

**The University of British Columbia
Department of Mechanical Engineering**

**MECH 488
Introduction to Ship Hydrodynamics**

Monday / Wednesday / Friday: 09.00-10.00

COURSE INSTRUCTOR: Dr. Chris McKesson, P.Eng., P.E.

CEME 2050

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Office Hours: any time the door is open (typically 09.00 – 16.00) or by appointment

Preferred contact is by e-mail

You are welcome to “friend” me on Facebook, but FB messages are not a good way to raise technical questions.

Also, I work a 40-hour week and often turn my electronics off (or go to sea) over the weekend.

COURSE OBJECTIVE

Mech 488 is an introductory course in Naval Architecture covering the fundamental hydrostatic and hydrodynamic principles related to the design of ships. Specific topics covered in this course include: ship nomenclature, the form of the hull, flotation and trim calculations, ship stability, loading, prediction of vessel resistance, propulsion selection, and vessel motions in waves.

New in 2016 I intend to go a little further in some of the hydrostatic and stability considerations, and this means that I will probably not complete the propulsion considerations. I have noted these changes in the detailed plan given below.

Since the enrollment in this course is normally modest (~25 students), we strive to develop a student friendly environment where lectures are more 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.

By the end of the course, students are expected to:

1. know all the principles, terms and coefficients related to the profession of Naval Architecture.

2. be able to develop a table of offsets and set of ship lines.
3. be proficient at calculating the draft and trim angle for a vessel under various loading conditions.
4. be able to determine the vessel's stability characteristics for both undamaged and damaged conditions.
5. be able to determine the vessel's stability characteristics when some fraction of her weight rests on the ground.
6. be able to understand and predict a vessel's resistance based on model test data and computer modelling.
- ~~7. be familiar with propulsion selection techniques including propeller charts.~~
- ~~8. be familiar with modern computer software techniques for vessel resistance prediction.~~

MARK DISTRIBUTION

Problem Sets	40%	(probably eight problem sets)
Midterm	20%	(given at, or near, week 7)
Final Exam	40%	(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 term project) to pass the course. The exams are normally knowledge, skills and values based. I plan to attempt having both a closed book and open book portion for the midterm and final exams. 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 are two prescribed textbooks for this course.

Ship Knowledge by Dokkum is an attractive and easy to read introduction to everything in ship design. It is an appropriate choice for students who do not intend to make a career of naval architecture.

PNA: "*Principles of Naval Architecture - Volumes 1 through 4.*" This textbook series is the most used reference book in the industry. Non-NAME students may access the full text of PNA through the UBC library on line, and thus need not purchase the hard copy. (If you take this option, you will probably want to print substantial chunks of the work for use in exams etc.) NAME students are recommended to purchase the book. Copies can be

purchased from The Society of Naval Architects and Marine Engineers (SNAME). I strongly recommend that students become members of SNAME student section at UBC. The Principles of Naval Architecture (PNA) is a six volume set that covers all topics related to Naval Architecture. Each volume has a student price of approximately US\$35.00

PNA is written largely as a reference book, and not a textbook. Students may benefit from a more tutorial approach, and may wish to consider any of the following supplemental works:

Introduction to Naval Architecture by T. Gillmer and B. Johnson. The text is well priced and provides a good overview of materials presented in the lectures.

Basic Ship Theory by K.J. Rawson and E.C. Tupper

This well written textbook serves as an excellent reference for this course. Copies of the textbook can be obtained through many of the online bookstores (amazon.com, chapters.ca, etc.) at a cost of approximately \$80.00. The main drawback with this text is that it does not contain as much additional materials compared to PNA. As such, it does make a valuable reference book, once the introductory courses are completed.

Principles of Yacht Design by Lars Larsson and Rolf Eliasson

This text written by two famous Swedish Naval architects is written primarily for sailing enthusiasts. It covers all the basics but is written at a level for non-naval architects. However, I appreciate the practicality of this textbook. If you are considering sailboat design, I recommend you obtain this text. It is also available through the Society of Naval Architects and Marine Engineers (cost approx. US\$60).

