MA4J1-15 Continuum Mechanics

21/22

Department
Warwick Mathematics Institute
Level
Undergraduate Level 4
Module leader
Thomas Hudson
Credit value
15
Module duration
10 weeks
Assessment
100% exam
Study location
University of Warwick main campus, Coventry

Description

Introductory description

The modeling and simulation of fluids and solids with significant coupling and thermal effects is an important area of study in applied mathematics and engineering. Necessary for such studies is a fundamental understanding of the basic principles of continuum mechanics and thermodynamics. This course, which will closely follow the text "A first course in continuum mechanics" by Andrew Stuart, is a clear introduction to these principles.

The outline will be as follows: we will begin with a review of tensor algebra and calculus, followed by mass and force concepts, kinematics, and then balance laws. We will then proceed to derive some commonly used models governing isothermal fluids and solids, consisting of systems of partial differential equations (PDEs). If time permits we will also explore the thermal case.

Module aims

To give students a clear theoretical background for models in continuum mechanics, which are the basis for many real-world engineering applications, and to develop an appreciation for the power of using physical principles to rigorously derive PDE models.

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.

- Tensors, their algebra and calculus.
- Forces, kinematics and balance laws.
- Derivation of models for isothermal fluids and solids.
- Solution of the model equations in some special cases.

Learning outcomes

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

- Manipulate tensors using their algebra and calculus
- Explain the physical concepts of mass, force, stress, deformation, displacement and strain as used in continuum modelling
- Apply physical principles including conservation of mass and momentum to derive general PDE balance laws
- Solve the resulting equations in some simple cases, and interpret these results to make physical predictions

Interdisciplinary

This module provides a rigorous mathematical approach to deriving partial differential equation models used in Physics, Engineering and Life Sciences, and so naturally connects with these disciplines.

Subject specific skills

Ability to apply tools of calculus to derive models fluid and solid systems
Ability to convert physical principles into mathematical equations
Ability to interpret mathematical models of the real world

Transferable skills

Ability to translate scientific ideas into mathematical language
Ability to communicate complex ideas and mathematical results clearly

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Study

Study time

Type	Required
Lectures	30 sessions of 1 hour (20%)
Private study	117 hours (78%)
Assessment	3 hours (2%)
Total	150 hours

Private study description

Homework problems.

Costs

No further costs have been identified for this module.

Assessment

You must pass all assessment components to pass the module.

Students can register for this module without taking any assessment.

Assessment group B1

	Weighting	Study time
In-person Examination Standard 3 hour written exam.	100%	3 hours

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- Answerbook Gold (24 page)

Feedback on assessment

Written feedback on the outcome of the exam.

Past exam papers for MA4J1

Availability

Courses

This module is Optional for:

- Year 1 of TMAA-G1PE Master of Advanced Study in Mathematical Sciences
- Year 1 of TMAA-G1PD Postgraduate Taught Interdisciplinary Mathematics (Diploma plus MSc)
- Year 1 of TMAA-G1P0 Postgraduate Taught Mathematics
- Year 1 of TMAA-G1PC Postgraduate Taught Mathematics (Diploma plus MSc)
- USTA-G300 Undergraduate Master of Mathematics,Operational Research,Statistics and

Economics
    - Year 3 of G300 Mathematics, Operational Research, Statistics and Economics
    - Year 4 of G300 Mathematics, Operational Research, Statistics and Economics

This module is Option list A for:

- Year 2 of TMAA-G1PD Postgraduate Taught Interdisciplinary Mathematics (Diploma plus MSc)
- Year 2 of TMAA-G1PC Postgraduate Taught Mathematics (Diploma plus MSc)
- Year 4 of USTA-G1G3 Undergraduate Mathematics and Statistics (BSc MMathStat)
- Year 5 of USTA-G1G4 Undergraduate Mathematics and Statistics (BSc MMathStat) (with Intercalated Year)

This module is Option list B for:

- Year 2 of TMAA-G1PD Postgraduate Taught Interdisciplinary Mathematics (Diploma plus MSc)
- Year 2 of TMAA-G1PC Postgraduate Taught Mathematics (Diploma plus MSc)
- Year 3 of USTA-G1G3 Undergraduate Mathematics and Statistics (BSc MMathStat)

This module is Option list C for:

- UMAA-G105 Undergraduate Master of Mathematics (with Intercalated Year)
    - Year 3 of G105 Mathematics (MMath) with Intercalated Year
    - Year 5 of G105 Mathematics (MMath) with Intercalated Year
- UMAA-G103 Undergraduate Mathematics (MMath)
    - Year 3 of G103 Mathematics (MMath)
    - Year 3 of G103 Mathematics (MMath)
    - Year 4 of G103 Mathematics (MMath)
    - Year 4 of G103 Mathematics (MMath)
- UMAA-G106 Undergraduate Mathematics (MMath) with Study in Europe
    - Year 3 of G106 Mathematics (MMath) with Study in Europe
    - Year 4 of G106 Mathematics (MMath) with Study in Europe

This module is Option list E for:

- Year 4 of USTA-G300 Undergraduate Master of Mathematics,Operational Research,Statistics and Economics
- Year 5 of USTA-G301 Undergraduate Master of Mathematics,Operational Research,Statistics and Economics (with Intercalated