Course Outline

Semester 2 2015

Never Stand Still | Engineering | Mechanical and Manufacturing Engineering

NAVL3620

Ship Hydrodynamics

Contents

1. Staff Contact Details

Contact details and consultation times for course convenor

Mr David Lyons CEng FRINA
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Consultation concerning this course is available by email, by phone or in person. For an in-person appointment, please contact me by email first or see me in class.

Contact details and consultation times for additional lecturers/demonstrators/lab staff

Part A – Flow experimentation:
A/Prof. Noor-e-Alam Ahmed
Room 311E
Tel (02) 9385 4080
Email n.ahmed@unsw.edu.au

Part B – Hydrodynamics:
Dr Rozetta Payne
Tel (0438) 602 459
Email rozetta_payne@hotmail.com

Mr Phil Helmore (week 11 excursion)
Tel (02) 9385 5215
Email p.helmore@unsw.edu.au

2. Course details

Credit Points:

This is a 6 unit-of-credit (UoC) course, and nominally involves 6 hours per week (h/w) of face-to-face contact. See 5. Course schedule below for detailed break-down.

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.

NAVL3620 is taught in parallel with AERO3630 Aerodynamics for Part A Flow Experimentation, but separately for Part B Hydrodynamics.

Contact Hours

Lectures	**Day**	**Time**	**Location**
Dr Payne Part B	Monday	10am – 1pm	UNSW Business School 232 (weeks 1-13)
A/Prof Ahmed Part A	Wednesday	2pm - 5pm	Ainsworth 202 (weeks 5-6)
Dr Payne Part B	Wednesday	2pm – 5pm	Week 12
Laboratory A/Prof Ahmed Part A	Wednesday	2pm – 5pm	J18 L116A (weeks 9, 10)
Excursion Mr Helmore	Thu, Fri, Sat Sun		AMC Tasmania (week 11)

Summary of the Course

This course focuses on the hydrodynamics of ships, both with reference to the flow of fluid around the ship due to its movement (usually forward), and the response of the ship to fluid flow by way of wave action.

Aims of the Course

This course enables you to explore the flow of fluid around streamlined shapes, both qualitatively and quantitatively, using experimental techniques in the wind tunnel. Qualitatively, flow visualisation is used for flow around bluff and streamlined bodies with the aim of showing you the benefits of streamlining. Quantitatively, the aim is to determine the forces generated on a body moving through a fluid. Measurements of pressure distributions around bluff and streamlined bodies are made to obtain the lift forces produced on them, together with measurements of the wake field of a streamlined body to obtain the drag force on it.

The course also provides you with the terminology of fluid dynamics and methods for determining the physical forces exerted by fluids (especially those considered as incompressible and inviscid) on their boundaries. The aim is for you to be able to calculate the hydrodynamic forces on streamlined bodies, such as ships, propeller blades and the like. You will also be introduced to the basic techniques associated with towing-tank tests for resistance and seakeeping predictions.

This course builds on the principles of conservation of mass, momentum and energy which you learned in MMAN1300. It also builds on the principles of fluid mechanics, dimensional analysis and Bernoulli's principle which you learned in MMAN2600. It uses the ship terminology which you learned in NAVL3610, and lays the groundwork for the hydrodynamics component of NAVL4140.

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:

Learning Outcome		EA Stage 1 Competencies
1.	Describe the flow around bluff and streamlined bodies, and to discuss the benefits of streamlining.	PE1.1 – PE1.5, PE2.1 – 2.3
2.	Measure the pressure distribution around a body in a wind-tunnel test and to determine the lift force produced on it.	PE1.1 – PE1.5, PE2.1 – 2.3
3.	Measure the wake field of a streamlined body and to determine the drag force on it.	PE1.1 – PE1.5, PE2.1 – 2.3
4.	Apply fluid flow principles, including conservation of mass, momentum and energy, Bernoulli's principle, the stream and potential functions, and sources and sinks, to assess the forces applied by the flow to streamlined bodies.	PE1.1 – PE1.5, PE2.1 – 2.3
5.	Set up the parameters for a series of resistance or seakeeping tests in a towing tank, and to extrapolate the results of the tests to full size	PE1.1 – PE1.5, PE2.1 – 2.3

Note: EA = Engineers Australia; PE = Professional Engineers

3. Teaching strategies

Lectures in the course are designed to cover the terminology and core concepts and theories in the flow of fluids around ships and streamlined bodies. They do not simply reiterate the texts, but build on the lecture topics using examples to show how the theory is applied in practice and the details of when, where and how it should be applied.

The laboratory classes in flow experimentation are conducted in groups, with each group making their own qualitative and quantitative measurements.