Naval Architecture for non-Naval Architects by Prof. Harry Benford

This text was written for yachtsmen, mariners, and other enthusiasts who wish to learn the principles of naval architecture without necessarily absorbing the theoretical and mathematical basis for those principles. Professor Benford has a half-century of experience teaching naval architecture to students who come in as non-naval architects, and he has a pleasant and engaging writing style. While it's true that five years from now you might be qualified to *write* this book, during your enrollment in MECH 488 you may benefit from *reading* this book. It is also available through the Society of Naval Architects and Marine Engineers (Student price: US\$30).

HOMEWORK

Assignments will usually be due two weeks after issue. I am new here and don't know what other courses you are taking, so if my due date conflicts badly with some big lab report in another class, please mention this when I give the assignment. I am happy to help manage the workload for all of us. However let me warn you of a couple of things:

Students find that my homework assignments look deceptively simple: The calculations are easy, but it takes a lot of work to think your way through the process. Don't wait until the last minute to discover you have underestimated the amount of work required. Late

submission of homework will be heavily penalized if it is done without my prior consent. (It is penalized somewhat less heavily if you let me know in advance.)

A word on homework preparation: Welcome to the professional world. Your boss will reject your work if you hand him a handwritten scrawl on a crumpled piece of paper. Your CLIENT will certainly reject such a product. For purposes of this class, I am your boss and your client. Make up your homework as you would for a customer. A format requirement is provided on CONNECT. In brief, this requires you to:

- write neatly and orderly
- describe the steps leading to the solution
- explain choices and assumptions you made
- summarize and discuss results with respect to their accuracy and significance (e.g. for example by comparing it with published data)
- summarize and discuss the impact these results have upon the design decision you are making. In other words: In light of this homework, so what? What does this mean to the ship, to the customer, to the project?

These elements will always be significant components of the grade in the homework

Much of the homework will require you to get familiar with a spreadsheet program (Excel, etc), writing small programs, or using commercial software packages. I will try to introduce these packages in class, but there will still be a fair amount of self-learning involved. You all have excellent computer skills, indeed you pick up some of this software faster than I do. My skill will be in teaching you the naval architecture that you are using the software for.

TOPIC OUTLINE (SUBJECT TO CHANGES)

Theme One: Ship Geometry

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| Week 1 | Introduction
Ship Nomenclature
Ship Geometry – Principal Dimensions & Coefficients of Form |
| Week 2 | Ship Lines (standard Naval Architecture vessel representation)
Table of Offsets
Parametric Representations of Curves
Fairness
B-Splines |
| Week 3 | Geometry of solids (ship hulls)
Review of Numerical Integration (Trapezoidal and Simpson's rules)
Numerical Calculation of Vessel Properties
Flotation and Trim Calculations
Displacement and the Center of Buoyancy |

Weight Changes

Theme Two: Ship Stability

- Week 4** Determination of the Metacenter
Introduction to Stability Criteria
Calculation of Initial and Small Angle Stability
Effect of Free Surfaces on Stability
Effect of Freely Suspended Weights on Stability
- Week 5** Calculation of Cross Curves of Stability
Calculation of the GZ Curve (General Stability Curve)
Designing for Static Stability
Dynamical Stability
Stability in Waves and Storms
General Inclining Experiment
- Weeks 6-8** Stability of a Damaged Vessel
Calculation of Floodable Length
Stability Regulations (Coast Guard, etc.)
- Weeks 9-11** Stability at large angles
Effect of cargo movement
Effect of on-board liquids
Effect of Grounding
Stability while Launching

Theme Three: Ship Resistance

- Weeks 11+** Dimensional Analysis
Froude's Law
Model Testing
Components of Resistance
Wave Resistance
Shallow Water Effects

PREREQUISITES

I will assume that you are comfortable with static equilibrium, basic $F=MA$ dynamics, basic fluid forces in the form $F = C_F \frac{1}{2} \rho S V^2$, and the relationship between torque, RPM, and power. If these concepts aren't clear to you I am happy to help, but you may wish to obtain a quick reference guide of some sort. (I am quick to use Wikipedia for this. I have trouble remembering the difference between a dot-product and a cross-product, or the function of the DEL operator.)

CONNECT

I will use CONNECT extensively to distribute course material, and to communicate using the CONNECT e-mail interface. Please make sure that you can access the course, and check the site regularly. I won't always notify you when I post something.

