MODULE TITLE	**Fluid Dynamics**	**CREDIT VALUE**	**15**
MODULE CODE	**MTH3007**	**MODULE CONVENER**	**Dr Joanne Mason (Coordinator)**

DURATION: TERM	**1**	**2**	**3**
DURATION: WEEKS	**11 weeks**	**0**	**0**

Number of Students Taking Module (anticipated)	**152**

DESCRIPTION - summary of the module content

The aim of this module is to provide you with a further understanding of the basic concepts of fluid dynamics associated with flow of incompressible (constant density) fluids with both viscosity and inertia. You will learn to translate a physical problem into an appropriate mathematical system. Furthermore, you will learn about the many important applications of fluid dynamics in different branches of science and why solutions of fluid dynamics for many real physical problems cannot be obtained.

This module deals with the flow of incompressible fluids with both viscosity and inertia. The governing equations - the Navier-Stokes equations - admit an incredible variety of solutions, some of which will be presented. Topics covered will include some exact solutions of the NS equation in a variety of coordinate systems, together with similarity solutions and an introduction to boundary layer theory. This module leads on to a number of other modules in stages 3 and 4, for example MTHM019 Fluid Dynamics of Atmospheres and Oceans.

Prerequisite module: MTH2003 Differential Equations & MTH2004 Vector Calculus & Applications, or equivalent

AIMS - intentions of the module

This module is mainly concerned with the flow of viscous fluids, and it aims to provide you with a further understanding of the basic concepts of fluid dynamics associated with real fluids; to show you that there are many important applications of fluid dynamics in different branches of science and, at the same time, to show why solutions of fluid dynamics for many real physical problems cannot be obtained.

INTENDED LEARNING OUTCOMES (ILOs) (see assessment section below for how ILOs will be assessed)

On successful completion of this module, ***you should be able to:***
Module Specific Skills and Knowledge:

1 explain the basic concepts and equations of viscous fluid flow;

2 prove some key theorems and appreciate solutions of the Navier-Stokes equations in simple geometries.

Discipline Specific Skills and Knowledge:

3 translate a physical problem into an appropriate mathematical system;

4 interpret solutions of these equations in physical terms.

Personal and Key Transferable/ Employment Skills and Knowledge:

5 demonstrate enhanced ability to formulate and analyse real physical problems using a variety of tools of applied mathematics.

SYLLABUS PLAN - summary of the structure and academic content of the module

1. Fundamentals and basic examples: introduction to module:

- introduction to Navier-Stokes equation, continuity equation, density, mass flux;

- plane Poiseuille and plane Couette flow;

- cylindrical polars, Poiseuille and Couette flow;

- derivation I: Navier-Stokes equation, acceleration, continuity equation;

- derivation II: pressure, strain, viscous stress.

2. Similarity solutions:

- dimensional analysis;

- Rayleigh problem.

3. Boundary layers:

- examples;

- boundary layer equation;

- Blasius boundary layer.

4. Sokes flow:

- Stokes equation;

- flow round cylinder and sphere;

- corner eddies;

- uniqueness of Stokes flow.

5. Vorticity and vortex dynamics:

- vorticity equation in 3-D and in 2-D;

- Helmholtz laws, Kelvin circulation theorem;

- vortex stretching;

- Burgers vortex;

6. Introduction to waves in fluids:

- wave equation and wave parameters (wave number, wave length, wave vector, frequency);

- surface gravity waves;

- phase velocity and group velocity.

LEARNING AND TEACHING

LEARNING ACTIVITIES AND TEACHING METHODS (given in hours of study time)

Scheduled Learning & Teaching Activities	33.00	Guided Independent Study	117.00	Placement / Study Abroad	0.00

DETAILS OF LEARNING ACTIVITIES AND TEACHING METHODS

Category	Hours of study time	Description
Scheduled learning and teaching activities	33	Lectures
Guided independent study	20	Coursework
Guided independent study	97	Reading, revision, preparation

ASSESSMENT

FORMATIVE ASSESSMENT - for feedback and development purposes; does not count towards module grade

Form of Assessment	Size of Assessment (e.g. duration/length)	ILOs Assessed	Feedback Method
Coursework - examples and exercises	10 hours/ 3 to 5 questions per problem sheet (5 sheets)	1-5	Comments on each script, general comments uploaded to ELE, solutions uploaded to ELE, individual feedback on request.

SUMMATIVE ASSESSMENT (% of credit)

Coursework	20	Written Exams	80	Practical Exams	0

DETAILS OF SUMMATIVE ASSESSMENT

Form of Assessment	% of Credit	Size of Assessment (e.g. duration/length)	ILOs Assessed	Feedback Method
Coursework 1 – based on questions submitted for assessment	10	15 hours	All	Annotated script and written/verbal feedback
Coursework 2 - based on questions submitted for assessment	10	15 hours	All	Annotated script and written/verbal feedback
Written Exam – closed book	80	2 hours (Summer)	All	Written/verbal on request, SRS

DETAILS OF RE-ASSESSMENT (where required by referral or deferral)

Original Form of Assessment	Form of Re-assessment	ILOs Re-assessed	Time Scale for Re-assessment
Written Exam*	Written Exam (2 hours) (80%)	All	August Ref/Def Period
Coursework 1*	Coursework 1 (10%)	All	August Ref/Def Period
Coursework 2*	Coursework 2 (10%)	All	August Ref/Def Period

*Please refer to reassessment notes for details on deferral vs. Referral reassessment

RE-ASSESSMENT NOTES

Deferrals: Reassessment will be by coursework and/or written exam in the deferred element only. For deferred candidates, the module mark will be uncapped.

Referrals: Reassessment will be by a single written exam worth 100% of the module only. As it is a referral, the mark will be capped at 40%.

RESOURCES

INDICATIVE LEARNING RESOURCES - The following list is offered as an indication of the type & level of information that you are expected to consult. Further guidance will be provided by the Module Convener

ELE: http://vle.exeter.ac.uk
Reading list for this module:

Type	Author	Title	Edition	Publisher	Year	ISBN	Search
Set	Acheson, D.J.	Elementary Fluid Dynamics		Clarendon Press	1990	978-0-198-59679-0	[Library]
Set	Batchelor G.K.	An Introduction to Fluid Dynamics		Cambridge University Press	1999	000-0-521-04118-X	[Library]
Set	Berkshire, Frank H., Malham, Simon J.A. and Stuart, J. Trevor	Introductory incompressible fluid mechanics		Cambridge University Press	2022	9781009084185	[Library]
Set	Childress, S	An Introduction to Theoretical Fluid Mechanics		American Mathematical Society	2009	978-0821848883	[Library]
Set	Tritton D.J.	Physical Fluid Dynamics	2nd	Clarendon Press, Oxford	1988	000-0-198-54493-6	[Library]
Set	Worster, M G	Understanding Fluid Flow		Cambridge University Press	2009	978-0521132893	[Library]

CREDIT VALUE	15	ECTS VALUE	7.5

PRE-REQUISITE MODULES	MTH2004, MTH2003
CO-REQUISITE MODULES	

NQF LEVEL (FHEQ)	6	**AVAILABLE AS DISTANCE LEARNING**	No
ORIGIN DATE	Tuesday 10 July 2018	**LAST REVISION DATE**	Wednesday 22 February 2023

KEY WORDS SEARCH	Fluid flow; pressure; viscosity; vorticity; boundary layer theory; applications of vector calculus.