# ES4F4-15 Advanced Structural Engineering

## 20/21

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

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## Description

### Introductory description

ES4F4-15 Advanced Structural Engineering

### Module aims

The module aims to give students a critical understanding of the behaviour of new structural elements and systems built with Fibre Reinforced Polymers (FRP) composites, FRP reinforced concrete (FRP RC), and cold-formed steel. Fundamental theory and advanced methods widely used in everyday design (including Eurocodes) are covered. Strong emphasis is given to composite construction that can offer improved response to load and savings in member sizes, thus leading to more economic designs from a whole-life costing perspective.

### 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.

PART 1 – Fibre Reinforced Polymers for New Build Structures

- Composite processing methods for structural shapes and systems
- Framework for using Eurocode design philosophy with FRPs
- Ultimate limit state design of members, and connections and joints (bolted and adhesively bonded)
- Serviceability limit state design for FRP structures
- Design for durability (temperature, moisture, creep, fatigue)
- Construction and maintenance
- Whole life costings and sustainability context

PART 2 – Fibre Reinforced Polymer composites in Concrete

- Introduction to FRPs in concrete
- Materials and constitutive relationships
- Flexural behaviour
- Shear behaviour
- Fibre Reinforced Concrete

PART 3 – Cold-formed steel design

- Introduction (manufacturing methods, modular construction, connections)
- Behaviour of thin-walled components (local, distortional, global buckling, web-crippling, flange curling)
- Design of cross-sections
- Design of members

## Learning outcomes

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

- Critically assess the suitability of different structural solutions for new structures based on the desired performance
- Demonstrate forefront knowledge and understanding of theory and concepts used to design structures of FRP composites, FRP RC or cold-formed steel.
- Design advanced composite structural systems of either FRP composites, FRP RC or cold formed steel.
- Interpret and systematically apply international design guidelines for composite construction with FRPs and cold formed steel.
- Demonstrate advanced knowledge and sound understanding on materials, composite processing methods, design, execution, maintenance and sustainability of all-FRP structures.

## Indicative reading list

1. J. T. MOTTRAM and J. Henderson (Eds.), 'FRP Bridges - Guidance for Designers', prepared by Composites UK: Construction Sector Group, CIRIA C779, London, 2018. ISBN 978-0-86017-794-4 (free download) https://www.ciria.org/Resources/Free_publications/Fibre_reinforced_polymer_bridges.aspx

FRP reinforcement in RC structures, fib Bulletin 40, 2007. Latest edition of international design guidelines on FRP RC: Model Code 2010, ACI 440.1, fib Bulletin 14.

Design of cold-formed steel structures, ECCS, 2012. Designers' Guide to Eurocode 4. ICE Publishing, 2011

### International

The module has an international dimension as it covers not only UK standards, but also those from Europe, the USA and other countries. This module will expose students to design standards from other countries, which is critical nowadays as the construction industry is more and more global and much of the infrastructure has to be built abroad.

### Subject specific skills

- Ability to conceive, make and realise structural components using non-traditional materials.
- Interpret and apply advanced design standards and methods to design different types of non-traditional structural components.
- Ability to seek to achieve more sustainable and economic solutions for the construction industry using non-traditional materials.
- Ability to be pragmatic, taking a systematic approach and the logical and practical steps necessary for, often complex, advanced structural solutions to become reality.

### Transferable skills

- Apply mathematical methods to communicate parameters, model and optimize structural solutions using non-traditional materials.
- Exercise initiative and personal responsibility, including time management, of a module made of three different parts.
- Plan self-learning and improve performance, as the foundation for lifelong learning/CPD which is widely needed in civil engineering.
- Overcome difficulties in structural engineering by employing skills, knowledge and understanding gained in Years 1 to 3 in a flexible and coherent manner.
- Develop awareness of the nature of the global landscape of the construction industry by familiarising, interpreting and applying design standards from inside and outside the UK.

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## Study

## Study time

| Type | Required |
|---|---|
| Lectures | 24 sessions of 1 hour (16%) |
| Practical classes | 6 sessions of 1 hour (4%) |
| Total | 150 hours |

| Type | Required |
|---|---|
| Other activity | 2 hours (1%) |
| Private study | 118 hours (79%) |
| Total | 150 hours |

### Private study description

118 hours of guided independent learning

### Other activity description

2x1 hours revision classes

## Costs

No further costs have been identified for this module.

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## Assessment

You must pass all assessment components to pass the module.

### Assessment group D

| | Weighting | Study time |
|---|---|---|
| Open-ended written assignment (replacing part of our 3 hour summer examination) | 30% | |
| Part 1 will be assessed through a written assignment with a weight of 30% of the final mark | | |
| Online Examination | 70% | |
| The QMP exam of Parts 2 & 3 weights 70% of the final module mark | | |
| ~Platforms - QMP | | |

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- Students may use a calculator
- Engineering Data Book 8th Edition
- Graph paper

### Feedback on assessment

Support through advice and feedback hours. Cohort level feedback on the QMP exam and written report.

Past exam papers for ES4F4

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## Availability

### Pre-requisites

To take this module, you must have passed:

- All of
  - ES3D1-15 Concrete Structures
  - ES3D2-15 Steel Structures
  - ES3B6-30 Geotechnical Engineering
  - ES3D5-15 Water Engineering for Civil Engineers
  - ES3E1-30 Design Project with Construction Management (Civil Engineering, BEng)
  - ES3E1-30 Design Project with Construction Management (Civil Engineering, BEng)

## Courses

This module is Core for:

- Year 4 of UESA-H217 MEng Civil Engineering
- Year 4 of UESA-H219 MEng Civil Engineering with Exchange Year

This module is Option list A for:

- Year 4 of UESA-H114 MEng Engineering