The University of British Columbia
Faculty of Applied Science

NAME 502 – HYDRODYNAMICS II

Course Instructors:

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Course Objective

NAME 502 is a course designed to highlight the key principles of ship hydrodynamics. It introduces advanced topics in resistance prediction, wave mechanics, propulsion, and sea-keeping. Students will be expected to develop a thorough understanding of the underlying principles related to the analysis and design of ships in motion.

It is expected that enrollment in this course will be approximately 15 students. With this size of class, we strive to develop a student friendly environment where lectures are presented in a tutorial format with ample opportunities for student input and questions. Students are encouraged to work cooperatively and bring to the class their specific knowledge and experiences related to the marine environment.

Mark Distribution

Midterm	20%	(scheduled for 11:30 – 12:30 on Mar 2)
Lab Assignments	10%	(three physical labs and reports)
Problem Sets	20%	(normally four to five problem sets)
Final Exam	50%	(scheduled during the final exam period)

Students are expected to achieve at least 50% in both the final exam and combined term work (midterm, problem sets, and lab assignments) to pass the course. The exams are normally knowledge, skills and values based. We may include both a closed book and

open book format to the midterm and exam. The closed book sections will deal with basic knowledge and facts. These facts should be well understood by the naval architecture student and should be described in his/her own words. The open book section of the exam will test the student on skills and values. In general, this section will ask, "Are you able to apply your analytical skills to solve a particular ship problem and are you able to assess the results to provide a conclusion or recommendation for further action."

Textbook and References

There is no prescribed textbook for this course. Instead material is gathered from a variety of sources. Reference materials and notes can be found on *Connect* website. In addition, course material has been developed by the instructors for distribution to students. These notes and handouts will be available *on Connect* by the start of each class session. The handouts will be based on the text, other reference texts, and technical papers. The reference texts include:

1. *Ship Resistance and Propulsion* **(SR&P)** by Mollard, Turnock, & Hudson, Cambridge Univ. Press.

   This recently published textbook provides an excellent overview of resistance prediction and propulsion. It contains detailed worked examples that will be studied and modelled in tutorials and homework assignments.

   Available on line through UBC Library:

   http://ubc.eblib.com.ezproxy.library.ubc.ca/patron/FullRecord.aspx?p=713024

2. *Ship Resistance and Flow* **(SR&F)** by Larsson and Raven, SNAME Press

3. *Propulsion* **(Prop.)** by Kerwin and Hadler, SNAME Press

   These textbooks are part of the *Principles of Naval Architecture* series published by the Society of Naval Architecture and Marine Engineers (SNAME). These texts are often used as reference books in the industry. Copies can be purchased from The Society of Naval Architects and Marine Engineers (SNAME). We strongly recommend that students become members of SNAME student section at UBC.

4. *Mechanics of Wave Forces and Offshore Structures* **(MWF&OS)** by Isaacson and Sarpkaya, Van Nostrand Reinhold Co.

   This textbook is reference standard for students studying ocean engineering. It covers details on wave mechanics and interactions of waves on floating bodies.

5. *Hydrodynamics of High-Speed Marine Vehicles* **(HSMV)** by O. Faltinson, Cambridge Univ. Press.

This textbook covers not only high speed planning hulls but gives detailed analysis of hydrofoils and surface effects ships.

Available on line through UBC Library:

http://ezproxy.library.ubc.ca/login?url=http://app.knovel.com/web/toc.v/cid:kpHHSMV002/viewerType:toc/root_slug:hydrodynamics-of-high

6. *Marine Propellers and Propulsion* **(MP&P)** by J. Carlton, Butterworth-Heinemann.

   The text covers detailed design and selection of propellers in addition to important topics such as vibration and manufacture.

   Available on line through UBC Library:

   http://ezproxy.library.ubc.ca/login?url=http://app.knovel.com/web/toc.v/cid:kpMPPE0011/viewerType:toc/root_slug:marine-propellers-and

LAPTOPS

Students are required to own and use a laptop computer that has *Microsoft Office* installed. [*Office* is available for $79 via www.microsoft.com/student/office/en-ca/default.aspx or through the UBC Bookstore.] Some homework assignments will be based on the use of Microsoft Excel.

Lab Projects

The Civil Engineering flume tank recently underwent an upgrade to include a high speed towing carriage. During the term we expect to perform experiments to predict the resistance of a displacement vessel and a planning hull vessel. In addition, students will perform a few experiments that are part of the core mechanical engineering program. These experiments are particularly useful for Naval Architects. These labs include the National Gas Engine, Introduction to Fluid Power, Introduction to PLC's, and Welding and Fasteners. We are also working on an engine simulation lab at the BCIT Marine Training Campus. More information will be made available as things become finalized. Students must complete laboratory reports detailing the results, observations, and conclusions of the experiments.

Topic Outline (subject to changes)

Note: As indicated below, Professor Mikkelsen (JM) will be teaching Parts I and III of the course, and Professor Isaacson (MI) will be teaching Part II of the course.

