s: C	70% of the Final Grade

P. Benardos)

(2.6.2278.9) Micro-Nanoprocesses [C] (GR & EN)

Classification – General aspects. Ultra-precision machining of metals, polymers and brittle materials. Ultra-precision grinding of glasses and ceramics. Superfinishing processes. Micro-Nanomachining. Energy-beam micromachining. Photo-Lithography, X-ray Lithography. LIGA. Electron-beam machining. Ion-beam machining. Laser-beam micromachining. Micro-EDM. Scanning Tunneling Microscopy. Atomic Force Microscopy. Chemical micromachining. Other micro-nanoprocesses. Micro-punching. Micro-Injection molding.

To attend this course, sufficient knowledge of the material of the following courses is strongly recommended: Manufacturing Processes: Material Removal Processes.

A. Markopoulos

Inter-Sectors Courses

(5.1.2161.1) Chemistry for Mechanical Engineers [C] (GR)

Introduction to the structure of matter. Fundamentals of Atomic Theory, Electronic Structure and the Periodic Table. Chemical bonds (Classical concepts, Molecular Geometry, Valence Bond Theory, Principles of molecular orbital theory). Gases and kinetic theory. States of matter: Intermolecular Powers – Properties of liquids and their interpretation, Solid State (Crystal structure, Types of crystalline solids). Phase diagrams. Solutions (Expressions of concentration, Electrolytic and non-aqueous solutions and their properties). Thermochemistry (Thermochemical equations and energy properties, Enthalpies of formation, Enthalpy charts, Fuels). Chemical Kinetics (Reaction rate, Law of reaction rate and reaction mechanisms, Catalysis). Chemical equilibrium (Equilibrium constant, Law of mass action, Le Châtelier principle). Electrochemistry (redox actions, semimetals and dynamic reduction potentials. Voltaic and electrolytic cells, Nernst equation). Introduction to Carbon compounds - Organic Chemistry (Homologous series - Nomenclature). Hydrocarbons and their derivatives (Simple and aromatic hydrocarbons, oxygenates, nitrogen compounds, petrochemicals, organic polymers, lubricants). Biological molecules (proteins, carbohydrates, nucleic acids).

D. Manolakos, (D. Kolaitis, D. Katsourinis)

(2.3.2012.1 & 2.6.2012.1) Mechanical Design I [C] (GR)

Drawing standards and regulation (Paper size. Drawing scales. Types of lines and their use). Orthogonal and auxiliary views. Dimensioning of the engineering drawings and dimensional tolerances. Section views. Fundamentals of descriptive geometry (Intersections and developments). Screws and mechanical components. Introduction to mechanical design. Computer aided design/drafting (CAD) and applications. Techniques for 3D CAD modeling of parts and creation of the relevant 2D drawings. Practice on 3D CAD software. The course is complemented with six (6) exercises of free hand sketching and drawings of real machine components, mechanical design labs, as well as machine tool workshop practice.

Free hand sketch (5): E 15 %	CAD Drawing (1): C 10%
Oral Exams on mechanical design labs: C 10%	Workshop Lab Work (1): C 15 %

D. Koulocheris, P. Benardos

(2.3.2147.2 & 2.6.2147.2) Mechanical Design II [C] (GR)

Drawing of bolted connections and machine elements (bearing, gears). Mechanical assembly drawing. Drawings of welded components. Hole and shaft fits. Geometrical tolerances. Surface roughness. 3D CAD modeling of assemblies and welded structures. Toolboxes. Extraction of assembly drawings. Advanced tools for drawing & control. Practice on 3D-CAD software.

The course is complemented with six (6) exercises of free hand sketching and drawings of real machine components, mechanical design labs, as well as machine tool workshop practice.

Free hand sketch (5): E 15 %	CAD Drawing (1): C 10%
Oral Exams on mechanical design labs: C 10%	Workshop Lab Work (1): C 15 %

D. Koulocheris, P. Benardos

(2.2.2261.7, 2.1.2261.7) Energy Management (GR)

Energy balance of Greece. Energy consumption by source and use. Development and trends of technology through time. Technologies of energy management and handling. Economical feasibility. Transportation of fuel and biofuels (logistics algorithms I). Transportation of fuel and biofuels (logistics computational techniques II). Storage and stacking methods of fuel and biofuels (logistics – techniques – technologies). Calculation of logistics cost. Investment analysis of power plants based on renewable energies. (NPV calculation) I. Investment analysis of power plants based on renewable energies. (Investment Evaluation) II. Investment analysis of power plants based on renewable energies. (Financing schemes) I. Investment analysis of power plants based on renewable energies (IRR Calculation) II. Forecasting – market research I (the importance of forecasting in the market research. Forecasting models).

