Liverpool John Moores University

Title:	Applied Finite Element Analysis
Status:	Definitive
Code:	**7106BEUG** (120609)
Version Start Date:	01-08-2019
Owning School/Faculty:	Civil Engineering
Teaching School/Faculty:	Civil Engineering

Team	Leader
Michaela Gkantou	Y
Geoffrey Parker	

Academic Level:	FHEQ7	**Credit Value:**	20	**Total Delivered Hours:**	72
Total Learning Hours:	200	**Private Study:**	128		

Delivery Options
Course typically offered: Standard Year Long

Component	**Contact Hours**
Lecture	24
Tutorial	48

Grading Basis: 50 %

Assessment Details

Category	Short Description	Description	Weighting (%)	Exam Duration
Test	Test 1	Test 1	20	
Report	Report 1	Report 1	30	
Test	Test 2	Test 2	20	
Report	Report 2	Report 2	30	

Aims

The module will introduce students to the finite element method and explore the underlying theory of finite element methods and computational fluid dynamics. Students will investigate the performance and reliability of finite element methods in civil engineering applications. 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.*

Learning Outcomes

After completing the module the student should be able to:

1 Undertake modelling analysis of finite elements for a range of engineering components or structures under non-linear and dynamic loading.
2 Critically evaluate the output from non-linear and general dynamics finite element analysis.
3 Undertake modelling analysis of computational fluid dynamics for a range of engineering flows under steady and unsteady conditions.
4 Critically evaluate the output from a computational fluid dynamics analysis.
5 Demonstrate critical appreciation of the theory underpinning commercial FE and CFD codes.

Learning Outcomes of Assessments

The assessment item list is assessed via the learning outcomes listed:

Test 1	1	5
Report 1	2	
Test 2	3	5
Report 2	4	

Outline Syllabus

Practical aspects of Finite Element Analysis inlcuding:
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.

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.

Introduction to Computational Fluid Dynamics including:
Review the governing equations, N-S equations, continuity, and energy. Methods for the discretisation of the governing equations. Methods for handling advection/diffusion problems, upwinding etc. Solving for pressure fields. Application of boundary conditions. The use of appropriate turbulence models in CFD. Time averaging and the modification of the N-S equations to predict the effects of turbulence (RANS). Selection of appropriate turbulence model e.g. consideration of a number of different modelling approaches for example, Prandtl' mixing length model, k-epsilon model, Reynolds Stress Equation model, (RSM), Large Eddy Simulation (LES) methods. Modelling of the boundary layer. Law of the wall and use of wall functions. Basic iterative numerical methods for solving the discretised equations, use of relaxation, time steps etc. Meshless techniques. Critical analysis of CFD results, including errors and uncertainty in CFD calculations and meshing strategy.

Learning Activities

Lectures, tutorials, practicals, case studies and assignments.

Notes

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