University of Dundee

CE50031
Hydrodynamics of Fluid-Structure Interaction

2017-2018 Academic Year

Civil Engineering
School of Science and Engineering
University of Dundee
11 September, 2017

Module Instructor

Dr. Masoud Hayatdavoodi

Civil Engineering Discipline
J10 Fulton Building
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https://sites.dundee.ac.uk/masoud/

Hydrodynamics of Fluid-Structure Interaction

- **MARINE HYDRODYNAMICS**
  - **Principles of the motion of viscous and ideal fluids**
  - **Laminar and turbulent boundary layers**
  - **Water wave mechanics**

- **FLUID-STRUCTURE INTERACTION**
  - **Wave and current loads on structures**
  - **Diffraction, radiation problems**
  - **Response of floating and submerged bodies**

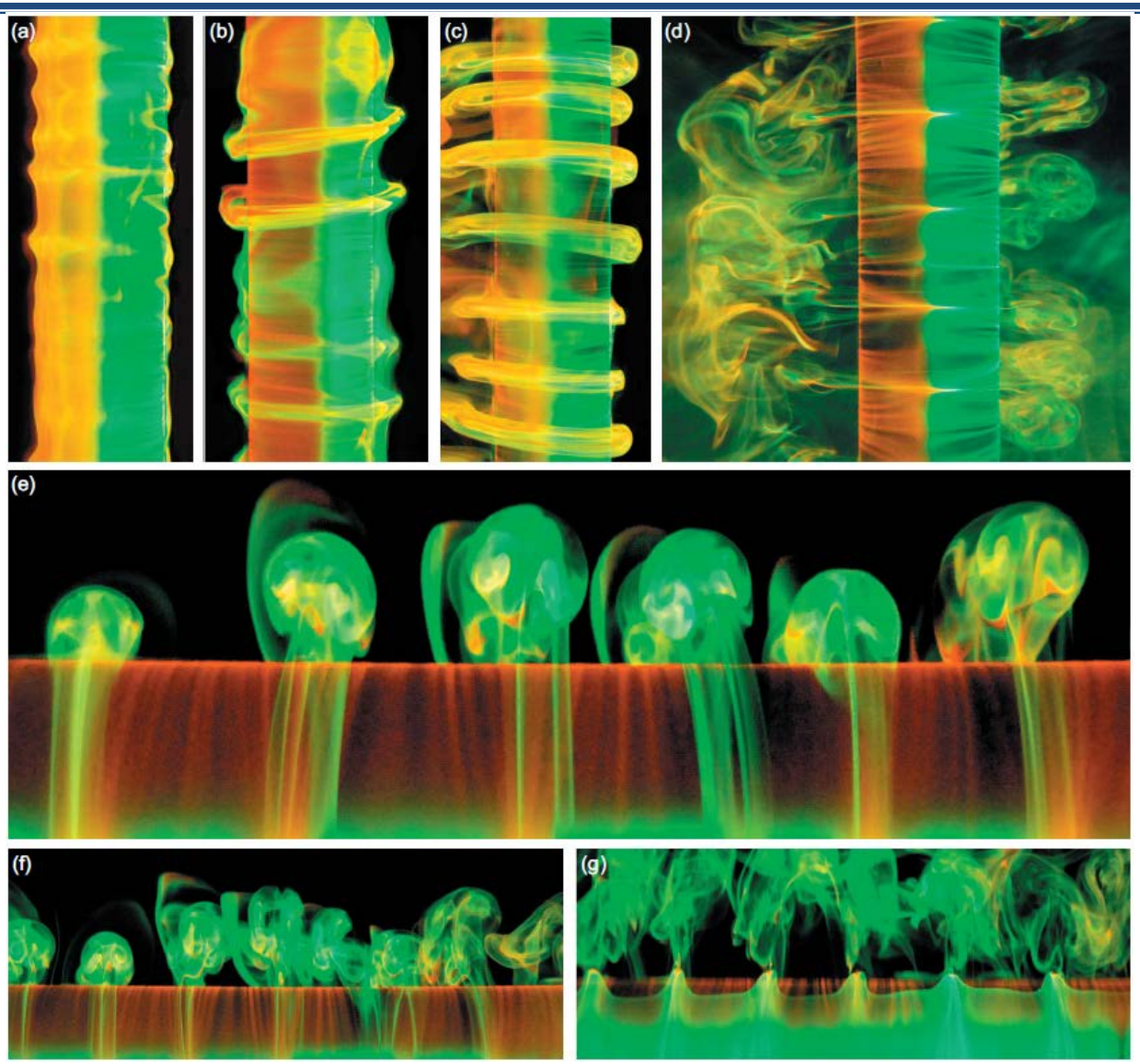
Fluid-Structure Interaction

Powerful Waves vs Lighthouse (Photo: Jean Guichard)

Wave-Structure Interaction

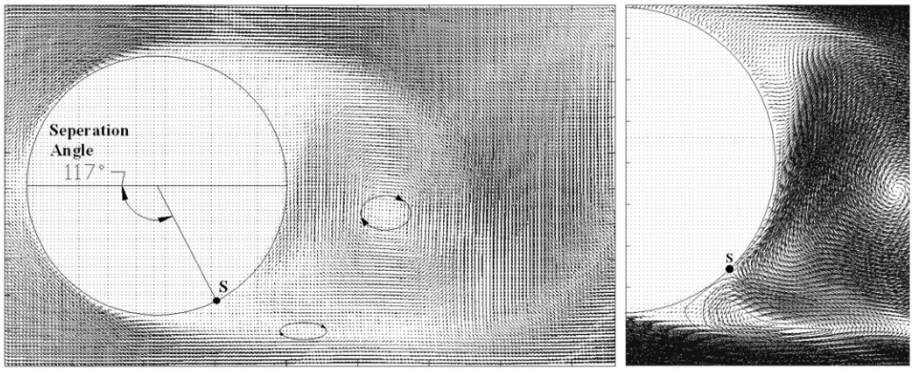
Photo by Joe Richard

Fluid-Structure Interaction



(Canal and Pawlak, PoF, 2008)

Fluid-Structure Interaction



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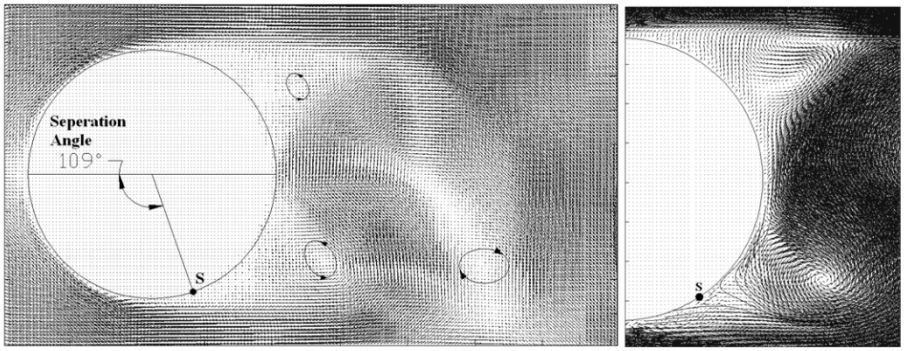

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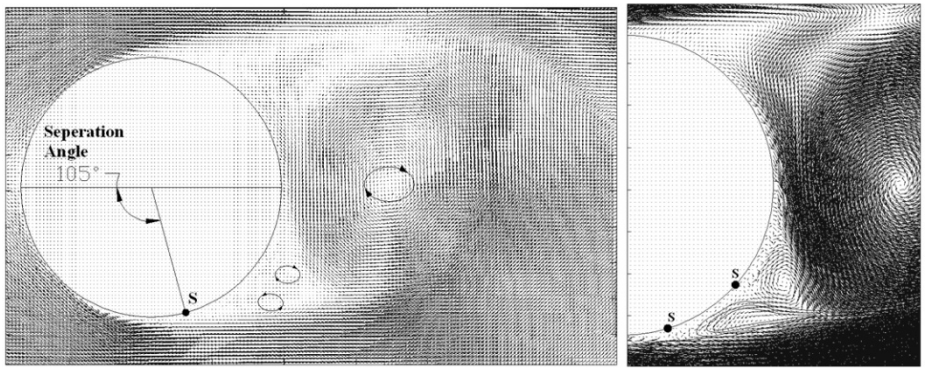

