MODULE DESCRIPTION FORM

DEPARTMENT OF MECHANICAL AND AEROSPACE ENGINEERING

ME514 ADVANCED TOPICS IN FLUID SYSTEMS ENGINEERING

Module Registrar: Dr Paolo Capobianchi paolo.capobianchi@strath.ac.uk	**Taught To (Course): Cohorts for whom module is compulsory - MEng Mechanical Engineering / optional**	
Other Lecturers Involved: Dr Monica Oliveira Dr Emad Chaparian Dr William Dempster	**Credit Weighting: 10 (ECTS 5)**	**Semester: 2**
Compulsory / Optional module	**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 Newtonian fluid Mechanics, including application of continuity equation, momentum equation and energy equation for internal flow systems.
Vector and tensor notation and operations. Methods of fluid flow formulation using finite and differential control volumes.

Content of modules Heat and Flow 3 and 4.

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

Lecture/Tutorial/Demo (Hybrid)	Laboratory	Groupwork	External	Online	Project	Assignments	Private Study	**Total**
30							70	100

Educational Aim

The aim of this module is to examine the fundamentals of complex fluid flow systems. Previous studies have focused on Newtonian fluids where the fluid viscosity can generally be taken as a constant. However, more complex viscous properties introduce new fluid flow phenomenon that have not been previously encountered in your studies. Furthermore, flow complexity can also be easily achieved by the addition of additional fluids or phases to the flow. These features are common to a whole range of practical engineering problems where the study of the fluid mechanics has acquired new descriptors to define them including non-Newtonian flows, rheological flows, multi-phase flows. However, in this module we will simply refer to them more generally as complex fluid flows. The more complex characteristics of these flows will be examined and how the analysis procedures introduced in early years can be adapted to study these flows and apply them to engineering problems.

Learning Outcomes

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

LO1 Be able to identify the existence of more complex flow systems, recognise the basic observed behaviours and classify the level of complexity and recommend an analysis approach for a range of practical applications.

LO2 Achieve a competency to analyse internal flow systems where non-Newtonian and multiphase fluids are flowing.

LO3 To be able to formulate equations for the analysis of discrete phases such as bubbles, drops and particles and to assess their fundamental behaviour.

LO4 Be able to analyse momentum and thermal boundary layers for non-Newtonian fluids.

Syllabus

The module will teach the following:

An introduction to the wide range of different behaviours that are observed in non-Newtonian and multiphase flows. Characteristics and mathematical models of non-Newtonian fluids. Measurement methods for viscous behaviour, non-Newtonian fluids flows in pipes and ducts. Two phase flow systems in pipes: determination of flow regimes, pressure drop and holdup. Discrete behaviour of bubble, drops and particles. Heat Transfer behaviour and its analysis of complex fluids.

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: Be able to identify the existence of more complex flow systems, recognise the basic observed behaviours and classify the level of complexity and recommend an analysis approach for a range of practical applications

C1: To recognise and identify of phenomenon characteristic of non-Newtonian and multiphase flow behaviour
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: Be able to recognise and apply different mathematical models of viscosity for non-Newtonian fluids
C5: Recognise various multi-phase flow regimes and their physical behaviour.

LO2: Achieve a competency to analyse internal flow systems where non-Newtonian and multiphase fluid are flowing and calculate the basic hydraulic features of the flow including pressure drop, flowrate and holdup and the conditions when heat transfer applies

C1: For specific non-Newtonian fluid flows, to calculate the basic hydraulic characteristics of a pipe flow system: pressure drop and flowrate.
C2: For multiphase flows, be able to calculate the flow regime, pressure drop and hold up for different pipe flow conditions.
C3: For non-Newtonian flows with heat transfer, calculate the thermal behaviour including heat transfer rate and temperature conditions.

LO3: To be able to formulate equations for the analysis of discrete phases such as bubbles, drops and particles and to assess their fundamental behaviour.

C1: Being able to formulate and apply discrete Lagrangian methods for the analysis of bubbles, drop and particles.
C2: To recognise and have a physical understanding of the forces acting on bubble drops and particles.
C3: To be able to analyse the behaviour of bubble drops and particles for simple applications.

LO4: Be able to analyse momentum and thermal boundary layers for non-Newtonian fluids.

C1: Be able to the integral boundary layer method to non-Newtonian fluids.
C2: Be able to calculate the boundary layer characteristics for laminar flow.

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/)

Formal, summative feedback will be provided by the return of examination marks to students after assessment in April/May. Informal feedback will be provided at regular tutorial sessions primarily through verbal discussion with individuals or groups on tutorial exercises attempted.

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	Apr/May	2 hours	100%						
* 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*):
Resit Assessment Procedures: 2hr examination in July/August diet.

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**

** Non- Newtonian Flow and Applied Rheology, Engineering Applications 3rd editions, R.P. Chhabra, S.A.Patel
* Dynamics of Polymeric Liquids, Volume 1: Fluid Mechanics. Second Edition, R.B. Bird, R.C. Armstrong, O. Hassager.

Online access Myplace for class slides and tutorial problems

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

Date	Time	Room No

Session: 2025/26

Approved:

Programme Lead/Director Signature: Dr Andrew McLaren
Date of Last Modifications 04 August 2025

(MAE template updated June 2025)

MODULE TIMETABLE

Module Code:	**ME514**	**Module Title:**	**Advanced Topics in Fluid Systems Engineering**

Brief Description of Assessment:

2 hour end of semester exam

Assessment Timing

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

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.	Exam