DEPARTMENT OF MECHANICAL ENGINEERING & AERONAUTICS

ERASMUS COURSES

SCHOOL OF ENGINEERING

UNIVERSITY OF PATRAS

ACADEMIC YEAR 2022-2023

Ref.No	1st SEMESTER	Hours/ Week T	L	Teaching Credits	ECTS Credits	Avail. For ERASMUS Students	Teaching Faculty
24111	MATHEMATICS I	5		6	5	√	Malefaki S.
24115	MECHANICAL DRAWING & MACHINE-SHOP TRAINING I	4	4	6	5	√	Mourtzis D., Stavropoulos. P
24128	SPECIAL TOPICS IN PHYSICS FOR ENGINEERS	4		4	4	√	Loutas Th.

Ref.No	2nd SEMESTER	Hours/ Week T	L	Teaching Credits	ECTS Credits	Avail. For ERASMUS Students	Teaching Faculty
24127	MECHANICAL DRAWING & MACHINE-SHOP TRAINING II	4	4	6	5	√	Mourtzis D., Stavropoulos. P
24Π124	HISTORY OF TECHNOLOGY	3		3	2	√	Mourtzis D.

Ref.No	3rd SEMESTER	Hours/ Week T	L	Teaching Credits	ECTS Credits	Avail. For ERASMUS Students	Teaching Faculty
24213	MECHANICS (DYNAMICS)	5		6	5	√	Kostopoulos V., Loutas Th.
24218	MANUFACTURING PROCESSES & LABORATORY I	3	1	4	5	√	Mourtzis D., Stavropoulos. P

Ref.No	4th SEMESTER	Hours/ Week T	L	Teaching Credits	ECTS Credits	Avail. For ERASMUS Students	Teaching Faculty
24225	MANUFACTURING PROCESSES & LABORATORY II	3	1	4	5	√	Mourtzis D., Stavropoulos. P

Ref.No	5th SEMESTER	Hours/ Week T	L	Teaching Credits	ECTS Credits	Avail. For ERASMUS Students	Teaching Faculty
24318	HEAT TRANSFER I	3		3	4	√	Panidis Th., Siakavellas N.
24319	Probability & Statistics	3	1	4	4	√	Malefaki S.

Ref.No	6th SEMESTER	Hours/ Week T	L	Teaching Credits	ECTS Credits	Avail. For ERASMUS Students	Teaching Faculty
24324	KINEMATICS OF MECHANISMS & MACHINES	5		5	5	√	Mourtzis D., Stavropoulos. P
24327	HEAT TRANSFER II	3	2	4	5	√	Panidis Th.

SPECIALIZATION COURSES ON MECHANICAL ENGINEERING

Ref.No	7th SEMESTER COMPULSORY COURSES	Hours/ Week T	 L	Teaching Credits	ECTS Credits	Avail. For ERASMUS Students	Teaching Faculty
24411	DYNAMICS OF MECHANISMS & MACHINES	5		5	3	√	Mourtzis D., Stavropoulos. P
24MY1	Theory of Elasticity	3		3	3	√	Tserpes K.
24ME4	Mechanical Behavior of Materials	3		3	3	√	Tserpes K.
24ME38	Light Structures	4		4	3	√	Lampeas G.
MEA_ME5	Biomechanics I	3		3	3	√	Deligianni D., Michanetzis G.

Division of Design and Manufacturing Engineering

Ref.No	8th Semester	T	L	Teaching Credits	ECTS Credits	Avail. For ERASMUS Students	Teaching Faculty
24KY9	COMPUTER NUMERICAL CONTROL (CNC)	2	2	3	3	√	Mourtzis D.

Ref.No	9th Semester	T	L	Teaching Credits	ECTS Credits	Avail. For ERASMUS Students	Teaching Faculty
							Mourtzis D., Nikolakopoulos P.
							Dermatas E.
24KE15	Introduction to Manufacturing Systems	3		3	3	√	Mourtzis D., Stavropoulos P.

Ref.No	10th Semester	T	L	Teaching Credits	ECTS Credits	Avail. For ERASMUS Students	Teaching Faculty
24KY16	COMPUTER AIDED DESIGN	3		3	3	√	Stavropoulos P.
24KE21	Non Conventional Manufacturing Processes	3		3	3	√	Mourtzis D. Stavropoulos.

Division of Energy, Aeronautics & Environment

Ref.No	9th Semester	T	L	Teaching Credits	ECTS Credits	Avail. For ERASMUS Students	Teaching Faculty
24EE17	TRANSPORT PHENOMENA	3		3	3	√	Panidis Th.
MEA_EE50	Numerical Methods for partial differential equations	3		3	3	√	Papadopoulos P.

Division of Applied Mechanics, Technology of Materials and Biomechanics

Ref.No	8th Semester	T	L	Teaching Credits	ECTS Credits	Avail. For ERASMUS Students	Teaching Faculty
24MY2	INTRODUCTION TO COMPOSITE MATERIALS	3		3	3	√	Kostopoulos V., Saravanos D., Lampeas G., Tserpes K.
24ME16	Advanced Strength of Materials	3		3	3	√	Lampeas G., Tserpes K.
24ME18	Wave Propagation and Scattering	3		3	3	√	Kostopoulos V., Polyzos D., Loutas Th.

