



# Course Outline

Semester 2 2015

Never Stand Still

Engineering

Mechanical and Manufacturing Engineering

## **MMAN2600**

## **FLUID MECHANICS**

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# 1. Staff Contact Details

## Contact details and consultation for course convener

### Lecturer and Course convener:

A/Prof Tracie Barber  
Room 401A, Building J17  
Tel (02) 9385 4081  
Email [t.barber@unsw.edu.au](mailto:t.barber@unsw.edu.au)

### Lecturer:

Dr Shaun Chan  
Room 402D, Building J17  
Tel (02) 9385 4116  
Email [ging.chan@unsw.edu.au](mailto:ging.chan@unsw.edu.au)

For consultation concerning this course, please contact the lecturer and if necessary, arrange a time for meeting. For questions regarding demonstration/example problems, the demonstrators in your demonstration will be the first contact.

### Head Demonstrator (contact for demonstration and laboratory etc.):

Mr Lewis Clark  
Email [lewis@unsw.edu.au](mailto:lewis@unsw.edu.au)

# 2. Course details

## Units of credit

This is a 6 unit-of-credit (UoC) course, and involves 6 hours per week (h/w) of face-to-face contact.

The UNSW website states “The normal workload expectations of a student are approximately 25 hours per semester for each UoC, including class contact hours, other learning activities, preparation and time spent on all assessable work. Thus, for a full-time enrolled student, the normal workload, averaged across the 16 weeks of teaching, study and examination periods, is about 37.5 hours per week.”

This means that you should aim to spend about 9 h/w on this course. The additional time should be spent in making sure that you understand the lecture material, completing the set assignments, further reading, and revising for any examinations.

## CLASS CONTACT

The class contact will include the following sessions:

- **Lecture periods**

Monday 1200 to 1400 (Science Theatre)

Thursday 1300 to 1400 (Science Theatre)

Mid-session tests in weeks 5 and 9 will take place in the Monday lecture time.

- **Laboratory periods**

There are 5 compulsory 2-hour laboratories to attend commencing in week 4. At the time of enrolment you selected one of eight possible laboratory timeslots.

- **Demonstration periods**

There are eight demonstration sessions per week. The demonstration session you will be required to attend corresponds to the timeslot you selected for your laboratory period. In addition, you can attend other sessions as many times as you want, if your questions are not answered in your demonstration or you need further support from demonstrators. The demonstrators will run for the first hour of the laboratory time. For example, if you enrolled to M15A Monday 1500-1700 laboratory, then your weekly demonstration timeslot is Monday 1500-1600. For the 4 weeks that you have laboratories, you will be unavailable to attend your regular demonstration. During these weeks, you may attend any of the other 7 demonstrations that suit your course timetable.

Demonstrations			Room
M15A	Mon	1500 – 1600	MechEng102
T09A	Tue	0900 – 1000	MechEng102
T12A	Tue	1200 – 1300	MechEng102
W10A	Wed	1000 – 1100	ElecEng224
W16A	Wed	1600 – 1700	ElecEng418
H14A	Thu	1400 – 1500	MechEng202
H16A	Thu	1600 – 1700	MechEng202

The problems that you will work on during the demonstration period will be posted on Moodle before the demonstration. You are highly encouraged to look over and attempt the problems before entering the demonstration.

### Summary of the course

This course introduces the student to the terminology, principles and methods used in engineering fluid mechanics. Fluid mechanics is a subject which deals with both fluid statics (fluids at rest) and fluid dynamics (fluids in motion). Fluid flow has a broad application area ranging from car/airplane aerodynamics, heat exchangers, combustion systems, micro-fluidics, and flows in artificial hearts.

In this course the topics covered include: fluid properties, fluid statics and buoyancy, Bernoulli's equation and its use/limitations, linear momentum, dimensional analysis, laminar

and turbulent flow, flow in pipes and pipe networks including pressure drop calculations, boundary layer in external flow, drag or immersed bodies, turbines, fans and pumps and analysis of turbo-machines.