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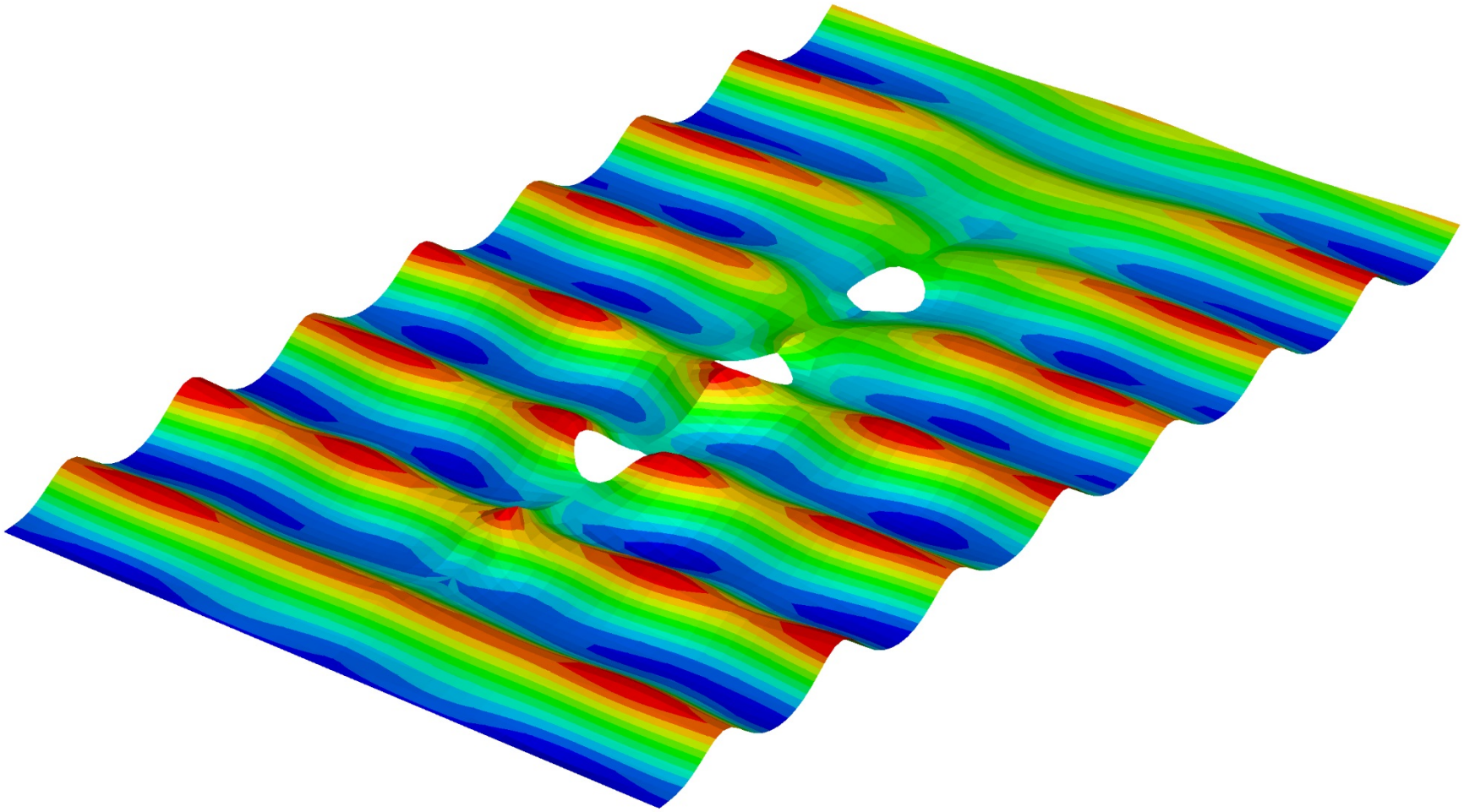
Wave-Structure Interaction