Ref.No	9th Semester	T	L	Teaching Credits	ECTS Credits	Avail. For ERASMUS Students	Teaching Faculty
24MY13	Fracture Mechanics and Structural Integrity	3		3	3	√	Lampeas G.
24ME33	Design with Failure Tolerance	3		3	3	√	Kostopoulos V.
24ME19	Introduction to Aeronautical Materials	3		3	3	√	Lampeas G., Tserpes K., Academic Personnel
24ME40	Structural Dynamics			3	3	√	Saravanos D., Chrysochoidis N.
MEA_ME27	Biomaterials & Tissue Engineering	3		3	3	√	D. Deligianni, G. Michanetzis, academic personnel

Ref.No	10th Semester	T	L	Teaching Credits	ECTS Credits	Avail. For ERASMUS Students	Teaching Faculty
24MY22	EXPERIMENTAL METHODS FOR COMPOSITE MATERIALS	3		3	3	√	Kostopoulos V.
24ME14	Non Destructive Inspection of materials and structures	3		3	3	√	Loutas Th.

Division of Management & Organization Studies

Ref.No	8th Semester	T	L	Teaching Credits	ECTS Credits	Avail. For ERASMUS Students	Teaching Faculty
24ΔΥ14	Experimental Data Analysis	3		3	3	√	Malefaki S.

COURSES DESCRIPTION

1st SEMESTER

24111. MATHEMATICS I

Introduction to the calculus of one variable. Functions of one variable, limit and continuity, First and higher order derivatives of functions, derivation rules and differential.

Integral calculus. Indefinite integral of functions and analytic techniques of integration. Riemann integral, definite integral, improper integrals. Applications of integrals to the calculation of plane areas, cartesian and polar coordinates on the plane, curve's length.

Sequences, number series and convergence tests. Series of functions, uniform convergence tests and power series. Generalized mean value theorem or Taylor formula and local approximation of function, binomial expansion. Taylor and Maclaurin series, binomial series and convergence.

Introduction to plane vectors and the meaning of the third spatial dimension. Inner, exterior, mixed and double – exterior product, geometric interpretation.

Matrix theory and square matrices, determinant and their properties and inverse matrix. Homogeneous and non homogeneous systems of linear equations, solution with Gauss elimination method. Spectral analysis of matrix, in spaces of finite dimensions, eigenvalues and eigenvectors or characteristic magnitudes and physical meaning, Cayley – Hamilton theorem. Algebraic and geometric multiplicity of eigenvalues, diagonalization of square matrix.

Instructors: Malefaki S.

24115. MECHANICAL DRAWING & MACHINE-SHOP TRAINING I

- *Basic drafting rules and drafting equipment (rules, drafting media and equipment, lettering, scales, Computer Aided Design principles),*
- *Common geometric constructions (angle bisection, dividing geometric elements into equal parts, up- and downscaling, drawing parallel perpendicular and tangent lines, drawing curves),*
- *Multiview projection (metric, orthographic or Monge views), solid sections, involute splines*
- *Mechanical drawing (working and detail drawings, assembly drawings, auxiliary views),*
- *Dimensioning (basics and rules, fundamentals and preferred dimensional practices, baseline dimensioning, direct and chain dimensioning, dimensioning for CAM),*
- *Sectional views (rules, section lines, full sections, half and offset sections, unsectioned features and intersections in section),*

Machine shop training – machining simple parts – lathe, milling machine, drilling and fitting, quality assurance and measurement.

Instructors: Mourtzis, Stavropoulos.

24128. SPECIAL TOPICS IN PHYSICS FOR ENGINEERS

Linear motion, Vectors, General motion in two and three dimensions, Force and motion (Newton's laws), Kinetic energy and work, Dynamic energy - Potentials, Enegry conservation, Linear momentum and impulse, Equilibrium, Fluids, Electric charge, Electric fields, Gauss' law, Electric potential, Magnetic fields, Magnetic fields due to currents, Induction and inductance

Instructors: Loutas Th.

2nd SEMESTER

24127. MECHANICAL DRAWING & MACHINE-SHOP TRAINING II

- *Surface characteristics and quality (roughness, criteria for quality, rules and symbols),*
- *Tolerancing (placing of symbols according to ISO, geometric tolerances),*
- *Drawing metal parts and assemblies (permanent joining, welding drawings, fasteners - dimensioning, rules and tools),*
- *Drawing anti-vibrating systems (helical springs, shock absorbers, torsion springs, anti-vibration sheets, rules and drawings, shock absorbers),*
- *Drawing mechanisms and machine elements (axles, bearings, pins, wedges, clutches, brakes, linkages, gears, belt and chain drives, pulleys, lifting mechanisms, wire ropes, winches),*
- *Drawing hydraulic systems (piping, pipe connection, flanges, valves, steam valves, pumps, propellers),*
- *Introduction to three-dimensional (3D) drawing and solid modeling,*

Machine shop training – gear milling, grinding, welding, assembly of mechanism, quality assurance and measurement.

