Liverpool John Moores University

Title:	FINITE ELEMENT ANALYSIS FOR DESIGN
Status:	Definitive
Code:	**6081ENG** (115896)
Version Start Date:	01-08-2018
Owning School/Faculty:	Maritime and Mechanical Engineering
Teaching School/Faculty:	Maritime and Mechanical Engineering

Team	Leader
Glynn Rothwell	Y

Academic Level:	FHEQ6	**Credit Value:**	10	**Total Delivered Hours:**	30
Total Learning Hours:	100	**Private Study:**	70		

Delivery Options
Course typically offered: Semester 1

Component	Contact Hours
Lecture	10
Practical	20

Grading Basis: 40 %

Assessment Details

Category	Short Description	Description	Weighting (%)	Exam Duration
Test	AS1	Invigilated Blackboard test	40	
Test	AS2	Invigilated Blackboard test with prior seen project element	60	

Aims

The module will introduce the students to the finite element method and extend their experience and skill in engineering analysis with the aid of industry standard software.

Learning Outcomes

After completing the module the student should be able to:

1. Set up and validate an efficient and accurate FE model of an engineering component, assembly or structure.
2. Identify the limitations of FEA as part of the design process.
3. Critically evaluate the output from FE analysis.
4. Apply the theory underpinning commercial FE codes.

Learning Outcomes of Assessments

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

Blackboard test	1	4	
Test with seen project	1	2	3

Outline Syllabus

Practical aspects of FEA
Modelling strategy. Planning the analysis. Loading, point loads, stress singularities, pressure loading, examples. Boundary conditions, use of symmetry, balanced loading and minimum constraint avoidance of free body motion, problems associated with inappropriate boundary conditions, basic contact in assemblies, examples.

Choice of element, mesh controls and mesh density, convergence of results, problems with element distortion, adaptive meshing. Managing the solution, types of solver, analysis of errors and warnings.

Post processing and results checking. Review of available results, stress, strain, displacement, primary and derived quantities etc. Interpretation of results, checking results, reaction forces, displaced shape, nodal and element plots, hand calculations.

Thermal analysis and thermal stress analysis. Planning the analysis, steady state, transient. Boundary conditions, temperature, convection, heat flux, radiation, solution output, temperature distribution, derived field quantities. Thermal stress analysis, sequential, coupled (description only) transfer of mesh and nodal temperatures to structural analysis. Examples

Modal Dynamics. Brief description of eigenvalue extraction techniques. Planning the analysis, boundary conditions, number of modes to extract, symmetry conditions, interpretation of results output. Examples

Shell and beam modelling. Modelling thin components, shells. Modelling using beam elements. Mixed meshing, solids, shells and beams. Examples

Theoretical aspects of FEA.
Review of matrix algebra, matrix representation of linear simultaneous equations, types of matrix, multiplication, transpose, inverse, quadratic form, solution of equations using Gaussian elimination or equivalent. General FEA principles,

application to simple one dimensional problems, comparison with traditional methods. Example using two stepped bar elements represented as springs, concept of nodes and elements, element stiffness matrix determination by direct approach, incorporation of loads and BC's, solution.

Global stiffness matrix assembly and solution. Example using three or more springs, derivation of element stiffness matrix using direct approach, element connectivity and assembly of global stiffness matrix, incorporation of loads and BC's to remove singularity, solution. Bandwidth and alternative element connectivity. Multiple load cases.

Truss elements (2D), local coordinates, coordinate transformation, transformation matrix, solution.

Learning Activities

Lectures and guided computer workshops

Notes

The module will introduce the students to the finite element method. 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.