Energy control, evaluation and monitoring (e.g. in buildings). Benefits. Planning of energy evaluation and exploitation system. Energy conversion and distribution. Energy use.

Estimations for basic applications (heating, air conditioning, steam generation, industrial activities, lighting). Estimations of results. Passive planning of energy consumption in buildings: principles. Climatic changes, solar radiation, thermal losses and benefits. Thermal comfort. Thermal energy and building. Heat insulation. Wind and building. Humidity and building. Lighting. Passive solar systems. Computational programs, inaccuracies, assumptions. Computational models, examples for buildings.

S. Karellas, A. Tolis, (P. Pallis)

(2.4.2255.8) Materials Testing Using Radiation and Ultrasounds (GR & EN)

Lab*: C*

N. P. Petropoulos, D. Koulocheris

(2.5.2197.8, 2.6.2197.8) Introduction to the Aircraft [C] (GR)

This is an introductory course aiming at setting the basis for the subsequent courses related to the dimensioning of an aircraft, its propulsion system and the structural design. It is attempted to provide the students with fundamental knowledge on the basic quantities relevant to the geometry of the aircraft, basic physical principles and the performance of the aircraft and its components. Then, through a historical review of the evolution of aircrafts and analysis of its basic components, the progress in aircraft design and the current state-of-the-art, as well as the goals and expectations of aircraft design in the future are explained. Data regarding costs of the aircraft design are presented and a preliminary dimensioning of the aircraft is attempted. Regarding aircraft materials, it is attempted to present the fundamental knowledge (on loading, operation and construction of structural elements, principles of static and dynamic analysis, crashworthiness) in order to evaluate the characteristics of each material, as well as explain the special requirements for the aircraft structures. Supersonic flows and applications in cases of flow around an axisymmetric body and aircraft wing.

To attend this course, sufficient knowledge of the material of the following courses is strongly recommended: Fluid Mechanics I.

Sp. Voutsinas, D. Manolakos, A. Markopoulos (P. Chasapogiannis)

(2.1.2291.8, 2.3.2291.8) Operation and Maintenance Management [C] (GR)

Introduction to plant operation & maintenance. Management of technical objects. Maintenance planning and control (preventive maintenance, order management, repair jobs). Organization of maintenance operation. Replacement of Equipment: replacement with similar equipment, replacement with advanced equipment, continuous technological improvement. Spare Parts Replacement and Equipment Maintenance: renewal theory, replacement of individual components, replacement of technical system components, inspection and maintenance problems. Reliability of Technical Equipment: definitions, calculation of reliability of technological systems, determination of optimum level of reliability. Analysis and evaluation of damages and investigation of their causes in machines and mechanical constructions. Use of instruments and industrial software. Typical types of machine and device / system components failure in industry. Real-time logging methods and sample failure recording and machine operation condition. Destructive and non-destructive testing methods. Calculation of residual life and decision change / replacement. Temporary repair - replacement solutions and their implementation methods. Lubrication and determination of inspection-refill-change intervals. Attention and risk indicators. Technical methods for dealing with exceptional failures in Industry.

V. Spitas,, A. Tolis, (S. Gagialis)

(2.0.2288.9) Design of innovative mechanical products [all courses] (GR)

Through a design project, students have the opportunity to apply knowledge and skills acquired during diverse courses, designing an innovative product combining high functionality, ease production methods, low ecological footprint and usability. The scope is to understand through experience the stages of industrial design –from the conceptual design to the prototype evaluation–. Students are supervised by at least two faculties with different specialization.

To attend this course, sufficient knowledge of the material of the following courses is strongly recommended: Mechanical Design II.

Project/s*: C* | *100* % of the Final Grade

G.-X. Vosniakos, D. Nathanail

(2.2301.9) Internship (equivalent course) (GR)

The objective of Internship is the acquisition of practical experience by the students in scientific areas related to the position of a Mechanical Engineer. The Internship can be offered after the completion of the 6th Semester in case that the student has not failed in more than nine (9) modules from the first six semesters. It is performed in places where the professional practice of a Mechanical Engineer takes place, such as factories, design offices, construction sites, laboratories of industrial research etc. Internship is supervised by an Instructor of the School of Mechanical Engineering. The evaluation of a student’s Internship is performed by the supervisor and gets a “pass” or “fail” mark.

http://www.mech.ntua.gr/gr/studies/ugrads/praktikimech

Project/s: C *100* % of the Final Grade

Scientific Responsible: N. Panayiotou

(ALL SECTORS. 2301.8) Computational Project [all courses] (GR)

Professors