## MODULE DESCRIPTION FORM

**DEPARTMENT OF MECHANICAL AND AEROSPACE ENGINEERING**

# ME514 ADVANCED TOPICS IN FLUID SYSTEMS ENGINEERING

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|---|---|---|
| **Module Registrar: Dr Paolo Capobianchi** **paolo.capobianchi@strath.ac.uk** | **Taught To (Course): Cohorts for whom class is optional** | |
| **Other Lecturers Involved: Dr Monica Oliveira<br>Dr Emad Chaparian** | **Credit Weighting: 10 (ECTS 5)** | **Semester: 1** |
| **Optional class** | **Academic Level: 5** | **Suitable for Exchange: Y** |

## Required prerequisites

**Note: It is the responsibility of ALL students to ensure that they satisfy the prerequisite knowledge for this module BEFORE adding as part of curriculum selection. If unsure, please contact the Module Registrar or discuss with your Programme/Year Adviser of Studies.**

Fundamental knowledge:

- Prior knowledge of principles and concepts of fluid Mechanics.
- Knowledge of partial derivatives, partial differential equations and differential relations of fluid flow (i.e., continuity equation, momentum equation etc.).
- Linear algebra, vectors, matrices.

Basic skills:
- Ability to research a given engineering subject and to work collaboratively in order to present it

**Module Format and Delivery (HOURS i.e. 1 credit = 10hrs of study):**

| Lecture | Tutorial | Laboratory | Groupwork | External | Online | Project | Assignments | Private Study | **Total** |
|---|---|---|---|---|---|---|---|---|---|
| 20 | | | 30 | | | | | 50 | 100 |

## Educational Aim

Rheology is responsible for the study of the deformation and the flow of matter. This scientific field is focussing on the study of the flow behaviour of “complex fluids” such as polymers, biological fluid systems, pastes, foods and other compounds, which are of great importance for a wide range of engineering applications. These fluids are commonly referred as non-Newtonian and when flowing their behaviour significantly deviates from the simple and well-reported Newtonian fluid response. The aim of this module is to introduce the basic ideas and principles of the field of Rheology and the various complex systems examined within, while also to present the existing procedures and methods that are typically employed to study these fluids.

## Learning Outcomes

On completion of the module the student is expected to be able to:

LO1 Understand the importance of the field of Rheology and its significance for investigating the flows of non-Newtonian fluids for a range of existing applications, recognise the basic observed behaviours of non-Newtonian fluids and compare with the equivalent of Newtonian fluids

LO2 Recognise the different types of constitutive equations that are used to model non-Newtonian complex behaviours based on the continuum approach

LO3 Understand fundamental aspects of multiphase interfacial flows, their governing equations, and their relevance in engineering applications. Have a basic understanding of advanced computational techniques adopted to simulate interfacial flow. **Note**: actual numerical simulations will not be performed by the students during the course.

LO4 Be able to create and deliver high quality presentations on specific scientific topics and conduct high level scientific discussions with their peers and class tutors

**Syllabus**

The module will teach the following:

An introduction to the wide range of different behaviours that are observed in non-Newtonian and interfacial fluid flows and what the field of Rheology investigates. Vectors and tensor operations highlighting importance of Einstein notation. Constitutive relationships that are employed to best describe the flow of complex fluid systems. Definitions and importance of dimensionless numbers that exist in order to characterise the flow of complex fluids and how to present data in appropriate formats. Different existing techniques and methods that are considered in order to investigate and study these fluids. Explain phenomena and underlying mechanisms of closely related engineering topics.

**Assessment of Learning Outcomes**

**Criteria**

For each of the Module Learning Outcomes the following criteria will be used to make judgements on student learning:

**LO1: Understand the importance of the field of Rheology and its significance for investigating the flows of non-Newtonian fluids for a range of existing applications, recognise the basic observed behaviours of non-Newtonian fluids and to compare with the equivalent of Newtonian fluids**

C1: To recognise the role of Rheology and identify applications that are benefited by this scientific field
C2: Adequately explain the different types of shear-dependent and extensional viscosities.
C3: Be able to draw the viscosity vs shear-rate diagrams and compare with Newtonian fluid responses.
C4: Understand and explain the significance of the appropriate dimensionless numbers.

**LO2: Recognise the different types of constitutive equations that are used in order to model non-Newtonian complex behaviours based on the continuum approach**
C1: Being able to recognise the different models, the meaning of their parameters and the introduced physics.
C2: To be able to perform evaluations and discussions of rheological properties when considering standard viscometric flows.

**LO3: Understand the relevance of multiphase interfacial flows in engineering and scientific contexts and have a basic knowledge of their mathematical formulation and of the numerical techniques adopted for their simulations**
C1: Being able to recognise different subclasses of interfacial flows and their implications in practical problems
C2: Have an understanding of the physical meaning of different dimensionless parameters adopted in different types of multiphase interfacial flows and how their values can be used and interpreted to diversify different flow regimes
C3: Have a basic understanding of some of the most popular numerical techniques used to simulate interfacial flows.

