DEPARTMENT OF MECHANICAL ENGINEERING & AERONAUTICS

ERASMUS COURSES

SCHOOL OF ENGINEERING
UNIVERSITY OF PATRAS
ACADEMIC YEAR 2022-2023
<table>
<thead>
<tr>
<th>Ref.No</th>
<th>1st SEMESTER</th>
<th>Hours/Week</th>
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<th>ECTS</th>
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<tbody>
<tr>
<td>24111</td>
<td>MATHEMATICS I</td>
<td>5</td>
<td>6</td>
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<td>√</td>
<td>Malefaki S.</td>
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<tr>
<td>24115</td>
<td>MECHANICAL DRAWING &amp; MACHINE-SHOP TRAINING I</td>
<td>4</td>
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<td>Mourtzis D., Stavropoulos. P</td>
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<tr>
<td>24128</td>
<td>SPECIAL TOPICS IN PHYSICS FOR ENGINEERS</td>
<td>4</td>
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<tr>
<td>24127</td>
<td>MECHANICAL DRAWING &amp; MACHINE-SHOP TRAINING II</td>
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<tr>
<td>24Π124</td>
<td>HISTORY OF TECHNOLOGY</td>
<td>3</td>
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<tbody>
<tr>
<td>24213</td>
<td>MECHANICS (DYNAMICS)</td>
<td>5</td>
<td>6</td>
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<td>√</td>
<td>Kostopoulos V., Loutas Th.</td>
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<tr>
<td>24218</td>
<td>MANUFACTURING PROCESSES &amp; LABORATORY I</td>
<td>3</td>
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<tr>
<td>24225</td>
<td>MANUFACTURING PROCESSES &amp; LABORATORY II</td>
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<tr>
<td>24318</td>
<td>HEAT TRANSFER I</td>
<td>3</td>
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<td>Panidis Th., Siakavellas N.</td>
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<tr>
<td>24319</td>
<td>Probability &amp; Statistics</td>
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<tr>
<td>24324</td>
<td>KINEMATICS OF MECHANISMS &amp; MACHINES</td>
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<tr>
<td>24327</td>
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# SPECIALIZATION COURSES ON MECHANICAL ENGINEERING

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<tr>
<th>Ref.No</th>
<th>7th Semester COMPULSORY COURSES</th>
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<tr>
<td>24411</td>
<td>DYNAMICS OF MECHANISMS &amp; MACHINES</td>
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<tr>
<td>24MY1</td>
<td>Theory of Elasticity</td>
<td>3</td>
<td>3</td>
<td>√</td>
<td>Tserpes K.</td>
<td></td>
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<tr>
<td>24ME4</td>
<td>Mechanical Behavior of Materials</td>
<td>3</td>
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<td>Tserpes K.</td>
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<tr>
<td>24ME38</td>
<td>Light Structures</td>
<td>4</td>
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<td>Lampeas G.</td>
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<tr>
<td>MEA_MES</td>
<td>Biomechanics I</td>
<td>3</td>
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<td>Deligianni D., Michanetzis G.</td>
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### Division of Design and Manufacturing Engineering

<table>
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<tr>
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<th>8th Semester</th>
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<tbody>
<tr>
<td>24KY9</td>
<td>COMPUTER NUMERICAL CONTROL (CNC)</td>
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<tr>
<td>24KE15</td>
<td>Introduction to Manufacturing Systems</td>
<td>3</td>
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<tr>
<td>24KY16</td>
<td>COMPUTER AIDED DESIGN</td>
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<tr>
<td>24KE21</td>
<td>Non Conventional Manufacturing Processes</td>
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### Division of Energy, Aeronautics & Environment

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<tr>
<td>24EE17</td>
<td>TRANSPORT PHENOMENA</td>
<td>3</td>
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<tr>
<td>MEA_EE50</td>
<td>Numerical Methods for partial differential equations</td>
<td>3</td>
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### Division of Applied Mechanics, Technology of Materials and Biomechanics

<table>
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<tr>
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<tbody>
<tr>
<td>24MY2</td>
<td>INTRODUCTION TO COMPOSITE MATERIALS</td>
<td>3</td>
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<tr>
<td>24ME16</td>
<td>Advanced Strength of Materials</td>
<td>3</td>
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<tr>
<td>24ME18</td>
<td>Wave Propagation and Scattering</td>
<td>3</td>
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<tr>
<td>24MY13</td>
<td>Fracture Mechanics and Structural Integrity</td>
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<tr>
<td>24ME33</td>
<td>Design with Failure Tolerance</td>
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<tr>
<td>24ME19</td>
<td>Introduction to Aeronautical Materials</td>
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<td>Lampeas G., Tserpes K., Academic Personnel</td>
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<td>24ME40</td>
<td>Structural Dynamics</td>
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<tr>
<td>MEA_ME27</td>
<td>Biomaterials &amp; Tissue Engineering</td>
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<td>D. Deligianni, G. Michanetzis, academic personnel</td>
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<tr>
<td>24MY22</td>
<td>EXPERIMENTAL METHODS FOR COMPOSITE MATERIALS</td>
<td>3</td>
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<td>24ME14</td>
<td>Non Destructive Inspection of materials and structures</td>
<td>3</td>
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# Division of Management & Organization Studies

<table>
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<tr>
<th>Ref.No</th>
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<th>Teaching Credits</th>
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<tr>
<td>24ΔY14</td>
<td>Experimental Data Analysis</td>
<td>3</td>
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<td>v</td>
<td>Malefaki S.</td>
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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.


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, Energy 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
Instructor: Mourtzis D.
24213. MECHANICS (DYNAMICS)

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

Kinetics of Particles: Newton’s Second Law

Kinetics of Particles: Energy and Momentum Methods

Systems of Particles

Kinematics of Rigid Bodies

Plane Motion of Rigid Bodies: Forces and Accelerations

Plane Motion of Rigid Bodies: Energy and Momentum Methods
Introduction.

Kinetics of Rigid Bodies in Three Dimensions
Introduction.
Instructor: Kostopoulos V., Loutas Th.

24218. MANUFACTURING PROCESSES & LABORATORY I
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
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 binominal, 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

Instructor: Mourtzis D., Stavropoulos P

24327. HEAT TRANSFER II

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

**Instructor: Mourtzis D., Stavropoulos. P**

**24MY1. Theory of Elasticity**

INTRODUCTION: Objectives, Historical

CARTESIAN TENSORS.


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. Mechanical 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_MES. Biomechanics**


_Instructor:_ D. Deligianni, G. Michanetzis
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.
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, search 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
Instructors: Dermatas E.

24KE15. Introduction to Manufacturing Systems
Instructor: Mourtzis D., Stavropoulos P.

10th SEMESTER

24KY16. COMPUTER AIDED DESIGN
Instructor: Stavropoulos P.


Instructor: Mourtzis, Stavropoulos.
24EE17. TRANSPORT PHENOMENA
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
Instructor: Papadopoulos P.
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
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.
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
24MY13. Fracture Mechanics and Structural Integrity
Instructors: Lampeas G.

24ME19. Aeronautical 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.
Damage size and strength considerations. Determination of residual strength. Analysis of damage growth. Damage tolerance analysis guidelines
Damage identification and quantification in composites.
Design guidelines 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**


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**


**Instructors: D. Deligianni, G. Michanetzis**
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.

24ΔΥ14. 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.