University of Victoria **Department of Mechanical Engineering**

MECH 450F/580 COURSE OUTLINE
INTRODUCTION TO OCEAN ENGINEERING

Spring 2014

Course Web Site

See the "MECH 450F" Moodle site on the UVic Moodle system.

Course Numbers: **MECH 450F A01: 22116** **MECH 580 A04: 23729**

Instructor

Dr. Brad Buckham
Phone: 250.721.6035
Email: bbuckham@uvic.ca

Office Hours

Days: M
Time: 1:30pm-4:00pm
Location: EOW 531

Lectures

A – A01 / A04
Section(s):
Days: T, W, F
Time: 9:30-10:20
Location: ELL 160

Note: The instructor has requested a room change for the lecture. Students will be emailed if this request is accommodated.

Teaching Assistants

Mr. Kush Bubbar
Phone: 250.472.4202
Email: kbubbar@uvic.ca

Laboratories

Section(s): B01
Days: W
Time: 1:00pm-4:00pm
Location: ELW 307

The laboratory session will not be utilized every week. In the labs, students will be introduced to new software, complete software tutorials and work on assignment problems. Students are encouraged to use the computer lab facilities outside of scheduled lab hours.

Required Text

There is no required textbook for MECH 450F or MECH 580 A04. Course notes and assignment and project materials will be provided on the Course's Moodle site as the term progresses. Students are responsible for monitoring the Moodle site and downloading material as it is made available.

Assessment method	# of occurrences	Percentage of Final Grade
Assignments	4-5†	65%
Computational Labs	2	15%
ProteusDS Design Project	1	20%

†Depending on the progress of the lectures, a fifth assignment may be introduced. The assignment component of the final grade will not change from 80%.

Course Content

MECH 450F – INTRODUCTION TO OCEAN ENGINEERING: focuses on the application of mechanical engineering fundamentals to the mathematical modeling, analysis, simulation and design of dynamic offshore infrastructure. In the context of simulation and design, advanced software, *ProteusDS* developed by the Victoria based company Dynamic Systems Analysis Ltd, will be used to assemble time domain simulations of moored floating platforms. The procedures through which simulation results are manipulated to extract data that can inform design decisions will be demonstrated and a final project will provide opportunity to execute simulation based design of a moored offshore platform/system.

During the lecture periods, engineering fundamentals necessary to the completion of the assignment work will be presented. In the context of a student's work with ProteusDS, lecture material provides an understanding of how calculations are performed in the software, but the laboratory periods are used to demonstrate how the software is applied to generate time series data. Through the combination of the assignment and laboratory work, students will be exposed to different levels of approximation to hydrodynamic forces acting over a moored system.

The lectures will attempt to cover the material presented in the textbook as follows:

Module	Topics Covered	Dates (mm.dd)
1	Fourier analysis. Fourier's hypothesis, Fourier series & the Fourier transform; wave spectra: spectral moments, significant wave height & wave statistics.	01.08 – 01.17
2	Airy waves. Derivation of linear wave kinematic equations; shallow and deep water conditions.	01.17 – 01.24
3	Rigid body dynamics. Newton Euler equations; angular velocity and kinematic transformations; inertia transformations.	01.28 - 02.05
4	Hydrodynamics. Underwater vehicle/platform dynamics; Morrison's equation; drag and added mass	02.05 - 02.14
5	Mooring Dynamics. Lumped mass modeling of mooring cables; Numerical integration of cable equations; quasi-static approximation to mooring forces.	02.18-02.26
6	Wave forces. Froude Krylov force, radiation & diffraction; potential theory and coefficient calculations.	02.28 – 03.12
7	Frequency domain analysis. Linearizing equations of motion; natural modes of motion; Response Amplitude Operator calculations.	03.14 – 03.28
8	Project preparation. Design standards, ProteusDS simulation strategies, post processing of ProteusDS data.	04.01-04.04
9	**Final Project Due**	**DUE 04.23**

Learning Outcomes

By the completion of MECH 450F, students will be able to:

1. Decompose a wave elevation time series into a discrete wave power spectra, synthesize a wave elevation time series from a wave power spectra.

2. Calculate spectral moments, significant wave height and energy period associated with a wave spectra.
3. Apply knowledge of a empirically derived wave spectra models to synthesize wave spectra from basic statistical parameters like significant wave height, peak period, etc.
4. Classify Airy waves as deep or shallow water waves and apply the appropriate wave kinematics in the study of floating platform dynamics.
5. Form the equations of motion for a rigid body using a local frame of reference and the Euler angles associated with that frame.
6. Numerically integrate the state of a submerged or floating body forward in time using common numerical integrators.
7. Calculate the mooring line forces on a floating or submerged rigid body.
8. Apply Morrison's approximation to the hydrodynamic forces within the rigid body equations of motion.
9. Estimate the hydrodynamic coefficient values used in Morrison's approximation based on the Reynolds number and Keulegan-Carpenter (KC) number.
10. Apply wave radiation and diffraction forces within the rigid body equations of motion.
11. Estimate the hydrodynamic coefficient values used in the calculation of the radiation and diffraction forces based on the wave kinematics being experienced.
12. Complete a frequency domain analysis of the motion of a rigid body (floating or submerged).

