

Applied Finite Element Analysis

Module Information

2022.01, Approved

Summary Information

Module Code	7204CIV
Formal Module Title	Applied Finite Element Analysis
Owning School	Civil Engineering and Built Environment
Career	Undergraduate
Credits	20
Academic level	FHEQ Level 7
Grading Schema	50

Teaching Responsibility

LJMU Schools involved in Delivery
Civil Engineering and Built Environment

Learning Methods

Learning Method Type	Hours
Lecture	22
Tutorial	11
Workshop	22

Module Offering(s)

Display Name	Location	Start Month	Duration Number Duration Unit
SEP-CTY	CTY	September	12 Weeks

Aims and Outcomes

Aims	The module will introduce students to the finite element method and explore the underlying theory of finite element methods. Students will investigate the performance and reliability of finite element methods in civil engineering applications, such as structural problems including material nonlinearity. Whilst the theoretical aspects of the method will be covered in lectures the module is intended to be practical in nature with students having the opportunity to practice via a range of tutorials and assignments using industry standard software.
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After completing the module the student should be able to:

Learning Outcomes

Code	Number	Description
MLO1	1	Use continuum and structural elements to formulate, integrate and solve elastic problems.
MLO2	2	Use different plasticity models to approximate the behaviour of different materials.
MLO3	3	Explain fundamental concepts of geometric nonlinearity and number difficulties that can be experienced.
MLO4	4	Use commercial finite element analysis packages to carry out linear and nonlinear analysis of steel and concrete structures.
MLO5	5	Make informed decisions on the use and calibration of elastoplastic constitutive models.

Module Content

Outline Syllabus	Practical aspects of Finite Element Analysis including: Non-linear analysis. Planning the analysis. Element selection, plane stress, plane strain, axisymmetric, brick elements, full integration, reduced integration, shear locking, hour glassing. Geometric non linearity. Material non linearity. Managing the solution, incremental solution and convergence of results. Plastic behaviour in metals, von-Mises plasticity, available material models, elastic, perfectly plastic, elastic linear strain hardening, piecewise plasticity model. Hardening models, isotropic, kinematic. Practical application to plasticity problems. Implicit and explicit dynamics analysis, mode superposition, damping, modal dynamics. General dynamics analysis, direct integration, time steps. Practical application to dynamics problems. Application of explicit dynamics to pseudo static situations. Use of commercial finite element software to solve structural problems. Post processing and results checking. Review of available non-linear results, stress, strain, displacement, velocity, acceleration, primary and derived quantities etc. Interpretation of results, checking results, reaction forces, displaced shape, nodal and element plots, energy balance for explicit dynamics, hand calculations. Theoretical aspects of Finite Element Analysis including: Review of basic theory. Global stiffness matrix assembly and solution. Determination of element stiffness matrix by variational approach. Either minimum potential energy or virtual work. Application to 2 noded bar element. Element formulation, linear and quadratic, shape functions, implicit and explicit for two dimensional elements. Isoparametric elements. Determination of element stiffness matrix, Gaussian quadrature, fully and reduced integration elements. Obtaining non-linear solutions, time and load steps, incremental analysis, Newton Raphson. Methodology for dynamics solutions using implicit and explicit dynamics.
Module Overview	
Additional Information	The module will introduce students to the use of the finite element method and explore the underlying theory of finite element methods.

Assessments

Assignment Category	Assessment Name	Weight	Exam/Test Length (hours)	Module Learning Outcome Mapping
Centralised Exam	Examination	80	3	MLO1, MLO2, MLO3, MLO5

Report	FINITE ELEMENT SOFTWARE REPORT	20	0	MLO4, MLO5
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Module Contacts

Module Leader

Contact Name	Applies to all offerings	Offerings
Michaela Gkantou	Yes	N/A

Partner Module Team

Contact Name	Applies to all offerings	Offerings
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