Freie Universität Bozen
Libera Università di Bolzano
Università Liedia de Bulsan

Syllabus
Course description

Course title	Finite Element Analysis (FEA)
Course code	47556
Scientific sector	ING-IND/14
Degree	Master in Industrial Mechanical Engineering
Semester	2
Year	I
Academic year	2025/26
Credits	5
Modular	No

Total lecturing hours	28
Total lab hours	
Total exercise hours	18
Attendance	
Prerequisites	none
Course page	https://www.unibz.it/en/faculties/engineering/master-industrial-mechanical-engineering/course-offering/?academicYear=2025

Specific educational objectives	The course introduces the theoretical background of the Finite Element Method in order to promote a critical and aware approach to its application in in machine design. It also provides exposure practical design cases to encourage understanding of the broader implications of design.
Lecturer	Prof. Franco Concli
Scientific sector of the lecturer	ING-IND/14
Teaching language	English
Office hours	15
Teaching assistant (if any)	none
Office hours	By appointment
List of topics covered	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. In detail: • Introduction to FEM: the method of displacements applied to FEM

	• Formal Procedure For FEM: discretization, Shape functions, displacement, strain, stress, stiffness matrix, solution, recovery of results. • Bar, Simple Beam, 2D and 3D Beam Element. Property and limitations of beam elements • Plane Elements, Plane stress and plane strain, linear and quadratic triangular and quadrilateral elements. Properties and limitations of plane elements • Isoparametric elements. Properties, limitations • Solid Elements, linear and quadratic tet and hex elements. Solid of Revolution. Properties, limitations. • Theory of Plates and Shells. Finite elements for plates and shells • Theory of composite laminate materials. Orthotropy. Finite elements for orthotropic laminated composite materials Nonlinear analyses, contact analysis, large deformation analysis, modal analysis and structural instability analysis will also be addressed. 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 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.
Teaching format	Frontal lectures, exercises, labs, projects, etc.

Learning outcomes	**Intended Learning Outcomes (ILO)** By the end of the course, students should be able to: <u>Knowledge and understanding</u> 1. Know the theoretical bases of the Finite Element Method for the solution of structural problems <u>Applying knowledge and understanding</u>

	Know how to apply FEA to practical design cases in the field of stress analysis for machine design. Making judgements 3. Critically analyze the results of FEA simulation, discuss their accuracy, on the basis of the mesh and elements properties 4. Define a FEM model with a tradeoff between the accuracy and the computational effort Communication skills 5. Prepare a technical report describing the design application, expose and discuss it at the oral exam Ability to learn 6. Ability to autonomously extend the knowledge acquired

Assessment

Formative assessment

Form	Length /duration	ILOs assessed
In class exercises	9 X 120 minutes	2, 3, 4

Summative assessment

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%) Orla discussion (50%)	3,4, 5, 6

Assessment language	English
Evaluation criteria and criteria for awarding marks	The final mark will be obtained combining the evaluations of the l written test and of the oral examination.

Required readings	Lecture notes and documents for exercise will be available on OLE
Supplementary readings	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)