The knowledge of fluid mechanics gained in this course is a spring board for many other courses studied in the mechanical engineering degree programmes, including, advanced thermofluids (heat transfer and advanced thermodynamics), computational fluid dynamics (CFD), automobile engine technology, and aerodynamics and propulsion, as well as other disciplines particularly renewable energy.

### **Aims of the course**

This course will familiarise you with the terminology associated with fluid mechanics and the use of fluid properties in solving problems. At first, you will develop an intuitive understanding of fluid mechanics by emphasis of the physics and physical arguments. Then you will be given insight into the basic principles of fluid mechanics and you will learn how to measure fluid systems and be given the tools to design fluid systems. Also, you will be given an understanding of the workings of hydraulic systems e.g. turbines.

This course uses the mathematical and physical concepts which you learned in MATH1131 or MATH1141 and PHYS1121 or PHYS1131. It lays the groundwork for the procedure which you will use in undertaking more complex fluid dynamics problems in courses such as AERO3630 or MECH9620 as well as thermal engineering problems in courses such as MECH3610 and MECH9761.

### **Student learning outcomes**

This course is designed to address the below learning outcomes and the corresponding Engineers Australia Stage 1 Competency Standards for Professional Engineers as shown. The full list of Stage 1 Competency Standards may be found in Appendix A.

After successfully completing this course, you should be able to:

<b>Learning Outcome</b>		<b>EA Stage 1 Competencies</b>
1.	Be familiar with the terminology associated with fluid mechanics	PE1.1
2.	Be able to use fluid properties correctly to solve problems	PE2.1, 2.2
3.	Understand the principals of flow rates and velocity measurement	PE1.1
4.	Be able to determine pressure drops for pipe systems and choose appropriate pumps and turbines depending on the application	PE2.3, 2.4

### 3. Teaching strategies

Lectures in the course are designed to cover the terminology and core concepts and theories in fluid mechanics. They do not simply reiterate the texts, but build on the lecture topics using practical examples to show how the theory is applied in real engineering problems and the details of when, where and how it should be applied.

Demonstrations are designed to provide you with feedback and discussion on the example problems, and to investigate problem areas in greater depth to ensure that you understand the application and can avoid making the same mistake again.

## 4. Course schedule

Week	Lecturer	Lab	Topics	Chapter,
				Cengel Book
1 Jul-27	TB		Introduction, physical properties of fluids. Fluids in static equilibrium, pressure measurements, manometers.	Chapter 1 Chapter 2
2 Aug-03	TB		Fluid flow (Lagrangian and Eulerian Descriptions), continuity equation, flow visualisation.	Chapter 4 Chapter 8.2
3 Aug-10	SC		Bernoulli equation, Hydraulic and energy grade line, Energy transfer and general energy equation.	Chapter 5
4 Aug-17	TB	flow meas	Dimensional analysis and similarity. Introduction to laminar and turbulent flow. Reynolds number. CFD	Chapter 7 Chapter 15
5 Aug-24	TB	flow meas	<b>Mid-session test 1 (Monday)</b> Computational Fluid Dynamics (CFD)	Chapter 15
6 Aug-31	SC	CFD	Forces on submerged plane surfaces; Buoyancy and stability of floating objects; Pressures in accelerating fluid systems.	Chapter 3
7 Sep-07	TB	CFD	External Flow Boundary layers, characteristics of laminar, transition and turbulent zones. Drag of immersed bodies, skin friction, form drag.	Chapter 11
8 Sep-14	SC	hydrostat	Laminar and turbulent flow in pipes: analytical solutions, The Moody Chart and Darcy friction factor.	Chapter 8
9 Sep-21	SC	hydrostat	<b>Mid-session test 2 (Monday)</b> Pipe friction, minor loss, pipe network	Chapter 8
<b>Mid-session break</b>				
10 Oct-05	SC	pipe	<b>Monday Public Holiday</b> Linear momentum equation (Newton's Law).	Chapter 6.1-6.2
11 Oct-12	SC	pipe	Forces caused by deflection of jets, forces on nozzles. Linear momentum + Bernoulli/Energy Equations.	Chapter 6.3-6.6
12 Oct-19	TB	pelton	Turbomachinery	Chapter 14
13 Nov-19		pelton	<i>no lecture</i>	