Date	***Topic***	***Inst.***	***Content and Text Sections***
PART I (Stability, Boundary Layers and Ship Resistance)			
Jan. 6	Introduction & context	JM	History and nomenclature SR&P Chap.1 & 2

Jan. 7	Damage Stability	JM	Stability of a damaged vessel; calculations of floodable and permissible lengths; free communication effects Prepared Notes and handouts
Jan. 8	Damage Stability	JM	Case Study: Costa Concordia
Jan. 13	Fluid Mechanics Background	JM	Governing equations; Navier-Stokes equations SR&F 2.1 to 2.5
Jan. 14	Viscous Boundary Layers	JM	Navier-Stokes equations (cont.); laminar and turbulent boundary layers SR&F 6.2-6.3
Jan. 15	Viscous Boundary Layers	JM	2-D and 3-D Bodies (Flow Separation); roughness effects on turbulent boundary layers SR&F 6.4-6.6 SR&F 6.8-6.9
Jan. 20	Components of Ship resistance	JM	Boundary layers around a ship; wave-making resistance overview SR&F 5.5, 6.7 SR&P 3.1
Jan. 21	Components of Ship resistance	JM	Appendage drag; air resistance SR&P 3.2 SR&F 7.2, 7.3
PART II (Potential Flow Theory, Waves and Wave-Ship Interactions)			
Jan. 22 Jan. 27 Jan. 28	Potential Flow Theory	MI	Velocity Potential; stream function; complex potential; 2D and 3D boundary value problems; fundamental solutions; conformal mapping; solution methods; applications. (Notes issued) **Note: Tue/Thu lecture times moved to 12:00-1:30.** **(Jan 22 - Feb 26)**
Jan. 29 Feb. 4 Feb. 5	Ocean waves	MI	Linear wave theory; random waves; wave spectra; wave predictions (Notes issued) **Note: No lecture on Feb. 3rd.**
Feb. 10 Feb. 11 Feb. 12	Wave-ship interactions I – stationary vessels	MI	Fixed bodies in regular waves; freely floating vessel in regular waves; hydrodynamic coefficients and response amplitude operators (RAO's); Haskind relations; boundary integral and other solution methods (Notes issued)
Feb. 16-20	Reading Break		No Lectures
Feb 24 Feb 25	Wave-ship interactions II –	MI	Two- and three-dimensional ship waves; Kelvin wave system in deep and shallow water; encounter

Feb 26	vessels with forward speed		frequency; slow speed approximation; wave drift forces and motions; shallow and confined water effects; slender body hydrodynamics; strip theory for ship motions; hull interference. (Notes issued)
Mar. 2	Midterm	JM/ MI	Material will cover up to midterm break. Time and Location: TBD
PART III (Model testing, CFD and Propulsion)			
Mar. 3	Model Testing	JM	Physical Measurement of Resistance Components; Equipment; Data Acquisition; SR&P 7.1-7.4
Mar. 4	Model Testing	JM	Wake Fraction, Thrust Deduction, Relative Rotative Efficiency, Detailed Physical Measurement of Wake, Model Self Propulsion Experiments SR&P 8.1-8.7
Mar. 5 Mar 10	Model Testing	JM	Using Resistance Design Data for EHP Prediction Displacement Ship Data Series; Semi-Displacement; Wetted Surface Area SR&P 10.1-10.4
Mar 11	Planning Hullforms	JM	Introduction to Planning Hulls; Theory of Planning HSMV 9.1-9.3
Mar 12	Planning Hullforms	JM	Planning Hull Resistance, Savitsky's Method HSMV 9.4-9.7
Mar17	Model Testing	JM	Dynamic Stability Prediction for Planning Hulls
Mar 18	Computational Fluid Dynamics (CFD)	JM	Overview of Available Techniques; RANS Codes; Validation SR&P 9.1-9.4
Mar 19	Computational Fluid Dynamics (CFD)	JM	Tutorial Example: Intro to Star CCM+ (PACE Lab)
Mar 24	Computational Fluid Dynamics (CFD)	JM	Guest Lecture: Use of CFD in Vessel Design (to be confirmed)
Mar 25	Propulsion	JM	Review of Propeller Performance Curves; K_t K_q curves; Propulsive Coefficients SR&P 12.1 Prop 7.4-7.5
Mar 26	Propulsion	JM	Blade Element Theory, B_p - δ Curves MP&P 8.1-8.9
Mar 31	Propulsion	JM	Propeller Selection Using Performance Curves
Apr 1	Propulsion	JM	Cavitation; Criterion; Effects on Performance; Cavitation Check using Burrill Charts SR&P 12.2

			Prop 6.1-6.4, 6.8
Apr. 2	Propulsion	JM	Tutorial Example: Propeller Selection and Cavitation Check
Apr 7	Propulsion	JM	Propeller Noise; Prediction and Control; Impact on Marine Mammals. MP&P 10.1-10.7 Prop. 8.5
Apr 8	Propulsion	JM	Advanced Marine Vehicles; Surface Piercing Propellers; Waterjets; Ducted Propellers SR&P 16.2
Apr 9	Review	JM/ MI	Review of Material and Wrap-Up

Professional Conduct

Students are expected to uphold the principle that, in examinations and quizzes, they will not seek aid from others, nor give aid to others, nor make use of unauthorized materials or aids. More generally, students are deemed to be aware of and adhere to the relevant University regulations as provided in the University Calendar and in particular those relating to Academic Honesty and Standards, Attendance, and Academic Assessment.

http://www.calendar.ubc.ca/vancouver/index.cfm?tree=3,0,0,0,