**LO4: Be able to do high level scientific discussions**
C1: Be able to explain the basic principles and ideas around an agreed topic
C2: Illustrate the ability to exchange knowledge obtained

The standards set for each criterion per Module Learning Outcome to achieve a pass grade are indicated on the assessment sheet for all assessment.

**Principles of Assessment and Feedback**
*(within Assessment and Feedback Policy at: https://www.strath.ac.uk/professionalservices/staff/policies/academic/)*

**Deliver high quality feedback information that helps learners self-correct.**
Assessment by oral presentations and dialogue provides instant feedback on group performance in a two-way communication process. Students should make effective use of these sessions to discuss and obtain feedback.

The quiz will focus on individual understanding around the material taught. Immediate self-assessment & feedback to online quizzes/assignments, with solutions given to questions along with reasons for correct answers and why certain approaches are incorrect when relevant.

**Ensure that summative assessment has a positive impact on learning.**
The summative assessment through oral presentations, after which feedback/marks are provided. Groups are encouraged to discuss any issues with the assessors.

Group presentations to encourage collaborative understanding, knowledge exchange and initiate discussions around challenging topics that will enhance learning.

**Peer assessment that helps learners to develop critical thinking and deeper understanding.**
Providing students with the opportunity to use assessment criteria to evaluate and give feedback on each other's work helps students develop their understanding of the assessment criteria, and to evaluate their own work in light of the criteria.

**Assessment Method(s) Including Percentage Breakdown and Duration of Exams *(individual weightings)***

| **Examination** | | | | **Coursework** | | **Online Quiz** | | **Project** | |
|---|---|---|---|---|---|---|---|---|---|
| Number | Month(s) | Duration | ***Weighting*** | Number | ***Weighting*** | Number | ***Weighting*** | Number | ***Weighting*** |
| | | | | 1 | 75% | 1 | 25% | | |
| | | | | * LO1-4 | | * LO1-4 | | * | |

* ***L/Os:*** *Indicate which Learning Outcomes (L01, L02, etc) are to be assessed by exam/coursework/practical/project as required.*

**Coursework / Submission deadlines (*academic weeks*):**
Group coursework/presentation to be carried out in weeks 8 to 10 counting towards 75% of the final mark.
On-line time constrained quiz will be open during week 11 counting towards 25% of the final mark.

**Resit Assessment Procedures:**
Resubmission of ^^coursework(s) and presentation prior to commencement of the July/August exam diet.

**^^Students must contact the module Registrar for details as soon as results confirm that a resit is required.**

**PLEASE NOTE:**
**Students must gain a summative mark of 50% to pass the module. Students who fail the module at the first attempt will be re-assessed before the July/August exam diet. This re-assessment will consist entirely of a coursework and presentation. No marks from any previous attempts will be transferred to a new resit attempt.**

**Recommended Reading**

*****Purchase recommended **Highly recommended reading *For reference**


** "Understanding Rheology" by F. A. Morrison, Oxford University Press
* "Computational Rheology" by R. G. Owens and T. N. Phillips, Imperial College Press
* "Dynamics of Polymeric Liquids, vol. 1" by R. B. Bird, R. C. Armstrong and O. Hassager, Wiley, 1987
** Advanced Transport Phenomena, L. Gary Leal, Cambridge University Press, 2007


Online access Myplace for class notes.

Further class reading to be recommended by the individual lecturer invited to discuss a particular topic.

**Additional Student Feedback**
*(Please specify details of when additional feedback will be provided)*

| Date | Time | Room No |
|---|---|---|
| | | |

Session: 2024/25

**Approved:**

**Programme Lead/Director Signature: Dr A McLaren**

**Date of Last Modifications: 23/08/2024**

(MAE template updated July 2024)

# MODULE TIMETABLE

| **Module Code:** | **ME514** | **Module Title:** | **Advanced Topics in Fluid Systems Engineering** |
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**Brief Description of Assessment:**

Group coursework and presentation set in week 3 to be delivered in weeks 8-10.

Online time constrained quiz open during week 11 on material taught during the semester.

## Assessment Timing

Indicated on the table below are the start/submission dates for each assignment/project and the timing of each exam/assessment.

**Please note: Timings could change during unforeseen periods of disruption; this should only be used as a guide.**

| **Semester One** | W&D Wk | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 | WK10 | WK11 | Exam Period |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Choose an item. Choose an item. | Choose an item. Choose an item. | Choose an item. Choose an item. | Course work set | Choose an item. Choose an item. | Choose an item. Choose an item. | Choose an item. Choose an item. | Choose an item. Choose an item. | Presentation | Presentation | Presentation | Online Test | Choose an item. |

| **Semester Two** | C&D Wk | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 | WK10 | WK11 | Exam Period |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Choose an item. Choose an item. | Choose an item. Choose an item. | Choose an item. Choose an item. | Choose an item. Choose an item. | Choose an item. Choose an item. | Choose an item. Choose an item. | Choose an item. Choose an item. | Choose an item. Choose an item. | Choose an item. Choose an item. | Choose an item. Choose an item. | Choose an item. Choose an item. | Choose an item. Choose an item. | Choose an item. |