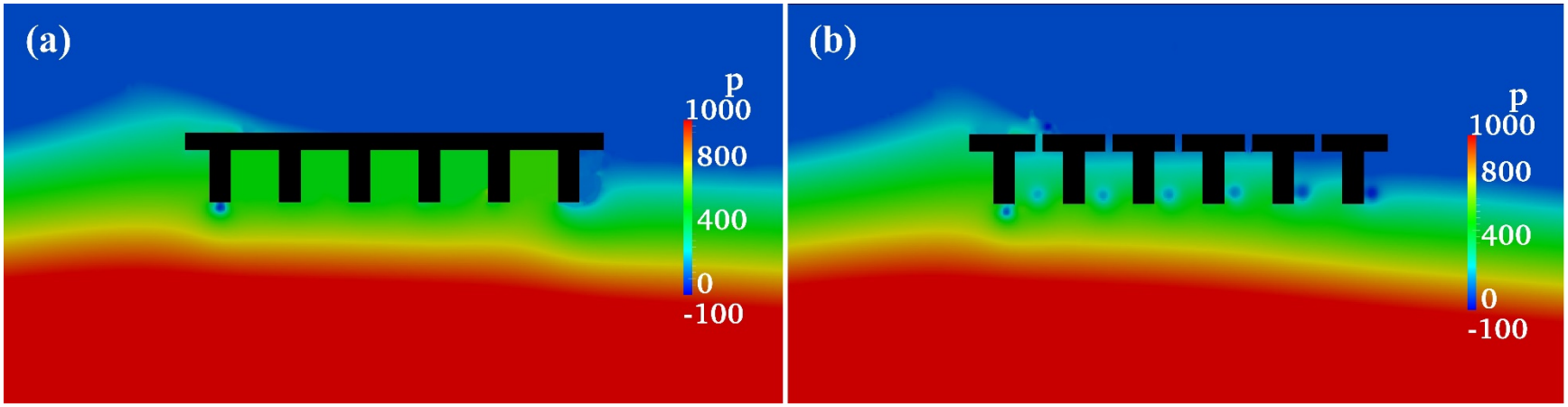
Wave-Structure Interaction

Mario Tama, Getty Images

Wave-Structure Interaction

Photo from washingtonpost.com

Wave-Structure Interaction



Wave Impact

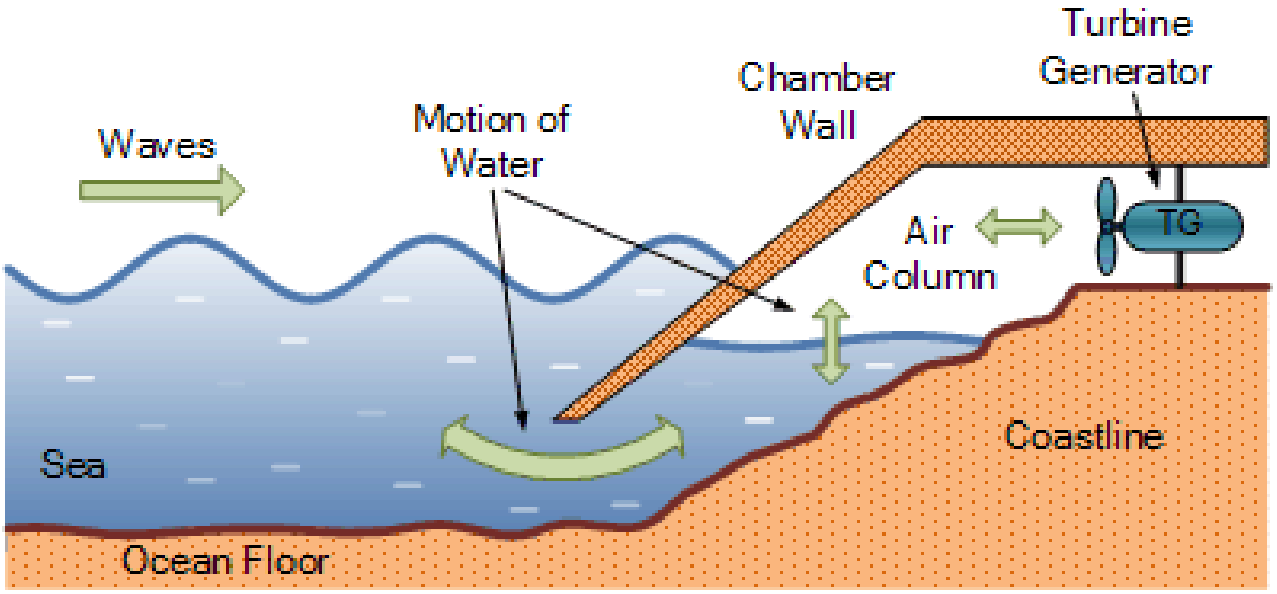
http://www.enteratedealgo.es

Waves Impact

Photo by Reza Alam

Wave Energy

- Ocean Wave Energy Converters
- Oscillating Wave Column



http://www.alternative-energy-tutorials.com

- Submerged Wave Energy Device

Wind Energy

Journal of Ocean Engineering and Marine Energy

Approach

- Observational
- Experimental
- Theoretical
  - Analytical
  - Computational

Aims of CE50031

- Analyse the theoretical and experimental principles of fluid-structure interaction problems in ocean engineering

- Develop and extend understanding of engineering principles as they relate to the design of floating or fixed structures in the oceans.

Topics Covered in CE5003

- The Motion of Viscous and Ideal Fluids
- Water Wave Mechanics
- Wave Diffraction and Wave Loads
- Hydrodynamics of Floating Bodies
- Hydroelasticity
- Random Waves and Wave Forces.

Classes (Semester 1)

- Lectures
  - Monday, 4-5 PM, Fulton H2
  - Wednesday*, 2-3 PM, Fulton H2

    *Wednesday of weeks 4, 8 and 10, 4-5 PM, Fulton H2

- Tutorials, Weeks 4, 6, 8 & 10
  - Friday, 11 AM-12 PM, Fulton H2

- Laboratory, Weeks 6-12
  - Thursday, 2-4 PM, Fulton F13 (Students will limited sessions during this period. Dates/times will be given in class.)

Assessments

- Coursework: 40%
