<table>
<tr><td>Course Title</td><td colspan="5">Advanced Engineering Design and Simulation</td></tr>
<tr><td>Course Code</td><td colspan="5">MED505</td></tr>
<tr><td>Course Type</td><td colspan="5">Elective</td></tr>
<tr><td>Level</td><td colspan="5">Masters (2nd Level)</td></tr>
<tr><td>Year / Semester</td><td colspan="5">1st year / Fall Semester</td></tr>
<tr><td>Teacher’s Name</td><td colspan="5">Dr. Loukas Papadakis, Dr. Antonios Lontos</td></tr>
<tr><td>ECTS</td><td>10</td><td>Lectures / week</td><td>3</td><td>Laboratories/week</td><td></td></tr>
<tr><td>Course Purpose</td><td colspan="5">The aim of this course is to provide a broad understanding of the theoretical background and the activities necessary in design and manufacturing activities, together with the corresponding experimental measuring and computational methods (FEA) for practical product and process design applications. On completion, successful candidates should be capable of demonstrating -in an advanced level- knowledge, understanding and capacity for analysis & synthesis on engineering design problems using simulation methods and tools.</td></tr>
<tr><td>Learning Outcomes</td><td colspan="5">By the end of the course, students must be able to:
1. Use advanced functions in commercial 3D modeling and simulation software.
2. Explain the theory, fundamentals and application of the finite element method in performing structural, thermal and flow analysis.
3. Develop solutions for engineering problems with the aid of the finite element method and apply appropriate approximation methods to determine nodal displacements and further mechanical parameter.
4. Apply of matrix algebra to describe mechanical problems with the finite element method and describe the relationship between external loads, displacement and structural stiffness.
5. Formulate discretization method and resulting the degrees of freedom for structural, thermal and flow problems.
6. Demonstrate the mesh generation and the approximation of the global solution through the appropriate mesh.
7. Perform division of the solution domain in finite elements and apply appropriate shape functions to describe the solution within the finite element.
8. Reproduce and compose complex engineering methods with the aid of the finite element method as to explain their behaviour and identify problematic regions with the use of commercial software.</td></tr>
<tr><td>Prerequisites</td><td colspan="3">None</td><td>Corequisites</td><td>None</td></tr>
<tr><td>Course Content</td><td colspan="5">1. General continuous solid mechanics
Overview of the applications of Computational Mechanics in</td></tr>
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	Engineering. Necessity and outline of the selected course topics. 2. Problems of Computational Mechanics Problems of structural, thermal and fluid flow analysis. Differential equations in 1D, 2D and 3D spaces. 3. Theory and fundamentals of the Finite Element Method Decompose the computational mechanics problem in “small” (finite) 1D, 2D or 3D elements. Use of low order Taylor approximation for the solution in each element. Introduce nodal interpolation and the nodal values as unknowns. Satisfy the differential equation within the finite element using the Galerkin-Ritz methodology, thus transforming the unknown functions in discrete unknown nodal values and the differential equation in algebraic equations. The Finite Volume Method as a zero-order finite element method. Matrix formulation. Today’s available Software. 4. Finite Elements in Computational Mechanics Problems Nodal variables matrices, load vectors and displacements hypotheses for bars, beams, plane elements, plates and shells, nodal variables matrices and load vectors for Laplace and Poisson equations. Demonstration using commercial Software. 5. Mesh generation Approximation of the global solution through an appropriate mesh of finite elements. Convergence aspects and self adaptive meshing with use of commercial mesh generating software. Structure and unstructured grids Delaunay or advancing-front methods, Constrained Delaunay Triangulation, Mixed-Element/Hybrid Grids. Demonstration using commercial Software. 6. Product design and simulation examples Application of the finite element analysis on specific structural, heat and flow problems. Demonstration using commercial Software. 7. Computer laboratory work Individual or small group studies where students can apply their gained knowledge on commercial FE-software (ANSYS, LS-DYNA) and evaluate practical problems in the field of manufacturing for better comprehension.
Teaching Methodology	The taught part of course is delivered to the students by means of lectures, conducted with the help of computer presentations. Lecture notes and presentations are available through the e-learning platform for students to use in combination with the textbooks. Furthermore, advanced design principles are explained by means of demonstration examples, videos and analytical and computer aided solutions on specific manufacturing and joining process examples. Lectures are supplemented with computer laboratory work carried out with the supervision of the lecturer. Modelling and numerical methods are facilitate in order to replicate the physical effects and are evaluated compared to experimental measurements. Each student has to choose a design project in which he will implement the advanced design and experimental methods and computational analyses discussed in the course. Each student is expected to read in the context of the chosen design project relevant literature, measuring equipment and

	software and computational models.
Bibliography	**Textbook** 1. M. Saeed, Finite Elements Analysis - Theory and Application with Ansys, Pearson, 2nd Edition, 2013 2. C. Tirupathi, R. B. Ashok, Introduction to Finite Elements In Engineering, Pearson, 3rd Edition, 2012 **References** 1. A. Law, Simulation Modeling and Analysis, McGraw Hill, 5th Edition, 2015 2. Brian Cooke, Peter Williams, Construction Planning, Programming and Control, Wiley-Blackwell, 2009 3. Harold Kerzner, Project Management: A Systems Approach to Planning, Scheduling and Controlling, John Wiley & Sons, 10th Edition, 2009 4. Dennis M. Buede, The Engineering Design of Systems: Models and Methods (Wiley Series in Systems Engineering and Management), Wiley 2009 5. George Dieter, Linda Schmidt, Engineering Design, Engineering Series, 2012 6. Robert K. Wysocki, Effective Project Management: Traditional, Agile, Extreme, 5th Edition, John Wiley & Sons, 2009 7. Jack R. Meredith, Samuel J. Mantel, Jr., Project Management: A Managerial Approach, International Student Version, 7th Edition, John Wiley & Sons, 2009
Assessment	1. Assignments 40% 2. Final Exam 60%
Language	English