## LABORATORY TIMETABLE

### Undergraduate Teaching Laboratory (UTL), J18 Willis Annexe

#### Laboratory Time Slots

M15A	Mon	1500 – 1700	UTL
T09A	Tue	0900 – 1100	UTL
T12A	Tue	1200 – 1400	UTL
W10A	Wed	1000 – 1200	UTL
W16A	Wed	1600 – 1800	UTL
H14A	Thu	1400 – 1600	UTL
H16A	Thu	1600 – 1800	UTL

Due to the large number of students, each of these timeslots will further be broken into 2 groups. You will be notified of which group, Archimedes or Bernoulli, you are in before the lab commences in week 4. For example, if you are enrolled to M15A and are selected for group Bernoulli, you will attend the lab on Mon 15:00-17:00 in week 5, 7, 9, 11 and 13. If you are enrolled to H16A and are selected for group Archimedes, your lab will be on Thurs 16:00-18:00 in week 4, 6, 8, 10 and 12.

Group	Week of Semester									
	4	5	6	7	8	9	10	11	12	13
Archimedes	Lab1		CFD		Lab2		Lab3		Lab4	
Bernoulli		Lab1		CFD		Lab2		Lab3		Lab4

#### Laboratory Topic

Lab 1 Flow measurement

CFD CFD laboratory, conducted in the computer labs

Lab 2 Hydrostatics

Lab 3 Pipe friction

Lab 4 Pelton wheel

**\*There will be no waiver of labs for repeating students.**

## 5. Assessment

### General

You will be assessed by way of two mid-session tests, laboratory works, online work and final examination.

Assessment	Weight	Learning outcomes assessed
5 Laboratories	20% of final mark	1, 2, 3, 4
1 LearnSmart modules	5% of final mark	1, 2, 3, 4
2 Mid-session tests	25% of final mark	1, 2, 3, 4
1 Final exam	50% of final mark	1, 2, 3, 4
<b>Total</b>	<b>100%</b>	

In order to pass the course, you must achieve an overall mark of at least 50%.

### Lab Assignments

There will be five laboratory experiments held as outlined in the “Laboratory Timetable”, including one computer-lab based CFD experiment.

You are required to obtain a bound laboratory book (alternate lined and graph pages) to record results of each experiment and analysis carried out whilst in the laboratory.

The laboratory demonstrators will mark your preliminary work at the start of the laboratory period and mark your data collection and analysis at the end of the laboratory period. Ensure that your work is marked before you leave the laboratory and that your mark is entered in the class record and your laboratory book and initialled by the demonstrator. You will not be admitted to the laboratory unless you are appropriately dressed for safe working, have a laboratory book, a calculator and present the assigned preliminary work.

The laboratory demonstrators will give instructions on how to operate the equipment, and will explain what is required of you. If in doubt, ask. It is important that you fully understand the experiment at the time it is being carried out, when instruction is available. In some experiments you are only required to take readings at intervals, use the intermediate time to ask questions and find out what other members of your group are doing. Little is learned merely by sitting and waiting to make a measurement - much is learned by inquiry and discussion.

**Attendance at all laboratory experiments to which you are assigned is compulsory and a register is taken.** If you are unable to attend, due to illness, it is important that you inform the Head Demonstrator as soon as possible so that you may be reassigned to that experiment at a later date. You might be asked to present a medical certificate later.