  - Six assignments total (three per semester).
  - One/two laboratory assignments.
  - The minimum pass mark for the combined coursework is 30%.
- Degree Exam: 60%
  - The minimum pass mark for the degree examination is 30%.

Module Schedule

2017 September

MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY	SUNDAY
28	29	30	31	01	02	03
04	05	06	07	08	09	10
11 **Module Introduction**	12	13 **Preliminaries**	14	15	16	17
18 **Indicial Notation**	19	20 **Cartesian Tensors**	21	22	23	24
25 **Dimensional Analysis**	26	27 **Viscous Fluid Motion**	28	29	30	01
02	03	Notes:				

Module Schedule

2017 October

MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY	SUNDAY
25	26	27	28	29	30	01
02 Viscous Fluid Motion	03	04 Viscous Fluid Motion	05	06 Tutorial 1	07	08
09 Viscous Fluid Motion	10	11 Viscous Fluid Motion	12	13	14	15
16 Ideal Fluid Motion	17	18 Ideal Fluid Motion	19 Laboratory	20 Tutorial 2	21	22
23 Ideal Fluid Motion	24	25 Ideal Fluid Motion	26	27	28	29
30 Linear Wave Theory	31	Notes:				

Module Schedule

2017 November

MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY	SUNDAY
30	31	01 Linear Wave Theory	02 Laboratory	03 Tutorial 3	04	05
06 Linear Wave Theory	07	08 Particle Kinematics and Dynamics	09	10	11	12
13 Particle Kinematics and Dynamics	14	15 Particle Kinematics and Dynamics	16 Laboratory	17 Tutorial 4	18	19
20 Wave Power and Energy	21	22 Nonlinear Wave Theories	23 Laboratory	24	25	26
27 Reading Day; No Class	28	29 Reading Day; No Class	30	01	02	03
04	05	Notes:				

