Course Title	Introduction to Finite Element Method in Structural Engineering				
Course Code	ME219				
Course Type	Compulsory				
Level	BSc (Level 1)				
Year / Semester	2nd Year / 4th Semester				
Teacher's Name	Dr.-Ing. Loucas Papadakis				
ECTS	5	Lectures / week	3	Laboratories/week	-
Course Purpose	Computational methods have recently gained vast ground in all fields of mechanical. Especially modern numerical tools based on the finite element method are part of everyday's business in structural engineering tasks. Novel structural configurations and material combinations in modern industries aim to reduce weight, to limit energy consumption and provide high strength and quality of structural solutions. The course purpose is to provide students with the necessary fundamental knowledge in the field of computational mechanics for mechanical engineering structures. Upon completion of this course, the students will be able to develop skills on analysing determinate and indeterminate structural problems and describing simple structural elements (bars, beams etc.) numerically with the aid of the finite element method. In this way students will get familiar with basic numerical methods used structural engineering design. The combination of theoretical knowledge and practical applications will enable students to comprehend the use and benefits of the finite element method for modelling structural problems in mechanical engineering and interpret numerical results appropriately.				
Learning Outcomes	By the end of the course, students must be able to: 1. Explain the theory, fundamentals and application of the finite element method for solving structural engineering problems. 2. Apply matrix algebra to describe mechanical problems with the finite element method. 3. Describe the relationship between external loads, displacement and structural stiffness. 4. Explain and apply the discretisation method and the degrees of freedom for describing structural problems. 5. Outline the definitions of bars/trusses and beam elements. 6. Compose the stiffness matrix with the assembly method. 7. Apply the matrix equation and perform the calculation of nodal displacements, reaction force and stresses. 8. Perform analysis of total structural problems with the use of the energy method and appropriate shape functions				

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<tr><td>Prerequisites</td><td>ME214, AMAT181</td><td>Corequisites</td><td>None</td></tr>
<tr><td>Course Content</td><td colspan="3">
Types of Statically Indeterminate Structures: Double-Integration Method, Method of Superposition, Moment-Area Method.
Theory and fundamentals of the Finite Element Method: matrix algebra for the problem description, space discretisation, constraints and loads.
Stress and strain tensors: Analysis of stress and strain for linear elastic materials and structures, traction and projection of stress and strain.
Bar and Truss Elements: axial stiffness, nodal displacements and internal forces of springs and bar elements.
Beam Elements: flexural stiffness, nodal displacements and rotations and internal forces and moments in beam elements.
Stiffness Matrix: Assembly method for the setup of the stiffness matrix of whole structural problems for the calculation of nodal displacements and loads (external and internal).
Shape functions: use of shape function for approximating solutions in the finite element analysis.
Application on different examples: the taught aspects in the finite element analysis are applied and demonstrated on specific structural problems
Computer laboratory work, where students can apply their gained knowledge on FE-software and evaluate practical problems for better comprehension.
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<tr><td>Teaching Methodology</td><td colspan="3">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 theoretical principles are explained by means of demonstration examples and solution of specific problems.

Lectures are supplemented with computer laboratory demonstrations work carried out with the supervision of the lecturer. Here a demonstration of numerical problems on commercial software takes place. Additionally, during the computer laboratory sessions, students apply their gained knowledge and identify the principles taught in the lecture sessions by formulating and appraising specific structural problems with the aid of the finite element method.</td></tr>
<tr><td>Bibliography</td><td colspan="3">(a) <u>Textbooks:</u>

N.-H. Kim and B. V. Sankar, Introduction to Finite Element Analysis and Design, Wiley, 2009</td></tr>
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	C. Tirupathi, R. B. Ashok, Introduction to Finite Elements In Engineering, Pearson, 3rd Edition, 2002 (b) References: D. Hutton, Fundamentals of Finite Element Analysis, McGraw Hill, 2004 M. Saeed, Finite Elements Analysis - Theory And Application With Ansys, Pearson, 2nd Edition, 2003 G. R. Buchanan, Finite Element Analysis, McGraw Hill, 1995
Assessment	The assessment consists of following methods for both the theoretical and practical part of the course. Each assessment method is assigned with a weight which is used for the calculation of the final grade. Problem solving assignments: 10% Mid-term exam: 20% Computer Laboratory work: 10% Final Exam (written): 60%
Language	English