UNSW SYDNEY | Australia's Global University

Mechanical and Manufacturing Engineering

# Course Outline

Semester 2 2017

# NAVL3620

# SHIP HYDRODYNAMICS

# Contents

# 1. Staff contact details

**Contact details and consultation times for course convenor**

Mr David Lyons FRINA
Naval Architecture Stream Coordinator
Room 208D, Ainsworth Building J17
Email david.lyons@unsw.edu.au
Tel (02) 9385 6120 or 0418 208370 (send SMS or leave voicemail if unattended)

Consultation concerning this Course is available by email, by phone or in person. For an in-person appointment, please contact David by email first – thank you!.

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

Dr Rozetta Payne is your lecturer in all parts of this course.
Tel (0438) 602 459
Email rozetta_payne@hotmail.com

# 2. Course details

**Credit Points**

This is a 6 unit-of-credit (UoC) course, and involves up to 4 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.

There is no parallel teaching in this course.

**Contact hours**

| | Day | Time | Location |
|---|---|---|---|
| **Lecture/tutorial** | Wednesday | 2pm – 6pm | Goldstein G07 |

**Summary of the course**

This course focusses 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. It also addresses the specialty area of hydrodynamics of high speed craft as well as ship manoeuvrability.

**Aims of the course**

This course enables you to explore the flow of fluid around streamlined shapes, both qualitatively and quantitatively. 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. Calculations of pressure distributions around bluff and streamlined bodies are made to obtain the lift forces produced on them, together with calculations 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.

In addition, the special case of the hydrodynamics of high speed craft is studied in detail, as is ship manoeuvrability.

**Student learning outcomes**

This course is designed to address the learning outcomes below 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. | PE1.3, PE1.5, PE2.1, PE2.2, PE2.3 |
| 2. | Calculate the pressure distribution around a body in a wind-tunnel test and to determine the lift force produced on it. | PE2.1-2.3 |
| 3. | Calculate the wake field of a streamlined body and to determine the drag force on it. | PE1.1, PE1.2, PE2.2 |
| 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, PE1.2, PE2.2 |
| 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. | PE2.1-2.4 |
| 6. | Analyse the manoeuvring characteristics of the vessel's hullform, compare that to achievable standards, and specify the steering gear required. | PE2.1-2.3 |
| 7. | Calculate the resistance and powering requirements of a range of high-speed craft (including monohulls, catamarans and hydrofoils), and judge whether the craft is performing efficiently in relation to others. | PE2.1-2.3 |

# 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 with specialised treatment of high speed craft and ship manoeuvrability. 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.

Tutorial aspects are also covered as part of blended learning in the periods identified as lectures, as required and 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

Black text – ship hydrodynamics. Blue text – ship manoeuvrability. Red text – high speed craft hydrodynamics.

| Week starting | Week | Topic |
|---|---|---|
| 24/7/17 | 1 | Conservation of energy and momentum.<br>Ship controllability. |
| 31/7/17 | 2 | Bernoulli's principle, fluid flow in pipes.<br>Equations of motion.<br>Introduction and dimensional analysis. |
| 7/8/17 | 3 | Stream function definition and properties.<br>Linearisation of equations. |
| 14/8/17 | 4 | Application of stream function to basic flows, construction of flow fields.<br>Meaning of terms and non-dimensionalisation.<br>Transport efficiency and sustention. |
| 21/8/17 | 5 | Potential function definition and properties.<br>Determination of coefficients and use of equations. |
| 28/8/17 | 6 | Application of potential function to flows, comparison with stream function;<br>Tank testing for resistance, seakeeping and cavitation.<br>Rudder terminology and selection criteria.<br>Planing vessel resistance prediction (1). |
| 4/9/17 | 7*** | Excursion to AMC University of Tasmania |
| 11/9/17 | 8 | Extrapolation of tank test results to full size;<br>Generation of bodies with line distribution of sources;<br>Generation of bodies with surface distribution of sources.<br>Rudder size, number, forces and torques.<br>Planing vessel resistance prediction (2).. |
| 18/9/17 | 9 | Thin-body approximations.<br>Rudder stock and tiller size |
| 23/9/17-2/10/17 | | Mid-semester break |
| 3/10/17 | 10 | Ocean waves and sea spectra; Response amplitude operators.<br>Rudder action in turning.<br>Analysis of hydrofoil lift, drag and cavitation. |
| 9/10/17 | 11 | Ship motions.<br>Acceleration of ships, deceleration of ships and backing. |

| | | |
|---|---|---|
| 16/10/17 | 12 | Manoeuvrability standards and high-performance rudders.<br>High-performance craft (hydrofoils, ACVs SES, etc.). |
| 23/10/17 | 13 | Revision and exam details tutorial. |

***** Visit to AMC/University of Tasmania in Launceston**

There will be a visit to the Australian Maritime College in Launceston, Tasmania, on the Thursday and Friday of Week 7, departing Sydney on Wednesday 6 September and returning Friday evening 8 September. 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.

