MA9M4-15 Modelling and Computation of Fluid Dynamics Across Phases and Scales

23/24

Department
Warwick Mathematics Institute
Level
Taught Postgraduate Level
Module leader
James Sprittles
Credit value
15
Module duration
10 weeks
Assessment
60% coursework, 40% exam
Study location
University of Warwick main campus, Coventry

Description

Introductory description

This module will provide students with a firm foundation in the modelling of fluid flows and arm them with a range of computational approaches for their simulation. There will be a particular focus on small scale flows, such as in micro- and nano-fluidics, where interfacial effects become dominant and can drive counter-intuitive flow dynamics. Finally, the limitations of conventional fluid dynamics, its interplay with molecular approaches and modelling bridges between the two will be considered.

Module aims

To provide students with a firm foundation in the modelling and computation of fluid flows in order to describe a phenomenal range of natural and technological processes.

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.

The syllabus will cover the following topics, with a focus on developing computational models and validating these against derived analytic results:

- Foundations and Models of Fluid Dynamics
- Canonical Fluid Flows
- Interfacial Fluid Dynamics
- Thin Film Flows
- Modelling beyond Navier-Stokes

Learning outcomes

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

- Understand the foundations of continuum mechanics and derive the classical governing equations of fluid dynamics.
- Develop and apply appropriate computational methods to solve real world phenomena.
- Be confident in formulating models that go beyond the Navier-Stokes paradigm in order to describe micro- and nano-scale phenomena.

Indicative reading list

D.J. Acheson, Elementary Fluid Dynamics
G. K. Batchelor, An Introduction to Fluid Dynamics

Research element

As part of the assessment students will conduct research and provide a report.

Interdisciplinary

Cuts across mathematics, engineering and physics.

Subject specific skills

It is expected that by the end of this module students will be able to:

- understand the foundations of continuum mechanics and derive the classical governing equations of fluid dynamics,
- find the solution to a range of canonical flow configurations using a variety of mathematical techniques,
- develop and apply appropriate computational methods to solve real world phenomena.

Transferable skills

Transferrable skills include:

- the development of advanced numerical methods to solve PDEs,
- the mastery of various computational techniques and software frameworks,
- the ability to conduct research and write article-level reports.

Study

Study time

Type	Required
Lectures	20 sessions of 1 hour (20%)
Tutorials	10 sessions of 2 hours (20%)
Private study	60 hours (60%)
Total	100 hours

Private study description

Revision of lecture material, development of computational models and working through examples sheets.

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 D

Assessment component	Weighting	Study time	Eligible for self-certification
Computationally-Focussed Project into a Fluid Flow	60%	30 hours	Yes (extension)

Students will be asked to provide a report into one of the topics presented during the lectures.

	Weighting	Study time	Eligible for self-certification
Reassessment component is the same			
Assessment component			
Oral Exam Tests of core material	40%	20 hours	Yes (extension)
Reassessment component is the same			

Feedback on assessment

Written individual feedback on the report and general feedback on the oral exams.

Past exam papers for MA9M4

Availability

Courses

This module is Core optional for:

- Year 1 of TESA-H1B1 Postgraduate Taught Predictive Modelling and Scientific Computing