Instructors: Mourtzis, Stavropoulos

24Π124. HISTORY OF TECHNOLOGY

The precursors of the Industrial Revolution,1500-1750: the agrarian revolution, metallurgy, materials, tools, measuring equipment, machines and mechanisms, fluid power, thermal engines, transport and public works. The Industrial Revolution, 1750-1830: textiles, steam power, steam in transport, measuring instruments, machine tools, metallurgy. The social effects of the industrial revolution. The Age of Steam and Steel, 1830-1900: new inventions, materials, machining technology, machines and mechanisms, hydraulic machines, thermal engineering, mining and metallurgy, constructions, agricultural technology, electricity, other technologies. The evolution of production tools. The transition to capitalism in production. Industrial domination of England, 1850-1870. Science and technology-a review of technology developments that accompanied the Industrial Revolution. The foundation of modern science.

Instructor: Mourtzis D..

3rd SEMESTER

24213. MECHANICS (DYNAMICS)

Kinematics of Particles

Introduction to Dynamics. Rectilinear Motion of Particles. Curvilinear Motion of Particles

Kinetics of Particles: Newton's Second Law

Introduction. Newton's Second Law of Motion. Linear Momentum of a Particle. Rate of Change of Linear Momentum. Equations of Motion, Dynamic Equilibrium. Angular Momentum of a Particle. Rate of Change of Angular Momentum. Equations of Motion in Terms of Radial and Transverse Components. Motion Under a Central Force. Conservation of Angular Momentum. Newton's Law of Gravitation. Trajectory of a Particle Under a Central Force. Application to Space Mechanics.

Kinetics of Particles: Energy and Momentum Methods

Introduction. Work of a Force. Kinetic Energy of a Particle. Principle of Work and Energy. Applications of the Principle of Work and Energy. Power and Efficiency. Potential Energy. Conservative Forces. Conservation of Energy. Motion Under a Conservative Central Force. Application to Space Mechanics. Principle of Impulse and Momentum. Impulsive Motion. Impact. Direct Central Impact. Oblique Central Impact.

Systems of Particles

Introduction. Application of Newton's Laws to the Motion of a System of Particles. Effective Forces. Linear and Angular Momentum of a System of Particles. Motion of the Mass Center of a System of Particles. Angular Momentum of a System of Particles About Its Mass Center. Conservation of Momentum for a System of Particles. Kinetic Energy of a System of Particles. Work-Energy Principle. Conservation of Energy for a System of Particles. Principle of Impulse and Momentum for a System of Particles. Variable Systems of Particles. Steady Stream of Particles. Systems Gaining or Losing Mass.

Kinematics of Rigid Bodies

Introduction. Translation. Rotation About a Fixed Axis. Equations Defining the Rotation of a Rigid Body About a Fixed Axis. General Plane Motion. Absolute and Relative Velocity in Plane Motion. Instantaneous Center of Rotation in Plane Motion. Absolute and Relative Acceleration in Plane Motion. Analysis of Plane Motion in Terms of a Parameter. Rate of Change of a Vector with Respect to a Rotating Frame. Plane Motion of a Particle Relative to a Rotating Frame. Coriolis Acceleration. Motion About a Fixed Point. General Motion. Three-Dimensional Motion of a Particle Relative to a Rotating Frame. Coriolis Acceleration. Frame of Reference in General Motion.

Plane Motion of Rigid Bodies: Forces and Accelerations

Introduction. Equations of Motion for a Rigid Body. Angular Momentum of a Rigid Body in Plane Motion. Plane Motion of a Rigid Body. D'Alembert's Principle. Systems of Rigid Bodies. Constrained Plane Motion.

Plane Motion of Rigid Bodies: Energy and Momentum Methods

Introduction.

Principle of Work and Energy for a Rigid Body. Work of Forces Acting on a Rigid Body. Kinetic Energy of a Rigid Body in Plane Motion. Systems of Rigid Bodies. Conservation of Energy. Power. Principle of Impulse and Momentum for the Plane Motion of a Rigid Body. Systems of Rigid Bodies. Conservation of Angular Momentum. Impulsive Motion. Eccentric Impact.

Kinetics of Rigid Bodies in Three Dimensions

Introduction.

Angular Momentum of a Rigid Body in Three Dimensions. Application of the Principle of Impulse and Momentum to the Three-Dimensional Motion of a Rigid Body. Kinetic Energy of a Rigid Body in Three Dimensions. Motion of a Rigid Body in Three Dimensions. Euler's Equations of Motion. Extension of D'Alembert's Principle to the Motion of a Rigid Body in Three Dimensions. Motion of a Rigid Body About a Fixed Point. Rotation of a Rigid Body About a Fixed Axis. Motion of a Gyroscope. Eulerian Angles. Motion of an Axisymmetrical Body Under No Force.

Instructor: Kostopoulos V., Loutas Th.

24218. MANUFACTURING PROCESSES & LABORATORY I

Cost, time, quality and flexibility in manufacturing. Introduction to manufacturing processes. Casting, deforming, material removal and joining processes. Comparative study of manufacturing processes. Machine tools and manufacturing equipment- types and functionality.

Laboratory project for the design and manufacturing using CAD, machining processes and statistical quality control (SPC).

Instructors: Mourtzis D., Stavropoulos P.