Office Hours

Students are welcome, and encouraged, to make inquiries regarding lecture material, assignment problems, and project work at any time but instructor availability can only be ensured during scheduled office hours. To make efficient use of meeting times, students are encouraged to discuss problems with their colleagues and come as a group to meet with the instructor. Office Hours provided on the first page of this outline are tentative. Should a reorganization of the instructor office hours be required, notice will be provided in lecture period.

ASSIGNMENTS

Four problem sets will be distributed over the course of the term via the course Moodle site.

Assignments are to be completed in teams of 2 students. Students are required to work with a different partner on each assignment.

The tentative assignment schedule is as follows:

Assignment #	Modules	Start	End
1	1-2. Fourier Analysis & Airy Waves	01.17	01.31
2	3. Rigid body dynamics	02.05	02.18
3	4-5. Hydrodynamics & Mooring dynamics	02.21	03.07
4	6-7. Wave Forces & Frequency domain	03.12	04.04

Laboratories

The laboratory sessions will be used to complete instruction and training on the use of ProteusDS. Not all of the laboratory periods will be used. Announcement of active laboratory sessions will be provided in lecture periods. The laboratories will include instructional work that is expected to help students develop proficiency with *ProteusDS* software as well as computational assignments with stated deliverables that the students will be responsible for submitting in report format.

Lab reports are to be completed in groups of 4 students. The Lab group can remain the same throughout the term.

Final Project

The final project will be a design problem approved by the course instructor. Students will be asked to propose project topics, including a research question, prior to **31 January 2014**. Using ProteusDS, students will be asked to create a feasible moored platform design and demonstrate that the design satisfies standards applied in the field of offshore engineering.

Projects are to be completed in the laboratory groups of 4 students.

MECH 580 A04

The graduate curriculum will follow that of the MECH 420 course. However, rather than working in teams of 4 for the project, student enrolled in MECH 580 A04 will complete the project in teams of 2.

Course policies:

Announcements:

Announcements of changes in the contents, delivery and/or policies used in the course will be made in lecture period.

HW Assignments & Lab reports:

1. Hardcopy submissions must be completed on Engineering computation paper or prepared using a word processor to be accepted. **Any other paper will be rejected**.

2. HW Assignments are to be submitted to the instructor before 4:30pm on the due date. A course drop box will setup and the location of the box will be provided as soon as possible.

3. Late Submissions will not be accepted.

4. Assignments are to be completed in teams of 2 people. One submission per team. Students must work with a different partner on each assignment.

5. Lab reports and projects are completed in teams of 4 people. The lab/project teams will remain the same throughout the term.

Projects:

1. The project posters will be submitted in electronic format. The poster content is to include text, images, plots and tables as needed to communicate the findings of the design study.

Final Grade

The final grade obtained from the above marking scheme will be based on the following percentage-to-grade point conversion:

90 ≤	A+	≤	100	
85 ≤	A	<	90	
80 ≤	A-	<	85	
77 ≤	B+	<	80	
73 ≤	B	<	77	
70 ≤	B-	<	73	
65 ≤	C+	<	70	
60 ≤	C	<	65	
50 ≤	D	<	60	
0 ≤	F	<	49	Fail, no supplemental exam.
	N			Fail, did not write examination or otherwise complete course requirements by the end of the term or session; no supplemental exam.

Guidelines on Religious Observances

1. Where classes or examinations are scheduled on the holy days of a religion, students may notify their instructors, at least two weeks in advance, of their intention to observe the holy day(s) by absenting themselves from classes or examinations.
2. Instructors will provide reasonable opportunities for such students to make up work or missed examinations.
3. Students will cooperate by accepting the provision of reasonable opportunities for making up work or missed examinations.
4. The University Secretary's Office will distribute a multi-faith calendar to each academic unit annually.

Commitment to Inclusivity and Diversity

The University of Victoria is committed to promoting, providing and protecting a positive, supportive and safe learning and working environment for all its members.

Standards of Professional Behavior

You are advised to read the Faculty of Engineering document Standards for Professional Behaviour at http://www.engr.uvic.ca/policy/professional-behaviour.php which contains important information regarding conduct in courses, labs, and in the general use of facilities.

Cheating, plagiarism and other forms of academic fraud are taken very seriously by both the University and the Department. You should consult

http://web.uvic.ca/calendar2009/FACS/UnIn/UARe/PoAcI.html for the UVic policy on academic integrity. *"The University reserves the right to use plagiarism detection software programs to detect plagiarism in essays, term papers and other assignments." Pg 32, University Calendar*

Attendance: Students are expected to attend all scheduled lectures and tutorials. It is entirely the students' responsibility to recover any information or announcements presented in lectures from which they were absent.

Electronic Devices: No unauthorized *audio* or video recording of lectures is permitted. Calculators are only permitted for examinations and tests if explicitly authorized and the type of calculator permitted may be restricted. No other electronic devices (e.g. cell phones, pagers, PDA, etc.) may be used during examinations or tests *unless explicitly authorized*.