UNIVERSITY OF PATRAS DEPARTMENT OF MECHANICAL AND AERONAUTICAL ENGINEERING Laboratory of Technology and Strength of Materials

Aeronautical education in Greece

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LABORATOTY OF TECHNOLOGY & STRENGTH OF MATERIALS

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Need for Aeronautical education in Greece

- Hellenic Aerospace Industry (big maintenance center, with limited production of aircraft components) requires about 10-12 eng. / year
- Greek airliners (about 10 eng / year)
- Greek Air-force (about 10 eng / year)
- .. and Europe is an open market

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- The need of Greek market for about 30 Aeronautical eng. / year is covered by Univ. Patras
- There is no pure Aeronautical Eng. Dept. in Greece
- Since 1995, <u>in</u> the Mechanical Engineering Dept. of Univ. Patras, a branch of Aeronautics has been established
- Mechanical and Aeronautical eng. share the first 3 years, and in the next 2 years (studies total duration is 5 years) they can select to become either mechanical or aeronautical engineers

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University of Patras

- The University of Patras was founded in the city of Patras in 1964 and it began functioning in the academic year 1966-67.
- It is the third largest University in the country, with:
 - 18,500 undergraduate students,
 - 2000 post-graduate students,
 - 670 teaching staff,
 - 369 administrative personnel,
 - 403 teaching and research assistants.





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Department of Mechanical & Aeronautical Engineering

- Founded in 1967, as Mechanical eng. dept
- The Department has 41 faculty members, over 950 undergraduate and over 100 post-graduate students

DIVISIONS

- Division of Applied Mechanics
- Division of Manufacturing Engineering
- Division of Energy Systems and Thermo-fluids
- Division of Business Administration



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Department of Mechanical & Aeronautical Engineering

• The courses for the Aeronautical engineers are shared between the above mentioned faculty divisions

Aeronautical eng. Courses provided

(12 courses at the 4th and 5th year of studies)

- Introduction to the Aircraft design
- Propulsion systems
- Analysis of Aircraft Structures
- Design of Aircraft Structures
- Aircraft Materials and Structures technologies
- Aerodynamics I, II
- Flight Mechanics I, II
- Aircraft systems
- Automatic control
- Flight control systems

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Department of Mechanical & Aeronautical Engineering

LABORATORIES

- Laboratory of Machine Tools
- Laboratory of Applied Mechanics
- Laboratory of Technology and Strength of Materials
- Laboratory of Biomechanics
- Laboratory of Thermodynamics and Statistical Applications
- Laboratory of Fluid Mechanics and Applications
- Laboratory of Thermodynamic Power
- Laboratory of Nuclear Technology
- Laboratory of Machine Element Design
- Laboratory of Machine Dynamics
- Laboratory of Specific Mechanical Engineering
- Laboratory of Manufacturing Processes

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Education - Lessons

Undergraduate courses

- Analysis of Aircraft Structures
- Design of Aircraft Structures
- Aircraft Materials and Structures technologies
- (Technology of Composite Materials)
- Material Science I, II
- Strength of Materials I, II
- Fracture Mechanics
- Mechanical Behaviour of Metallic Materials
- Advanced Strength of Materials
- Analysis of Metallic Constructions

Post-graduate courses (Ph.D. thesis + courses)

- Advanced Strength of Materials
- Structural integrity

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Main Research Activities

Basic and applied research in the scientific fields of Materials and Structures

The activities of LTSM concerning research and engineering services can be divided into <u>three main categories</u>:

- Materials Mechanical Behaviour and Materials Certification
- Structural analysis and design
- Development and Simulation of Production Technologies

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Materials Mechanical Behaviour and Materials Certification

STATIC TESTING

- Tension/Compression Test
- Bending Test
- Buckling load Test
- Shear Test
- Fracture Toughness Test



DYNAMIC TESTING

- Fatigue Test
- Fatigue crack propagation Test
- Impact Test



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ACCELERATED LABORATORY CORROSION TESTS

- Salt Spray Test
- Stress Corrosion Cracking
- Exfoliation Corrosion Test
- Alternate Immersion Test



HIGH TEMPERATURE TESTING

- Creep Test
- Special Environmental Chamber





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NON DESTRUCTIVE INSPECTION

- Hardness Test
- Ultrasonic methods





METALLOGRAPHIC INVESTIGATION

- Metallographic Characterization
- Failure Analysis Fractographic investigation
- Corrosion Characterization









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Materials Mechanical Behaviour and Materials Certification



The Laboratory of Technology and Strength of Materials is certified according to the following standards:

- EN ISO 9001:2000 for the measurement and testing of mechanical properties and suitability of materials
- by ESYD (Hellenic Accreditation System) as a Vehicles Test and Homologation Center



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Structural analysis and design