4th SEMESTER

24225. MANUFACTURING PROCESSES & LABORATORY II

Machine Tools Design for deforming and material removal processes. Control and automation of machine tools. Basic concepts and methods of process planning. Design and operation of manufacturing systems-applications.

Laboratory project for the design and assembly using rapid prototyping (RP), design for assembly techniques, and Virtual Reality (VR)

Instructors: Mourtzis D., Stavropoulos P.

5th SEMESTER

24318. HEAT TRANSFER I

Fundamental principles of heat transfer. Heat transfer modes: conduction, convection and radiation. The heat transfer equation. Heat conduction (steady state, one dimensional heat conduction, conduction in two and three dimensions, transient conduction). Radiation heat transfer (basic principles and laws, black and gray bodies. Solar radiation. Radiation heat exchange between black and gray surfaces. Radiation form factors)

Instructor: Panidis Th., Siakavellas N.

24319. Probability & Statistics

The importance of probability and statistics in engineering problems

Probability theory, random variables and distribution characteristics (Sample space and events, conditional probability, probability density and distribution functions, mean, moments of higher order, covariance and correlation.)

Useful distribution models: Discrete distributions (binomial, hypergeometric, geometric, negative binomial, the Poisson distribution and the Poisson process), continuous distributions (normal, uniform, exponential, gamma, Weibull).

Descriptive statistics

Sampling distributions and estimation (Central limit theorem, confidence intervals for means, variances and proportions with one and two samples.)

Tests of hypotheses (Errors, characteristic curve and power of a test of hypotheses, tests for means, variances and proportions with one and two samples, tests of significance, relationship between hypothesis tests and confidence intervals.)
Instructor: Malefaki S.

6th SEMESTER

24324. KINEMATICS OF MECHANISMS & MACHINES

Machines and Mechanisms - historical Review, terminology, definitions and assumptions, classification of kinematic pairs, mobility - degrees of freedom. Computer aided methods in design and production. Position analysis of a four-bar linkage with the graphical and the analytical method. Kinematic analysis of mechanisms using analytical and numerical methods, numerical methods in kinematics, planar kinematic analysis, linear algebraic equations, nonlinear algebraic equations. Cartesian coordinates, kinematic constraints, position analysis, velocity, and acceleration analysis. Kinematic modeling. Computer aided analysis of mechanisms. Cams. Gears. Epicyclic gear train analysis and design.
Instructor: Mourtzis D., Stavropoulos. P

24327. HEAT TRANSFER II

Introduction. Heat convection phenomenology. Newton law of cooling. Pi theorem. Dimensional analysis. Nondimensional Numbers. Forced convection. Free convection. Working correlations for forced convection. Working correlations for free convection. Conjugate heat transfer. Heat exchangers. Overall heat transfer coefficient. Types of heat exchangers. Mean temperature difference. Number of Transfer Units method. Analysis of heat convection. Mass, momentum, and energy conservation equations. Dimensional analysis. Boundary layer. Differential and integral equations of the boundary layer. Turbulence. Laminar forced convection past plane surfaces. Turbulent boundary layers. Reynolds, Prandtl and von-Karman analogies. Heat convection in fully developed pipe flow. Reynolds, Prandtl and von-Karman analogies. Free convection heat transfer. Free convection past vertical plane surfaces.
Instructor: Panidis Th.

SPECIALIZATION COURSES ON MECHANICAL ENGINEERING

7th SEMESTER

24411. DYNAMICS OF MECHANISMS & MACHINES

Basic concepts of dynamics. Dynamics of the rigid particle. Dynamics of a system of rigid particles. Dynamics of the rigid body. Dynamics of a system of rigid bodies. Plane motion. Dynamics of mechanisms and machines, the equations of motion, the vector of forces, and reactions in the links. The system of equations for plane motion. Static forces, static equilibrium, kinetostatic analysis. Computer aided algorithm for plane dynamic analysis. Damped vibration, logarithmic decrement, vibration spectra. The

method of spectral analysis. Dynamics of reciprocating engines. Engines types, indicative diagrams. Dynamic analysis of reciprocating engines, gas forces, equivalent masses, inertia forces. Bearing loads in a single-cylinder engine. Balancing, rotors balancing, dynamic and static balancing, balancing machines, balancing of reciprocating masses. analytical calculation of unbalance.
Instructor: Mourtzis D., Stavropoulos. P

24MY1. Theory of Elasticity
INTRODUCTION: Objectives, Historical
CARTESIAN TENSORS.
STRAIN AND STRESS TENSORS: The continuum model, External loads, The displacement vector, Components of strain, Assumption of small deformation, Proof of the tensorial property of strain, Traction and components of stress, Proof of the tensorial property of stress, Properties of the strain and stress tensors, Components of displacement for rigid body motion, The compatibility equations, The equilibrium equations, Cylindrical coordinates, Strain-displacement relations in cylindrical coordinates, Equilibrium equations in cylindrical coordinates, Compatibility equations in cylindrical coordinates.
STRESS-STRAIN RELATIONS: Uniaxial tension or compression under constant temperature, The torsion test, Effect of temperature, Stress-strain relations for elastic materials subjected to three-dimensional stress state, Stress-strain relations for linear elastic materials subjected to three-dimensional stress state, Stress-strain relations for orthotropic linear elastic materials, Stress-strain relations for isotropic linear elastic materials subjected to three-dimensional stress state.
FORMULATION AND SOLUTION OF BOUNDARY VALUE PROBLEMS: Introduction, Boundary value problems for computing the displacement and stress fields, The principle of Saint-Venant, Methods for finding exact solutions for boundary value problems, Prismatic body subjected to uniaxial tension, Prismatic body subjected to bending, Prismatic body subjected to torsion.
PLANE STRAIN AND PLANE STRESS PROBLEMS: Plane strain, Formulation of problems using the Airy stress function, Prismatic bodies in plain strain condition, The equations of plain strain condition in cylindrical coordinates, Plane stress, Plates in plain stress condition, Two-dimensional plane stress condition, Prismatic bodies in axisymmetric plane strain or plane stress conditions.
Instructors: Tserpes K.