Tutorials in hydrodynamics are designed to provide you with feedback and discussion on the assignments, 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

Lectures in Part A of the course are given by A/Prof. Noor-e-Alam Ahmed

Lectures in Part B of the course are given by Dr Rozetta Payne

Week	Time	Location	Day	Lecturer	Topic
1	1000–1300	UNSW Business School 232	Monday	RP	Conservation of energy and momentum
2	1000–1300	UNSW Business School 232	Monday	RP	Bernoulli's principle, fluid flow in pipes
3	1000–1300	UNSW Business School 232	Monday	RP	Stream function definition and properties
4	1000–1300	UNSW Business School 232	Monday	RP	Application of stream function to basic flows, construction of flow fields
5	1000–1300	UNSW Business School 232	Monday	RP	Potential function definition and properties
	1400–1700	AINSWORTH 202	Wednesday	NA	Introduction to Experimentation/ Dimensional Analysis
6	1000–1300	UNSW Business School 232	Monday	RP	Application of potential function to flows, comparison with stream function
	1400–1700	AINSWORTH 202	Wednesday	NA	Introduction to Experimentation/ Dimensional Analysis
7	1000–1300	UNSW Business School 232	Monday	RP	Generation of bodies with line distribution of sources
8	1000–1300	UNSW Business School 232	Monday	RP	Generation of bodies with surface distribution of sources
9	1000–1300	UNSW Business School 232	Monday	RP	Thin-body approximations
	1400–1700	J17 L116A	Wednesday	NA	**Experiment 1:** Smoke flow visualisation **Experiment 2:** Pressure Distribution around a cylinder

10	1000–1300	UNSW Business School 232	Monday	RP	Tank testing for resistance, seakeeping and cavitation
	1400–1700	J17 L116A	Wednesday	NA	**Experiment 3:** Lift of an airfoil **Experiment 4:** Drag of an airfoil
11	1000–1300	UNSW Business School 232	Monday	RP/NA	Extrapolation of tank test results to full size. Wrap-up by NA.
			Thu/Fri/Sat/Sun	DL/PH	AMC visit - Tasmania
12	1000–1300	UNSW Business School 232	Monday	RP	Ocean waves and sea spectra, ship motions
	1400–1700	AINSWORTH 202	Wednesday	RP/NA	Response amplitude operators, ship motions. Class test on flow experimentation (NA).
13	1000–1300	UNSW Business School 232	Monday	RP	Review, exam discussion

The schedule shown may be subject to change at short notice to suit exigencies.

5. Assessment

General

Part A – Flow Experimentation

You will be assessed by way of a logbook, a report and a class test in Part A Flow Experimentation, and assignments and an end-of-semester examination in Part B Hydrodynamics, all of which involve calculations and descriptive material.

Part A of the course counts 30% towards the overall grade in the course, and Part B counts 70% towards the overall grade, as follows:

	Part A	**Part B**	**Total**
A-FE Logbook	5		5
A-FE Report	15		15
A-FE Class test	20		20
B-HD Assignments		20	20
B-HD Exam		30	30
Total	40	50	90
Scaled	30%	70%	100%

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

Flow Experimentation Logbook

For the Flow Experimentation you must keep a logbook. The log book will be a bound A4 exercise book containing the date of experiment, observations, notes, calculations, figures and your comments while conducting the experiment. No loose sheets are acceptable. All handouts related to a particular experiment should be appropriately stapled or pasted into the log book. The log book is to be submitted to Dr Payne in Week 12 with the Flow Experimentation report.

Flow Experimentation Report

You will be required to write a report on one of the four experiments which have been conducted in the wind tunnel, using the details from your logbook and lecture notes. The specific experiment will be at random, and will be decided by the lecturer, but will be the same experiment for the whole class. Your report is to be submitted to Dr Payne in Week 12 with the Flow Experimentation logbook.

Flow Experimentation Class Test

The class test in Flow Experimentation will be held in the Wednesday lecture during Week 12. The test will be of one hour duration and will be based on the Flow Experimentation material covered. The test will be of the multiple-choice type.

Visit to AMC in Launceston

There will be a visit to the Australian Maritime College in Launceston, Tasmania, on the Thursday, Friday and weekend during and following Week 11. The visit is to acquaint you with the facilities available including the towing tank for resistance and seakeeping tests, the cavitation tunnel, the model basin, the flume tank, the shiphandling simulator, etc., and the calculations required to extrapolate the resistance and seakeeping results to full size.

Hydrodynamics Assignments

There will be four hydrodynamics assignments, as shown below.

Assignments

The set assignments for Part B Hydrodynamics during the semester are shown below. Assignments will be posted on Moodle.

Presentation

All submissions must have a completed standard School cover sheet available on this subject's Moodle page.

All submissions are to be TYPED, neat and clearly set out. All calculations should be shown as, in the event of incorrect answers, marks are awarded for method and understanding.