**Transfer from other groups** The laboratory groups are large so transfers between groups are granted only for the circumstances that are unexpected and beyond your control. The transfers must be arranged through the Head Demonstrator. Please note that according to the university's rule for special consideration, "Students are expected to give priority to their University study commitments and work commitments are not normally considered a justification."

Lab report marks will be allocated for completion of preliminary analysis, results obtained and calculations made during the laboratory period (2 marks for preliminary work, 2 marks for measurements, data analysis and conclusions). You do not have to submit a formal report; results of any calculations must be shown to the laboratory demonstrators for checking during the laboratory period.

**Preparation prior to the laboratory periods is essential.** Study the laboratory notes so that you know what the experiment is about in advance of each laboratory session. If you arrive without the necessary preparation you may not be allocated the laboratory mark. Bring a calculator to all laboratory periods. **Submission of preliminary work which is not your own, or copying during the laboratory period, will result in a mark of 0 for the laboratory.**

### Presentation

All submissions should have a standard School cover sheet which is available from this subject's Moodle page.

All submissions are expected to be neat, and clearly set out. Your results are the pinnacle of all your hard work. Presenting them clearly gives the marker the best chance of understanding your method; even if the numerical results are incorrect.

### Submission

Late submissions will be penalised 5 marks per calendar day (including weekends). An extension may only be granted in exceptional circumstances. Where an assessment task is worth less than 20% of the total course mark and you have a compelling reason for being unable to submit your work on time, you must seek approval for an extension from the course convenor **before the due date**. Special consideration for assessment tasks of 20% or greater must be processed through <https://student.unsw.edu.au/special-consideration>.

It is always worth submitting late assessment tasks when possible. Completion of the work, even late, may be taken into account in cases of special consideration.

### **Criteria**

Specific criteria will be given for each particular laboratory experiment, or test. In general, for any work that involves numerical calculations, the following criteria will be used:

- Accuracy of numerical answers.
- Use of diagrams, where appropriate, to support or illustrate the calculations.

- Use of graphs, where appropriate, to support or illustrate the calculations.
- Use of tables, where appropriate, to support or shorten the calculations.
- Neatness.

### **Mid-session Tests**

There will be two mid-session tests (held in weeks 5 and 9), during the 2-hr lecture time. For each test, there will be questions from week 1~4 lectures (Test 1) and week 5~8 lectures (Test 2).

### **Final Examination**

There will be one 3-hour examination at the end of the session for everything learned from this course.

You will need to provide your own calculator, of a make and model approved by UNSW, for the examinations. The list of approved calculators is shown at <https://student.unsw.edu.au/exam-approved-calculators-and-computers>

It is your responsibility to ensure that your calculator is of an approved make and model, and to obtain an “Approved” sticker for it from the School Office or the Engineering Student Centre prior to the examination. Calculators not bearing an “Approved” sticker will not be allowed into the examination room.

### **Special Consideration and Supplementary Assessment**

For details of applying for special consideration and conditions for the award of supplementary assessment, see [Administrative Matters](#), available on the School website and on Moodle, and the information on UNSW’s [Special Consideration page](#).

## **6. Expected Resources for students**

### **Textbook**

Cengel and Cimbala, Fluid Mechanics Fundamentals and Applications, 2nd Ed in SI unit. The textbook is available from the UNSW Bookshop and the UNSW Library.

### **Additional materials provided in UNSW Moodle**

This course has a Moodle page where **lecture notes and weekly demonstration questions** will be posted prior to the lecture. You are encouraged to study the notes so that you know what the lecture is about in advance of each lecture.

## Recommended Internet sites

If you wish to explore any of the lecture topics in more depth, then other resources are available and assistance may be obtained from the UNSW Library. One starting point for assistance is: [info.library.unsw.edu.au/web/services/services.html](http://info.library.unsw.edu.au/web/services/services.html)

## 7. Course evaluation and development

Feedback on the course is gathered periodically using various means, including the Course and Teaching Evaluation and Improvement (CATEI) process, informal discussion in the final class for the course, and the School's Student/Staff meetings. Your feedback is taken seriously, and continual improvements are made to the course based, in part, on such feedback.