24ME4. Mechanichal Behavior of Materials
Atomic structure of solids; Structure of metals: Structure of crystalline materials, Imperfections, Mechanisms of micro-structural hardening; Structure of composite materials: Definition, Constituents, Architecture, Specific mechanical properties; Mechanical behavior: Definition and basic considerations; Mechanical behavior of metals under quasi-static uniaxial loading: Tension test, Superposition of strain, Conditions of maximum load; Mechanical behavior of composite materials under quasi-static loading: Micro-mechanical and Macro-mechanical analysis of the elastic behavior of a lamina, Strength of a lamina; Mechanical behavior of metals under variable loading: Fatigue under constant stress amplitude, Low-cycle fatigue, Fatigue crack growth, Fatigue life prediction; Mechanical behavior of composite materials under variable loading: Fatigue damage mechanisms in composites, Fatigue damage functions, Fatigue life prediction based on S-N curves, Relation between fatigue damage and mechanical properties; Numerical modeling of the mechanical behavior of composite materials; Mechanical behavior of metals under elevated temperature (creep): Creep behavior of materials and components; Oxidation and corrosion: Corrosion mechanisms, Protection methods, Interaction of corrosion with mechanical loads, Mechanical behavior of corroded materials and structures.
Instructors: Tserpes K.

24ME38. Light Structures

The lightweight design philosophy and the application of strength of materials principles in lightweight design - Design principles. Analysis of thin-walled members with closed or open cross section - shear center - warping and distortion, torsion-bending problems of thin bodies. Analysis of thin-walled pressure vessels under internal / external pressure, bending disturbances due to geometrical discontinuities. Shear flow theory - analysis of beam shear in closed or open cross-section, multiple-web beams, flat or curved members. Simplified analysis of aeronautical structures (fuselage - wing under bending, torsion and shear, wing ribs). The principle of virtual work - The unit load method. Maxwell-Mohr method. Applications in aeronautical and lightweight structures.
Instructor: Lampeas G.

MEA_ME5. Biomechanics
Introduction to biomechanics: brief history of biomechanics. Kinematics in biomechanics. Statics and dynamics in biomechanics: 2-D and 3-D models of the musculoskeletal system. Human motion analysis. Deformable body mechanics: stress, strain, constitutive equations (elastic and viscous materials, etc.). Skeletal biomechanics: bone and soft connective tissues (ligament, tendon, cartilage). Functional adaptation and mechanobiology. Muscle modelling. Vascular system modelling. Mechanics of the cardiac muscle: Mechanical characteristic of the heart as deformable tissue, pressurised structure and muscle.
Instructor: D. Deligianni, G. Michanetzis

SPECIALIZATION COURSES

DIVISION OF DESIGN & MANUFACTURING

8th SEMESTER

24KY9. COMPUTER NUMERICAL CONTROL (CNC)

Introduction to Numerical Control, Definition and history of Numerical Control (NC), Special features of CNC,Concepts and advantages of CNC, applications in industry.Structure of a CNC machine tool, Control systems, Servomechanisms, Loop systems, Process planning and cutting tool selection, Hole making cutting tools, Milling cutters, Special Inserted Cutters, Process of changing and managing cutting tools, Automatic tool changers, tool length and diameter compensation.

CNC lathe and milling programming, Structure of a CNC program, Definition of programming coordinates, Machine tool reference point, (G) and (M) codes in turning and milling, Absolute and relative coordinates for point definition, Two (2) and Three (3) axes programming, Modal / Non-Modal Commands, Canned Cycles, Word Address Format, Do Loops and Subroutines, Mirror Imaging, Polar rotation, Turning, Programming examples in turning and milling.Basic mathematics for programming Numerical Controlled Machine Tools, Application in cutter compensation, Linear Interpolation, Circular interpolation, Helical Interpolation.Perspectives and future of CNC.

Instructor: Mourtzis D.

9th SEMESTER

24KY8. Engineering Design

Introduction to engineering design: A definition for design, human needs and technological advances, design as problem solving, design models and methods, design and designers, design tools. Analysis of design problem: Product anatomy, types of design, design strategies, dearch for information, information processing, catalogue of design specifications. Conceptual design: design concept, determination of functions, development of alternative design concepts, analysis and evaluation of design concepts. Configuration design: product configuration, part configuration, analysis and refinement of design configurations, analysis and evaluation of design configurations. Parametric design: valuing of design variables, development of alternative solutions, performance evaluation, solution optimization. Detailed design: final valuing of design variables, prototype testing, solution documentation.