# 5. Assessment

**Assessment overview**

Black text – ship hydrodynamics. Blue text – ship manoeuvrability. Red text – high speed craft hydrodynamics.

| No. | Assignment | Weight | Learning outcomes assessed | Assessment criteria | Due date and submission requirements | Marks returned: |
|---|---|---|---|---|---|---|
| 1 | (a) Conservation of mass and Bernoulli's principle.<br>(b) The equations of motion<br>(c) Dimensional analysis | 10% | 1-7 | Lecture material from weeks 1 - 4. | Week 5: 25/8/17 | 2 weeks after submission |
| 2 | (a) Conservation of momentum.<br>(b) Rudder design.<br>(c) Transport efficiency | 10% | 1-7 | Lecture material up to week 6. | Week 7: 8/9/17 | 2 weeks after submission |
| 3 | (a) Potential flow and stream function.<br>(b) Angle of heel in a turn.<br>(c) Resistance of planing craft. | 10% | 1-7 | Lecture material up to week 8. | Week 9: 22/9/17 | 2 weeks after submission |

| | | | | | | |
|---|---|---|---|---|---|---|
| 4 | (a) Towing tank calcs and report. (b) Acceleration and deceleration (c) Hydrofoil lift, drag and cavitation. | 10% | 1-7 | Lecture material up to week 10. | Week 11: 13/10/17 | 2 weeks after submission |
| Exam | | 60% | All | All | Examination period: 4-19/11/17 | After release of results |

**Assignments**

*Presentation*

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

**All submissions are to be neatly typed and clearly set out.** Presenting them clearly gives the marker the best chance of understanding your method; even if the numerical results are incorrect.

*Submission*

By email to Dr Payne or other agreed arrangement with Dr Payne.

Late submissions will be penalised 5% of the available 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 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.

**Examinations**

You must be available for all tests and examinations. The final School 3-hour examination for this Course will be held during the University examination period approx. 4-19 November 2017.

Provisional examination timetables are generally published on myUNSW in September for Semester 2.

For further information on exams, please see the Exams section on the intranet and contact the Course convenor.

*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 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 the School intranet, and the information on UNSW's Special Consideration page.

## 6. Expected resources for students

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.

Taggart, R. (Ed.) (1980), *Ship Design and Construction*, Chapter XII, Society of Naval Architects and Marine Engineers, Jersey City.

Doctors, L.J. (1985), Hydrodynamics of High-speed Small Craft, University of Michigan, Department of Naval Architecture and Marine Engineering, Report 292, Ann Arbor.

Doctors, L.J. (2015), Hydrodynamics of High-Performance Marine Vessels: Volumes 1 & 2 www.amazon.com

These are also available in the UNSW Library.

**Suggested additional readings**

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

This is available in the UNSW Library.

Journal *Fast Ferry International*.

Papers from Fast Sea Transportation (FAST) conferences.

Papers from Fast Ferry International (FFI) conferences.

**Additional materials provided in Moodle**

This course has a website on Moodle which includes:

- copies of hydrodynamics assignments
- previous examination papers in hydrodynamics from 2010 onwards;
- answers to the numerical questions in hydrodynamics examinations from 2010 onwards; and
- a discussion forum.

The discussion forum is intended for you to use with other enrolled students. The course lecturer will occasionally look at the forum and take note of any frequently-asked questions, but will not respond to questions on the forum.

**Recommended internet sites**

Principal particulars and design details of many different types of vessels are available on the Internet. You might like to try the following:

| | |
|---|---|
| Austal Ships | www.austal.com |
| Incat Crowther Design | www.incatcrowther.com.au |
| One2three Naval Architects | www.one2three.com.au |

**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.

UNSW Library website: https://www.library.unsw.edu.au/

# 7. Course evaluation and development

Feedback on the course is gathered periodically using various means, including the myExperience 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 the alignment of component parts within the course that complement each other. To that end, the ship's entire powering and propulsion train from the engines to the propeller are treated as a whole in order to meet the powering requirements that are assessed in order to overcome the vessel's resistance.

# 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: 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: www.gs.unsw.edu.au/policy/documents/studentmisconductprocedures.pdf

Further information on School policy and procedures in the event of plagiarism is available on the intranet.

## 9. Administrative matters and links

All students are expected to read and be familiar with School guidelines and polices, available on the intranet. In particular, students should be familiar with the following:

- Attendance, Participation and Class Etiquette
- UNSW Email Address
- Computing Facilities
- Assessment Matters (including guidelines for assignments, exams and special consideration)
- Academic Honesty and Plagiarism
- Student Equity and Disabilities Unit
- Health and Safety
- Student Support Services

*David Lyons FRINA*
*20 June 2017*

# Appendix A: Engineers Australia (EA) Competencies

*Stage 1 Competencies for Professional Engineers*

| | **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 |