ES4B5-15 Finite Element Methods

20/21

Department
School of Engineering
Level
Undergraduate Level 4
Module leader
Ken Mao
Credit value
15
Module duration
10 weeks
Assessment
70% coursework, 30% exam
Study location
University of Warwick main campus, Coventry

Description

Introductory description

ES4B5 Finite Element Methods

Module aims

The main aim of the module is to provide a practical training in Engineering design optimisation using finite element methods. The first half of the module aims at introducing the fundamental principles of the modelling for statics and dynamics analyses including non-linear FEM. In the second half of the module the student’s will be taught how to use the method in practice and to critically assess and evaluate the results, especially the advanced non-linear FEM simulations.

Outline syllabus

This is an indicative module outline only to give an indication of the sort of topics that may be covered. Actual sessions held may differ.

Design is at the heart of what professional engineers do. When components have complex construction, shape, and general boundary conditions (loading and restraint) the designer will often use finite element methods to determine their structural integrity. The first half of the module aims at introducing the fundamental principles of the mathematical modelling for statics and dynamics analyses. In the second half of the module the students will be taught how to use the

method in practice and to critically assess and evaluate the results. The module aims to provide an introduction to this important stress analysis technique, and by way of case studies shows how it may be used to design components.

Learning outcomes

By the end of the module, students should be able to:

- Critique the significance and importance of finite element methods to the professional design engineer.
- Communicate a theoretical understanding on the fundamentals of FEM for small displacement linear elastic analysis (statics).
- Autonomously develop models using non-linear finite element methods of analysis
- Evaluate problems using current commercial FE software.
- Work independently to develop suitable models and interpret the numerical results.
- Demonstrate written and graphical communication skills, and show initiative in designing model constraints that enable the development of practical models.

Indicative reading list

1. Budynas, R.G. and Nisbett, J.K. Shigley’s Mechanical Engineering Design, McGraw-Hill, 2014. (ISBN: 978-9814595285).
2. Cook, R.D., Malkus, D.S., Plesha, M.E. and Witt, R.J. Concepts and applications of finite element analysis, Wiley, 2007. (ISBN: 0470088214)

Research element

The teaching will be research led and industry focused approach and new techniques will be updated with the research progress. For example, a new method for design optimisation will be introduced soon.

Interdisciplinary

Finite Element Methods (FEM) have been applied to many fields, e.g. engineering, medicine and biology. Even within the engineering field, FEM has been effected used in mechanical design, automotive, cars manufacturing process, civil and bio-mechanics.

International

Due to Warwick University's international reputation, our graduates are world wide. Many teaching resources are international, e.g. a case study of German VW (Volkswagen) car gearbox casing design optimisation and another case study of America motorcycle Harley Division .transmission system fatigue analysis

Subject specific skills

The following should make significant contribution to enhance students’ personal development and

employment opportunities, including self-employment:

1. Advanced practical skills using Abaqus for design optimisation
2. Unique non-linear contact simulation, one of the most challenge issues
3. Ability to critical evaluate the simulation results

Transferable skills

The students will be able to establish their own methodology as they will obtain the essential practical skill training (e.g. design optimisation, non-linear simulation and validations)

Study

Study time

Type	Required
Lectures	12 sessions of 1 hour (8%)
Practical classes	9 sessions of 2 hours (12%)
Other activity	1 hour (1%)
Assessment	119 hours (79%)
Total	150 hours

Private study description

No private study requirements defined for this module.

Other activity description

1h x1 hour Revision lecture

Costs

No further costs have been identified for this module.

Assessment

You do not need to pass all assessment components to pass the module.

Students can register for this module without taking any assessment.

Assessment group D3

	Weighting	Study time
Shift fork design optimisation	70%	100 hours

The main aim of the assignment is to use FEM simulations to modify the initial design geometry of a shift fork component (mainly used in racing car application) with the objective of minimizing weight. Although weight saving is the main objective, the fork's practical application, manufacture, cost and possible materials should be considered as well.

Online Examination	30%	19 hours

An examination to check the students' learning outcomes on FEM

~Platforms - QMP

- Online examination: No Answerbook required
- Students may use a calculator
- Engineering Data Book 8th Edition

Feedback on assessment

- Class summary of typical strengths/weaknesses (individually annotated);
- Nominal mark via Tabula and feedback (or link to feedback on returned script);.

Past exam papers for ES4B5

Availability

Pre-requisites

CANNOT BE TAKEN IF ES3E5 HAS PREVIOUSLY BEEN TAKEN

Courses

This module is Core optional for:

- Year 1 of TESA-H643 Postgraduate Taught Electrical Power Engineering

This module is Optional for:

- Year 1 of TESA-H800 Postgraduate Taught Biomedical Engineering
- TESA-H1A0 Postgraduate Taught Sustainable Energy Technologies
  - Year 1 of H1A0 Sustainable Energy Technologies
  - Year 2 of H1A0 Sustainable Energy Technologies

This module is Option list A for:

- UESA-H311 MEng Mechanical Engineering
    - Year 4 of H311 Mechanical Engineering
    - Year 4 of H30J Mechanical Engineering with Appropriate Technology
    - Year 4 of H30L Mechanical Engineering with Automotive Engineering
    - Year 4 of H30G Mechanical Engineering with Business Management
    - Year 4 of H30P Mechanical Engineering with Fluid Dynamics
    - Year 4 of H30K Mechanical Engineering with Instrumentation
    - Year 4 of H30M Mechanical Engineering with Robotics
    - Year 4 of H30H Mechanical Engineering with Sustainability
    - Year 4 of H30N Mechanical Engineering with Systems Engineering
- Year 4 of UESA-H318 MEng Mechanical Engineering with Exchange Year

This module is Option list B for:

- Year 4 of UESA-H311 MEng Mechanical Engineering
- Year 4 of UESA-H318 MEng Mechanical Engineering with Exchange Year
- Year 5 of UESA-H317 MEng Mechanical Engineering with Intercalated Year