Instructors: Mourtzis D., Nikolakopoulos P.

24KY1. Applications of Artificial Intelligence

Introduction to Artificial Intelligence. Artificial Intelligence and real-world problems and applications. Problem description. Search algorithms: algorithms for exhaustive and heuristic search. Knowledge representation: propositional, predicate and clausal logic, semantic nets, frames, rules. Knowledge-based systems. Expert systems. Fuzzy logic. Intelligent control. Techniques for intelligent control. Fuzzy controllers: design and applications. Introduction to neural-network-based control.

Instructors: Dermatas E.

24KE15. Introduction to Manufacturing Systems

Design of manufacturing systems. The problem of resource requirements. The problem of resources layout. The problem of material flow. The problem of information flow. The problem of queue capacity. Complex design problems. Operation of manufacturing systems. Methods and tools for the operation of the manufacturing systems. The task – resource assignment problem. Decision-making for the operation of manufacturing systems.

Instructor: Mourtzis D., Stavropoulos P.

10th SEMESTER

24KY16. COMPUTER AIDED DESIGN

Introduction to computer graphics. Software for CAD. Graphics commands and design techniques. Mathematical elements for computer aided design. Points and lines. Transformations and projections in plane and space.

Axonometric and perspective drawings. Reconstruction of solids from his projections. Removing hidden lines and surfaces. 2D and 3D curves. Description and construction of surfaces. Shading of objects. Animation.

https://eclass.upatras.gr/courses/MECH1179/

Instructor: Stavropoulos P.

24KE21. Non Conventional Manufacturing Processes

Overview of manufacturing processes. Laser assisted processes. Types of Lasers. Characteristics of laser equipment. Basic Laser processes. Drilling. Cutting (two-dimensional, three-dimensional).Laser controlled processes. Heat transfer and fluid dynamics in laser Analysis of Laser processes. Applicationsof Laser processes. Rapid prototyping techniques. Stereolithography. Selective Laser sintering. Layer Object

Manufacturing. Direct CAD manufacturing. Material deposition manufacturing. Applications of rapid prototyping methods.
Instructor: Mourtzis, Stavropoulos.

DIVISION OF ENERGY, AERONAUTICS & ENVIRONMENT

9th SEMESTER

24EE17. TRANSPORT PHENOMENA

Introduction to transport phenomena. Molecular diffusion of momentum (viscosity), of heat (conduction) and mass. Similarities and differences. Molecular diffusion coefficients. Temperature and pressure dependence. Kinetic theory of gases. Theory of diffusion in liquids.

Introduction to mass transport. Definitions (concentration, velocity, flux etc). Fick's law of diffusion. Mass diffusion and convection. Conjugate heat and mass transport. High mass transfer.

Conservation equations. Definitions (material system, control volume, intensive and extensive properties). Reynolds and Gauss theorems. Continuity equation. Mass conservation of species. Conservation of momentum. Conservation of energy.

Vectors and tensors. Definitions, operations. Coordinate system transformation.

Simplification of conservation equations. Reduction of dimensions, Isothermal, inviscid, incompressible cases. Dimensional analysis. The concept of the boundary layer. Ordinary boundary conditions.

Instructor: Panidis Th., Papadopoulos P.

MEA_EE50. Numerical Methods for partial differential equations

Classification of Partial Differential Equations (PDEs): General Features of PDEs. Classification of PDEs. The existence of characteristics and their physical interpretation. Elliptic, parabolic and hyperbolic partial differential equations. The convection-diffusion equation. Initial Values and Boundary Conditions.

The Finite Difference Method: Taylor expansion, Forward, backward and central finite difference. Applications to the Diffusion equation, Implicit and explicit methods.

Solution Methods for Linear Systems – Elliptic equations: Direct methods: Gauss-Jourdan elimination, Lower-Upper decomposition, Thomas algorithm for tridiagonal systems. Iterative methods: Jacobi Gauss-Seidel , Successive Over-Relaxation, Successive Line Over-Relaxation, Steepest descent, Conjugate gradient. Convergence analysis for iterative methods. Solution of algebraic system. Solution methods for elliptic equations.

Parabolic Partial Differential Equations: Numerical errors. Consistency, Stability, Convergence. Solution methods for the Parabolic Differential equations (1D & 2D): Forward-Time Centered Space (FTCS), Backward-Time Centered Space (BTCS), Crank Nicolson, Alternating Direction Implicit (ADI). Newmann Boundary conditions.

Hyperbolic Partial Differential Equations: Solution methods for the 1D convection equation: Upwind, Forward-Time Centered Space (FTCS), Lax-Friedrichs, Lax-Wendroff, MacCormack, Implicit methods. The wave equation.

The Finite Volume Method: Conservative form Finite Volume Method (1D). Finite Volume Method (2D): Cartesian grids, orthogonal non-Cartesian grids, non-orthogonal meshes.

Instructor: Papadopoulos P.