- Structural analysis under static and dynamic loading
- Analytical methodologies applied to the initial design phases
- Calculation of buckling loads and vibration frequencies
- **Numerical analysis** using FEM (Finite Element Method), BEM (Boundary Element Method) and TMM (Transfer Matrix Method)





Finite element models of aeronautical structures

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Structural analysis and design

- **Structural integrity**: fatigue crack initiation, propagation and residual strength
- Evaluation of the effect of Multiple Site Damage and structural integrity of **ageing aircraft** structures







FE model of bolted joint using Super-elements

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Structural analysis and design

• Maintenance and Repair technologies of aircraft components



3-D analysis of crack propagation at metal laminate with crack stoppers

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Structural analysis and design

- Analysis of **composite material** aircraft structural components
- Failure analysis of Bolted Composite joints using the Progressive Damage Modelling approach



FE analysis of Compact-Tension specimen



FE analysis of simple bolted joint

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Structural analysis and design

• **Impact simulation** and determination of design guidelines for the improvement for structural elements behaviour

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Simulation of aeronautical structures behaviour under impact loading



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Structural analysis and design

 Design and dimensioning of structures for optimal behaviour under operating conditions (de-icing protection)



Aircraft wing de-icing process simulation

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Simulation of Production Technologies for aircraft structures

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Simulation of laser beam welding process :

- Simulation of different geometries, assembly types (butt-joint, T-joint), material types (steel, aluminium)
- Simulation of physical phenomenon (laser beam, material properties)





• Prediction of temperature, stress, strain distribution and distortions.

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Simulation of Production Technologies for aircraft structures

• Simulation of laser forming and stripping processes:

- Simulation of physical phenomenon (laser beam, material properties)
- Simulation of different geometries, shapes and material types (steel, aluminium)





• Prediction of temperature, stress, strain distribution and bending angle.



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- Universal testing machine 200 KN
- Compression testing machine 2500 KN
- Servo-hydraulic tension-compression fatigue testing machine 100 KN
- Servo-hydraulic tension-compression fatigue testing machine 250 KN
- Bending and torsion fatigue testing machine 160Nm
- Creep testing machines
- Impact testing machine
- Micro and macro hardness measuring machines (VICKERS, ROCKWELL and BRINELL)
- Portable strain gage apparatus
- DC potential drop apparatus for crack growth measurement
- Ultrasonic A-scan and C-scan apparatus

- Video microscope
- Heat treatment chamber
- Environmental chamber (-150+ 550)^oC
- Salt spay chamber
- Facilities for corrosion testing
- Facilities for cutting, grinding and polishing metallographic specimens
- Machining center
- Computing facilities:
 - Unix HP Workstations
 - Pentium IV PCs
- Software codes
 - ANSYS F.E. software code
 - LS-DYNA3D F.E. software code
 - BEASY boundary element code
 - PAM-CRASH FE software code
 - SYSWELS FE software code

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Participation of LTSM personnel in Research Projects

- **A.** Participation in 33 European-founded research projects
- B. Participation in 20 National research projects
- C. About 140 scientific publications over the last decade in international

journals and conferences

LABORATOTY OF TECHNOLOGY & STRENGTH OF MATERIALS

The European Aeronautics Science Network (EASN)

University of Patras – Greece EASN Scientific Co-ordinator



european aeronautics science network





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Regional Network Structure



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Thematic Network Structure Areas of Research

- 1. Flight Physics
- 2. <u>Aerostructures</u>
- 3. Propulsion

- 4. Aircraft Avionics, Systems and Equipment
- 5. Flight Mechanics
- 6. Integrated Design & Validation
- 7. Air Traffic Management
- 8. Airports
- 9. Human Factors
- 10. Innovative Concepts and Scenarios



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Aerostructures- Sub domains

Metallic Materials & basic processes Non-Metallic Materials & basic processes Composite Materials & basic processes Advanced Manufacturing Processes & Technologies Structural Analysis and Design Aero-elasticity Buckling, Vibrations and Acoustics Smart Materials and Structures Structures behaviour and Material Testing Internal Noise prediction Helicopter Aero-acoustics Noise Reduction Acoustic Measurements and Test Technology Aircraft Security

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Interest Groups Conception

• EASN Interest Groups are built up in the frame of the thematic structure, with the aim to act complementary to the industry (AECMA) and to the research establishments (EREA)

• For each technological area a number of IGs can be suggested

• <u>Since July 2003, 14 Interest Groups have</u> <u>been established</u>

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Objectives of the Interest Groups

- Enhance closer cooperation between scientists from the European academia with joint scientific and technological interests in aeronautics and to facilitate research cooperation with research establishments and industry by focusing on innovative ideas and upstream research
- Identify the capabilities existing across Europe
- Facilitate communication between individuals and stimulate the transfer of know-how
- Provide information on research opportunities
- Promote awareness for scientific and technological aspects in aeronautics