ES3E5-15 Finite Element Methods

21/22

Department
    School of Engineering
Level
    Undergraduate Level 3
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

ES3E5-15 Finite Element Methods

Module web page

Module aims

The main aim of the module is to provide a practical training in Engineering design 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 including non-linear FEM. 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, especially the advanced non-linear FEM simulations. 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. For example, a new method for design optimisation will be introduced in 2020/21, the new academic year.

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 VW car gearbox casing design optimisation.

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
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	14 sessions of 1 hour (9%)
Practical classes	10 sessions of 2 hours (13%)
Other activity	1 hour (1%)
Private study	115 hours (77%)
Total	150 hours

Private study description

115 hours Guided independent learning.

Other activity description

1h x1 hour Revision lecture

Costs

No further costs have been identified for this module.

Assessment

You must pass all assessment components to pass the module.

Assessment group D2

	Weighting	Study time
Shift fork design optimisation	70%	

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%	

A QMP test to check the student's learning outcomes on FEM

~Platforms - AEP,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 ES3E5

Availability

Courses

This module is Core for:

- Year 3 of UESA-H161 BEng Biomedical Systems Engineering
- Year 3 of UESA-H315 BEng Mechanical Engineering
- Year 4 of UESA-H314 BEng Mechanical Engineering with Intercalated Year
- Year 3 of UESA-H163 MEng Biomedical Systems Engineering
- Year 3 of UESA-H316 MEng Mechanical Engineering
- Year 4 of UESA-H317 MEng Mechanical Engineering with Intercalated Year

This module is Core optional for:

- Year 4 of UESA-H164 MEng Biomedical Systems Engineering with Intercalated Year
- Year 3 of UESA-H115 MEng Engineering with Intercalated Year
- UESA-H317 MEng Mechanical Engineering with Intercalated Year
  - Year 3 of H317 Mechanical Engineering with Intercalated Year
  - Year 4 of H317 Mechanical Engineering with Intercalated Year

This module is Optional for:

- Year 3 of UESA-H113 BEng Engineering
- Year 3 of UESA-H114 MEng Engineering
- Year 4 of UESA-H115 MEng Engineering with Intercalated Year
- Year 1 of TESA-H341 Postgraduate Taught Advanced Mechanical Engineering
- Year 1 of TESA-H1A0 Postgraduate Taught Sustainable Energy Technologies

This module is Option list A for:

- Year 4 of UESA-H111 BEng Engineering with Intercalated Year
- UESA-H112 BSc Engineering
  - Year 3 of H112 Engineering
  - Year 3 of H112 Engineering