The preferred set-out of any numerical calculation is similar to the following:

The preferred set-out of any numerical calculation is similar to the following:

$W = \rho g V$	(Equation in symbols)
$= 1.025 \times 9.80665 \times 200$	(Numbers substituted)
$= 2010$ kN	(Answer with units)

Submission

Assignments are due on the scheduled day of the class in the week nominated on the previous page, by 5pm and *are to be submitted via Moodle*.

Late submission of assignments attracts a penalty of five (5) marks for each calendar day the assignment is late. 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.

Part A Flow Experimentation

No.	Held/Due	Mark	Learning outcomes assessed
Exp. 1	Wed. Week 9	.	1
Exp. 2	Wed. Week 9	.	2 and 3
Exp. 3	Wed. Week 10	.	2 and 3
Exp. 4	Wed. Wek 10	.	2 and 3
Logbook	Wed. Week 12	5	1, 2 and 3
Report on one experiment	Wed. Week 12	15	1, 2 and 3
TOTAL		**20**	
SCALED		**20%**	

Part B Hydrodynamics

No.	Held/Due	Mark	Learning outcomes assessed
Conservation of mass and Bernoulli's principle	Mon. Week 5	10	4
Conservation of momentum	Mon. Week 7	10	4
Potential flow and stream function	Mon. Week 9	10	4
Towing tank calcs and report	Mon. Week 12	10	5
TOTAL		**40**	
SCALED		**20%**	

Criteria

The submissions in Part A are the logbook and laboratory report, and the following criteria will be used:

(a)	Logbook	The logbook must contain all the information relevant to each experiment (date, time, venue, handouts), calculations, discussion and conclusions. The information is to be written down on site; calculations, discussion and conclusions can be written later if necessary. You name and student number must be shown clearly, with the family name underlined.
(b)	Report	The report is to be in the usual format (introduction, method, results, discussion, conclusion and references), with a School cover sheet.

The following criteria will be used:

- Comparison of results with different meshes, different turbulence models, and the effects of convergence.
- Plots (graphs) of velocity vectors, streamlines, pressure distribution and lift and drag coefficients.
- Validation of results by comparison with experimental data

The assignments in Part B all involve numerical calculations, for which the following criteria will be used:

- Accuracy of numerical answers.
- Use of diagrams, where appropriate, to support or illustrate the calculations.
- Use of graphs, were appropriate, to support or illustrate the calculations.
- Use of tables, where appropriate, to support or shorten the calculations.
- Neatness.

The final assignment in Part B also involves a report on the results, and the following criteria will be used:

- Clarity of communication—this includes development of a clear and orderly structure and the highlighting of core arguments.
- Sentences in clear and plain English—this includes correct grammar, spelling and punctuation.
- Correct referencing in accordance with the prescribed citation and style guide.

Examinations

The final examination for the course is held during the University examination period in November.

Provisional Examination timetables are generally published on myUNSW in September.

For further information on exams, please see Administrative Matters.

Calculators

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

Textbooks

Part A

Relevant materials/notes will be available on the Moodle website.

Part B

Lewis, E.V. (Ed.) (1988), *Principles of Naval Architecture*, v.3, Motions in Waves and Controllability, Society of Naval Architects and Marine Engineers, Jersey City.

Newman, J.N. (1980), *Marine Hydrodynamics*, MIT Press, Cambridge, Massachusetts.

Both of these are available in the UNSW Library.

Lewis is available for purchase from the Society of Naval Architects and Marine Engineers, Jersey City, USA. However, the price to non-members exceeds the member price plus the cost of student membership, so it is advisable to join the Society and order the book at the same time.

Suggested additional readings

Flow Experimentation

Barlow, J.B., Rae, W.H. Jr. and Pope, A. (1999), Low-speed Wind Tunnel Testing, 3rd Edition, John Wiley, New York.

This is available in the UNSW Library.

Hydrodynamics

Bertram, V. (1999), *Practical Ship Hydrodynamics*, Butterworth-Heinemann, UK.

This is available in the UNSW Library.

Additional materials provided in Moodle

This course has a website on Moodle which includes:

- relevant material/notes for flow experimentation;
- copies of hydrodynamics assignments
- previous examination papers;
- answers to the numerical questions in hydrodynamics examinations; and
- a discussion forum.

The discussion forum is intended for you to use with other enrolled students.

Other Resources

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: https://www.library.unsw.edu.au/servicesfor/index.html

7. Course evaluation and development

Feedback on the course is gathered 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, a recent improvement is the incorporation of the flow experimentation component to improve your visualisations of flow and experimental technique.

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

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

David Lyons
20 July 2015

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

	Program Intended Learning Outcomes
PE1: Knowledge and Skill Base	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
PE2: Engineering Application Ability	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
PE3: Professional and Personal Attributes	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