ACADEMIC DISHONESTY POLICY

The academic enterprise is founded on honesty, civility, and integrity. As members of this enterprise, all students are expected to know, understand, and follow the codes of conduct regarding academic integrity. At the most basic level, this means submitting only original work done by you and acknowledging all sources of information or ideas and attributing them to others as required. This also means you should not cheat, copy, or mislead others about what is your work. Violations of academic integrity (i.e., misconduct) lead to the breakdown of the academic enterprise, and therefore serious consequences arise and harsh sanctions are imposed. For example, incidences of plagiarism or cheating may result in a mark of zero on the assignment or exam and more serious consequences may apply if the matter is referred to the President's Advisory Committee on Student Discipline. Careful records are kept in order to monitor and prevent recurrences.

Cheating of any kind on an exam or quiz will not be tolerated. Plagiarism of another student's homework, class work, or project will not be tolerated. The first offense will result in a grade of "F" for the student(s) involved. If a second offense of cheating or plagiarism is determined, the matter will be discussed with the Chair of the Department.

ACCOMMODATIONS FOR STUDENTS WITH DISABILITIES

Students who qualify for services will receive the academic modifications for which they are legally entitled. Students who require academic accommodations and support at UBC due to a disability or ongoing medical condition must register with Access and Diversity. It is the responsibility of the student to register and follow the procedures for obtaining assistance.

CLASSROOM CONDUCT

In brief: I will treat you like a professional colleague. I suggest you treat me like your boss. This means that you pay attention, don't nap, don't talk amongst yourselves while the boss is talking. When the boss calls a meeting you come on time, not five, ten, fifteen minutes late.

But more important than your body being present is that your mind must be present. Firstly, I don't think you can learn this material without paying attention to the lectures - there isn't a text book to rely upon. Secondly, this is your first participation in a professional environment. This – Naval Architecture – is what you are going to do for a living. Participate in the class with the same respect you intend to display on the job.

GRAMMAR AND PRESENTATION

As an engineer, your work will achieve nothing until it is communicated successfully to your client, to the fabricator, or to your boss. I know a lot of bright engineers whose careers are limited by impaired communication skills. Take the time now to improve these skills - they are as important as your calculus. But just like your calculus, there are tools to help you.

Use correct grammar in your work. Use the right words, and spell them correctly. There are a lot of clients and bosses out there who, like me, will tune out after the third or fourth faux pas.

As engineers, you understand the precision of numbers. But ask any lawyer: Words have the same degree of precision. You would never write “5” when you mean “7.” You would never write ρ when you mean π . So don’t write “then” when you mean “than.” Learn to spell, learn to write, and learn to speak. This will serve you extremely well in your career.

In fact, it has been said that I am the sort of instructor who will give you extra points simply because you turned your homework in nicely bound and with a color cover sheet. It’s true, and it’s true because your boss and your client will react the same way. It won’t turn an F into an A, but it can certainly work the other way!

Fortunately, there are a lot of tools to help you. Most of you know about the red underlining that MS-Word will insert in your document, when it thinks you may have misspelled a word. For starters, make sure your copy of Word has the spelling and grammar checking turned on. But be careful - we have a lot of words that Microsoft doesn’t know!

Please don’t describe any “planning boats” when you mean to talk about planing boats! But did you also know that Word will insert green underlining if it thinks that your grammar can be improved? You may need to turn on the “check grammar in this document” feature to get this, but I do find this feature useful.

As a rule of thumb, I would advise you to always accept Word’s suggestions for grammar. Word will often tell you that you have written in passive voice, or that the sentence is too long, and so forth. Most of the time this advice is very good, and you should follow it.

Many people reject Word’s suggestions, because they say “but I like to use this word.” or “but that’s not my writing style.” If you are Hemingway then you are qualified to have your own style, but for the rest of us I will go so far as to say that if you accept all of Word’s grammar suggestions then your document will be better than if you try to pick and choose. What I mean is, that Word “gets it wrong” less often than you. Or me!

Finally, buy a copy of “The Elements of Style” by Strunk and White, and download “The Literate Naval Architect” from the course CONNECT site. These two books have been my faithful companions for many years.