DIVISION OF APPLIED MECHANICS, TECHNOLOGY OF MATERIALS AND BIOMECHANICS

8th SEMESTER

24MY2. INTRODUCTION TO COMPOSITE MATERIALS

Nature of polymeric composites, polymeric matrices, mechanical and ultimate properties of polymers, physical properties of polymers, fabrication processes of polymeric systems, fibers, interfaces and interphases, introduction to composites, elastic properties of FRP, mechanical properties of composites, physical properties of composites, fabrication processes of polymer composites.

Instructors: Kostopoulos V., Saravanos D., Lampeas G., Tserpes K.

24ME16. Advanced Strength of Materials

Thick-walled pipes subjected to internal/external pressure, Limit load of pipes subjected to internal pressure, Composite pipes; Analysis of beams in elastic foundation, Applications to thin-walled pressure vessels; Frames and circular rings, Method of elastic center, Applications; Analysis of thin-walled axisymmetric vessels subjected to internal/external pressure, Perturbation of bending due to geometrical discontinuities; Transfer matrix method, The transfer matrix of beam subjected to bending, The transfer matrix of beam in elastic foundation, Analysis of thin-walled pressure vessels and circular rings using the transfer matrix method, Applications.

Instructors: Lampeas G., Tserpes K.

24ME18. Wave Propagation and Dispersion

Introduction to Non Destructive Testing. Ultrasonics, Acoustic Emission, Surface waves and their relation to wave propagation and scattering of elastic waves.

Definitions. Acoustic waves, electromagnetic waves, elastic waves. Homogeneous and non-homogeneous wave fields, radiation, propagation, scattering, inverse problems. Attenuation, Dissipation and mode conversion.

Spatial density and time density of waves (wave number and cyclic frequency), phase velocity, dispersive and non-dispersive media.

Wave equation in 3D space, coherent wave surface, plane waves, Fourier transform in time and space, characteristic equation, dissipation and dispersion characteristics.

Linear Elastic Waves in homogeneous and isotropic media. Characteristic equations, phase velocities and polarization vectors.

Linear elastic waves in homogeneous anisotropic media, Christoffel equation, phase velocities, polarization vectors, and slowness curves. Difference between phase velocity and group velocity. Scattering of elastic waves by a half space. Normal and oblique incidence. Snell's law. Critical angle of incidence, reflection and diffraction coefficients.

Inversion of bulk waves phase velocities for the calculation of the stiffness matrix of an orthotropic medium.

Surface waves. Types of elastic waves propagated in a plate. The analytical solution, symmetric and anti-symmetric waves. Dispersion Curves.

Instructors: Kostopoulos, Polyzos, Loutas

9th SEMESTER

24MY13. Fracture Mechanics and Structural Integrity

Fracture phenomena. Linear fracture mechanics theory - Griffith theory and failure criterion. The concept of stress intensity factors and methods of calculation (Westergard Complex Functions, Numerical methods, experimental methods). Parameters affecting the stress-intensity factor - influence of the plastic zone. The concept of critical stress intensity factor. Experimental techniques for determining the critical stress intensity factor. The concept of residual strength. Determination of critical crack length - critical load of failure. Cracks under complex loading and linear fracture mechanics limitations. Non-linear fracture mechanics, the J-integral concept and the concept of crack tip opening displacement as failure criteria. Fatigue of structural components and fatigue-life prediction models, fatigue load interaction problems. Crack propagation under variable loading.

Instructors: Lampeas G.

24ME19. Aeronautical Materials

Material selection for lightweight structures - Aeronautical materials - Aluminum - Aluminum alloys (effect of alloying elements on the mechanical behavior, intermetallic phases, hardening mechanisms of the microstructure, codification of aluminum alloys, technological and mechanical properties) - Technological processes and forming processes of the aeronautical aluminum alloys - Steels - Titanium alloys - Nickel alloys - Polymeric composite materials - Metallic composite materials - Fibers and fabrics - Forming processes of composite aeronautical materials - Ceramic materials

Instructors: Tserpes K., Lampeas G.

24ME33.* Design *with Failure Tolerance

Introduction to damage tolerance. Non-homogeneous state of loading, characteristic dimensions of a structure, degradation of stiffness and strength under operational loading conditions. Basic concept of damage tolerance.

The concept of strength in the case of structures. Strength under multi-directional loading. Failure criteria. Damage accumulation. The special case of composite materials.

The evolution/degradation of strength. Progressive damage. Remaining stiffness and strength.

Stiffness degradation of Composites due to matrix cracking. Evolution of stiffness in time. Degradation og stiffness due to hygrothermal loading. Degradation due to combine damage accumulation. Models for the prediction of the remaining life.

Damage size and strength considerations. Determination of residual strength. Analysis of damage growth. Damage tolerance analysis guidelines

Damage identification and quantification in composites.

Design guide lines for primary and secondary structures.

Damage tolerance evaluation. Impact and CAI. Hot wet compressive behavior.

Repair of composite structures.

Instructors: Kostopoulos V.

