

## Syllabus

### Course description

<b>Course title</b>	Finite Element Analysis (FEA)
<b>Course code</b>	47556
<b>Scientific sector</b>	ING-IND/14
<b>Degree</b>	Master in Industrial Mechanical Engineering
<b>Semester</b>	2
<b>Year</b>	I
<b>Academic year</b>	2024/25
<b>Credits</b>	5
<b>Modular</b>	No

  

<b>Total lecturing hours</b>	28
<b>Total lab hours</b>	
<b>Total exercise hours</b>	18
<b>Attendance</b>	
<b>Prerequisites</b>	none
<b>Course page</b>	<a href="https://www.unibz.it/en/faculties/engineering/master-industrial-mechanical-engineering/course-offering/?academicYear=2024">https://www.unibz.it/en/faculties/engineering/master-industrial-mechanical-engineering/course-offering/?academicYear=2024</a>

  

<b>Specific educational objectives</b>	The course introduces the theoretical background of the Finite Element Method in order to promote a critical and aware approach to its application in machine design. It also provides exposure practical design cases to encourage understanding of the broader implications of design.
<b>Lecturer</b>	Prof. Franco Concli
<b>Scientific sector of the lecturer</b>	ING-IND/14
<b>Teaching language</b>	English
<b>Office hours</b>	15
<b>Teaching assistant (if any)</b>	none
<b>Office hours</b>	By appointment
<b>List of topics covered</b>	<p>The course introduces the finite element method (FEM) for the analysis of solid structural problems. The background of the finite element method and its solution procedures for linear analysis will be provided and the different type of elements will be introduced.</p> <p>In detail:</p> <ul style="list-style-type: none"> <li>• Introduction to FEM: the method of displacements applied to FEM</li> </ul>

	<ul style="list-style-type: none"> <li>• Formal Procedure For FEM: discretization, Shape functions, displacement, strain, stress, stiffness matrix, solution, recovery of results.</li> <li>• Bar, Simple Beam, 2D and 3D Beam Element. Property and limitations of beam elements</li> <li>• Plane Elements, Plane stress and plane strain, linear and quadratic triangular and quadrilateral elements. Properties and limitations of plane elements</li> <li>• Isoparametric elements. Properties, limitations</li> <li>• Solid Elements, linear and quadratic tet and hex elements. Solid of Revolution. Properties, limitations.</li> <li>• Theory of Plates and Shells. Finite elements for plates and shells</li> <li>• Theory of composite laminate materials. Orthotropy. Finite elements for orthotropic laminated composite materials</li> </ul> <p>Nonlinear analyses, contact analysis, large deformation analysis, modal analysis and structural instability analysis will also be addressed.</p> <p>Beside the theoretical part, students will apply the above-mentioned approaches to some simple benchmark at the beginning and to the design of real mechanical components and systems then</p> <p>In particular a practical case study will be developed by the students in the application part and a report will be issued. The report will be object of discussion in the oral exam.</p>
<b>Teaching format</b>	Frontal lectures, exercises, labs, projects, etc.

<b>Learning outcomes</b>	<p><b>Intended Learning Outcomes (ILO)</b></p> <p>By the end of the course, students should be able to:</p> <p><u>Knowledge and understanding</u></p> <p>1. Know the theoretical bases of the Finite Element Method for the solution of structural problems</p> <p><u>Applying knowledge and understanding</u></p>
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	<p>Know how to apply FEA to practical design cases in the field of stress analysis for machine design.</p> <p><u>Making judgements</u></p> <p>3. Critically analyze the results of FEA simulation, discuss their accuracy, on the basis of the mesh and elements properties</p> <p>4. Define a FEM model with a tradeoff between the accuracy and the computational effort</p> <p><u>Communication skills</u></p> <p>5. Prepare a technical report describing the design application, expose and discuss it at the oral exam</p> <p><u>Ability to learn</u></p> <p>6. Ability to autonomously extend the knowledge acquired</p>
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<b>Assessment</b>	<p><b>Formative assessment</b></p> <table border="1"> <thead> <tr> <th>Form</th> <th>Length /duration</th> <th>ILOs assessed</th> </tr> </thead> <tbody> <tr> <td>In class exercises</td> <td>9 X 120 minutes</td> <td>2, 3, 4</td> </tr> </tbody> </table> <p><b>Summative assessment</b></p> <table border="1"> <thead> <tr> <th>Form</th> <th>%</th> <th>Length /duration</th> <th>ILOs assessed</th> </tr> </thead> <tbody> <tr> <td>Written exam questions</td> <td>50%</td> <td></td> <td>1,2</td> </tr> <tr> <td>Report and Oral discussion</td> <td>50%</td> <td>Quality of the technical report (30%), correctness of the results (20%) Oral discussion (50%)</td> <td>3,4, 5, 6</td> </tr> </tbody> </table>	Form	Length /duration	ILOs assessed	In class exercises	9 X 120 minutes	2, 3, 4	Form	%	Length /duration	ILOs assessed	Written exam questions	50%		1,2	Report and Oral discussion	50%	Quality of the technical report (30%), correctness of the results (20%) Oral discussion (50%)	3,4, 5, 6
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<b>Assessment language</b>	English																		
<b>Evaluation criteria and criteria for awarding marks</b>	The final mark will be obtained combining the evaluations of the I written test and of the oral examination.																		

<b>Required readings</b>	Lecture notes and documents for exercise will be available on OLE
<b>Supplementary readings</b>	Olek C Zienkiewicz, Robert L Taylor, J.Z. Zhu, The Finite Element Method: Its Basis and Fundamentals, Seventh Edition (ENG)  Robert D. Cook, Finite Element modeling for stress analysis, L Wiley & Sons, 1995 (ENG)