In this course, recent improvements resulting from student feedback include a new method of running demonstrations, more on-line lecture notes, the LearnSmart modules and a new assessment scheme.

## 8. Academic honesty and plagiarism

UNSW has an ongoing commitment to fostering a culture of learning informed by academic integrity. All UNSW students have a responsibility to adhere to this principle of academic integrity. Plagiarism undermines academic integrity and is not tolerated at UNSW. *Plagiarism at UNSW is defined as using the words or ideas of others and passing them off as your own.*

Plagiarism is a type of intellectual theft. It can take many forms, from deliberate cheating to accidentally copying from a source without acknowledgement. UNSW has produced a website with a wealth of resources to support students to understand and avoid plagiarism: <https://student.unsw.edu.au/plagiarism> The Learning Centre assists students with understanding academic integrity and how not to plagiarise. They also hold workshops and can help students one-on-one.

You are also reminded that careful time management is an important part of study and one of the identified causes of plagiarism is poor time management. Students should allow sufficient time for research, drafting and the proper referencing of sources in preparing all assessment tasks.

If plagiarism is found in your work when you are in first year, your lecturer will offer you assistance to improve your academic skills. They may ask you to look at some online resources, attend the Learning Centre, or sometimes resubmit your work with the problem fixed. However more serious instances in first year, such as stealing another student's work or paying someone to do your work, may be investigated under the Student Misconduct Procedures.

Repeated plagiarism (even in first year), plagiarism after first year, or serious instances, may also be investigated under the Student Misconduct Procedures. The penalties under the procedures can include a reduction in marks, failing a course or for the most serious matters (like plagiarism in an honours thesis) even suspension from the university. The Student Misconduct Procedures are available here:

<http://www.gs.unsw.edu.au/policy/documents/studentmisconductprocedures.pdf>

Further information on School policy and procedures in the event of plagiarism is presented in a School handout, [Administrative Matters](#), available on the School website.

## 9. Administrative Matters

You are expected to have read and be familiar with *Administrative Matters*, available on the School website: [www.engineering.unsw.edu.au/mechanical-engineering/sites/mech/files/u41/S2-2015-Administrative-Matters\\_20150721.pdf](http://www.engineering.unsw.edu.au/mechanical-engineering/sites/mech/files/u41/S2-2015-Administrative-Matters_20150721.pdf)

This document contains important information on student responsibilities and support, including special consideration, assessment, health and safety, and student equity and diversity.

*Tracie Barber*  
22/7/2015

## Appendix A: Engineers Australia (EA) Professional Engineer Competency Standards

	<b>Program Intended Learning Outcomes</b>
<b>PE1: Knowledge and Skill Base</b>	PE1.1 Comprehensive, theory-based understanding of underpinning fundamentals
	PE1.2 Conceptual understanding of underpinning maths, analysis, statistics, computing
	PE1.3 In-depth understanding of specialist bodies of knowledge
	PE1.4 Discernment of knowledge development and research directions
	PE1.5 Knowledge of engineering design practice
	PE1.6 Understanding of scope, principles, norms, accountabilities of sustainable engineering practice
<b>PE2: Engineering Application Ability</b>	PE2.1 Application of established engineering methods to complex problem solving
	PE2.2 Fluent application of engineering techniques, tools and resources
	PE2.3 Application of systematic engineering synthesis and design processes
	PE2.4 Application of systematic approaches to the conduct and management of engineering projects
<b>PE3: Professional and Personal Attributes</b>	PE3.1 Ethical conduct and professional accountability
	PE3.2 Effective oral and written communication (professional and lay domains)
	PE3.3 Creative, innovative and pro-active demeanour
	PE3.4 Professional use and management of information
	PE3.5 Orderly management of self, and professional conduct
	PE3.6 Effective team membership and team leadership