24ME14. Non Destructive Inspection of materials and structures

Introduction in Non-Destructive Testing (NDT) of materials and structures, Objectives of NDT, Review of types of discontinuities in metals and composites, Safe-life versus fail-safe design concepts, Review of classical and modern techniques in NDT, Visual testing (endoscopes, borescopes, videoscopes, basic principles), Liquid penetrant testing (analytical presentation, basic techniques and variations, consumables, applications, advantages-disadvantages, laboratory exhibition), Magnetic particles testing (analytical presentation, basic techniques and variations, advantages-disadvantages, applications, *equipment and consumables, laboratory exhibition), Eddy current testing (analytical presentation, basic techniques and variations, advantages-disadvantages, applications, equipment), Ultrasound testing (bulk waves, Lamb waves, analytical presentation, basic techniques and variations, advantages-disadvantages, applications, equipment, laboratory exhibition), Acoustic Emission testing (analytical presentation, basic techniques and variations, advantages-disadvantages, applications, equipment, laboratory exhibition), Radiographic testing (analytical presentation, basic techniques and variations, advantages-disadvantages, applications with emphasis in welding, equipment), Introduction to Structural Health Monitoring, visit to industrial site - real-life applications.*

Instructor: Loutas Th.

24ME40. Structural Dynamics

i. *Review of dynamic behavior of single degree-of-freedom systems with damping. Free vibration, forced harmonic vibration – frequency response function, Transient response.*

ii. Equations of motion of continuous deformable solids and structures. Spatial Discretization in the context of the finite element method. Discrete equations of motion. Consistent and lumped mass matrices.

iii. Discrete natural dynamic systems with multiple degrees of freedom (MDOF). Free vibration, modal frequencies and shapes, physical meaning and properties. Methods of calculating eigenvalues and eigenvectors. Dynamic analysis in the modal domain. The mode superposition method. Methods of condensation. Forced harmonic response and frequency response functions.

iv. Discrete non-conservative dynamic MDOF systems with damping. Proportional and arbitrary structural damping. Effect on dynamic response and method of solution.

v. Transient structural response of MDOF discrete systems subject to arbitrary time loading. Prediction of transient response using direct time integration. Discretization in the time domain. Explicit and implicit methods of time integration and FE solvers.

vi. Various practical problems.

vii. The course is combined with 2 laboratory seminars and exercises which include programing of various dynamic analysis methods and application of commercial software.

Instructor: Saravanos D., Chrysochoidis N.

MEA_ME27. Biomaterials & Tissue Engineering

Surface properties of biomaterials. Surface energy, critical surface tension. Measurement techniques. Metallic implant materials: Stainless steel, cobalt-chrome, titanium and alloys. Structure and mechanical properties. Fabrication-casting, forging, machining. Ceramics- aluminium and zirconium based, glass ceramics and bio-glasses, natural ceramics, hydroxyapatite. Structure and mechanical properties, fabrication. Polymers, addition and condensation. General structure and mechanical properties, glassy and elastomeric polymers. Chemical reactions, degradation of polymers. Polymeric implant materials examples. Fabrication of devices. Composites, fibres and matrix materials. Relation between structure and mechanical properties. Examples of biomaterial applications, joint replacement, soft tissue replacement, artificial organs. Case study- total hip replacement, metal/ceramic, polyethylene, bone cement. Outcome of implantation.

Interaction of biomaterials and the body. Stability, adsorption, corrosion: electrochemistry, Pourbaix diagram. Resorbable biomaterials. Cell-material interaction. Structure of proteins, adsorption to surfaces. Cell spreading and locomotion-physicochemical and thermodynamic aspects. Inflammation and wound healing. Haemocompatibility. Example of dialyser membranes. Blood vessel damage, tissue damage; clotting, complement and white cell activation. Cell and tissue culture methods- cytotoxicity, biofunctionality, animal testing. Biomaterials sterilization principles. Concepts of tissue engineering. Scaffold characteristics and design methodologies, cell seeding, biofunctionalization, bioreactors. Ethical issues for tissue engineering & regenerative medicine.

Instructors: D. Deligianni, G. Michanetzis

10th SEMESTER

24MY22. EXPERIMENTAL METHODS FOR COMPOSITE MATERIALS

- *Engineering Constants*
- *Effect of the shear coupling components SXS, SYS on the deformation behavior of generally orthotropic layers*
- *Principal Axes Systems for the stress and the strain matrices of orthotropic materials*
- *Use of strain gauges for strain measurements (1,2 and 4 gauge methods)*
- *Errors of experimental measurements in the case of Fiber reinforced composites.*
- *Measurement of the fiber volume fraction*
- *Mechanical tests based on standards for the full mechanical characterization of the single layer*
- *Interlaminar fracture toughness under mode I and mode II loading conditions*
- *Hygrothermal behavior of composites*
- *Measurements of the coefficient of thermal expansion and the swelling coefficient of composite laminates*
- *Fatigue behavior of composites*
- *Mechanical tests based on standards for the characterization of fatigue behavior of composites (S-N curves, constant life diagrams)*

Instructor: Kostopoulos V.

DIVISION OF MANAGEMENT & ORGANIZATION STUDIES

8th SEMESTER

24ΔY14. Experimental Data Analysis

Multivariate random variables and their distributions. Chi-square test (Goodness of fit test, Contingency tables, Test of independence, Test of Homogeneity, Test for several proportions), Simple and Multiple linear Regression and correlation. Analysis of Variance (one and two way ANOVA). Nonparametric statistics (Sign test, Wilcoxon, Mann – Whitney, Kruskall – Wallis, Friedman tests) . Bayesian decision theory.

Instructor: Malefaki S.