Recommended References

- **Text Books:**

- **Newman, John N. (1977), Marine Hydrodynamics, The MIT Press, 432 pp., ISBN: 978-0262140263.**
- **Batchelor, G.K. (2000), An Introduction to Fluid Dynamics, Cambridge University Press, 658 pp., ISBN: 978-0521663960.**
- **Kundu, Pijush K., Cohen, Ira M., Dowling, David R. (2011), Fluid Mechanics, Academic Press; 5 edition, 920 pp., ISBN: 978-0123821003.**
- **Currie, I.G. (2012), Fundamental Mechanics of Fluids, CRC Press, 603 pp., ISBN 978-1439874608.**
- **Chakrabarti, S.K. (2003), Hydrodynamics of Offshore Structures, WIT Press / Computational Mechanics, 464 pp., ISBN: 978-0905451664.**
- **Sarpkaya, Turgut and Isaacson, Michael (1981), Mechanics of Wave Forces on Offshore Structures, Van Nostrand Reinhold Company; First edition, 651 pp., ISBN: 978-0442254025.**
- **Le Méhauté, Bernard (1976), An Introduction to Hydrodynamics and Water Waves, Springer Berlin Heidelberg, 322 pp., ISBN: 978-3-642-85569-6.**
- **Lighthill, James (2001), Waves in Fluids (Cambridge Mathematical Library Series), Cambridge University Press; 2 edition, 524 pp., ISBN: 978-0521010450.**
- **Dean, Robert G. and Dalrymple, Robert A. (1991), Water Wave Mechanics for Engineers & Scientists (Advanced Series on Ocean Engineering-Vol. 2), World Scientific Pub Co Inc, 353 pp.**
- **Whitham, G. B. (1999), Linear and Nonlinear Waves, Wiley-Interscience, 660 pp., ISBN: 978-0471359425.**

Recommended References

- **Online References:**
  - **Journée, J.M.J. and Massie, W.W. (2001), Offshore Hydromechanics, Delft University of Technology, First Edition, 570 pp., available online at: http://www.shipmotions.nl/DUT/LectureNotes/OffshoreHydromechanics.pdf**
  - **Le Mehaute, B. (1976), An introduction to hydrodynamics and water waves, Springer-Verlag Berlin Heidelberg, 323 pp., 978-3-642-85567-2. https://repository.library.noaa.gov/view/noaa/10669/noaa_10669_DS1.pdf**
  - **Dhanak, M. R. and Xiros, N. I. (Eds.), (2016). Springer Handbook of Ocean Engineering, Springer, 1345 pp., ISBN 978-3-319-16649-0. http://www.springer.com/gb/book/9783319166483 (Available to UoD students free of charge through the library links.)**

More Information

University of Dundee

CE50031 Hydrodynamics of Fluid-Structure Interaction *MODULE GUIDE and SYLLABUS*

MODULE INFORMATION
CE50031 Hydrodynamics of Fluid-Structure Interaction
Semester 1 and 2, 2017-2018 Academic Year

MODULE INSTRUCTOR
Masoud Hayatdavoodi, Ph.D.
Lecturer
School of Science and Engineering
Office: Fulton Building, J10
E-mail: mhayatdavoodi@dundee.ac.uk
Website: https://sites.dundee.ac.uk/masoud/

SEMESTER 1 CLASS SCHEDULE
- **Lectures:**
  Weeks 1-12, Monday, 04:00PM - 05:00PM at Fulton H2
  Weeks 1-3, 5-7, 9, 11-12, Wednesday, 02:00PM - 03:00PM at Fulton H2
  Weeks 4, 8, 10, Wednesday, 04:00PM - 05:00PM at Fulton H2
- **Tutorials:** Weeks 4, 6, 8 and 10, Friday, 11:00AM - 12:00PM at Fulton H2
- **Laboratory:** Weeks 6-12, Thursday, 2:00PM - 04:00PM at Fulton F13, Hydraulics Lab

OFFICE HOURS
Monday: 03:00PM-04:00PM
Wednesday: 03:00PM-04:00PM
Friday: 03:00PM-04:00PM
And by appointments.

GRADING

Written Assignments (six over the year) *	30%
Laboratory Assignments (two over the year)*	10%
Final Examination **	60%

* The minimum pass mark for the combined coursework is 30%.
** The minimum pass mark for the final examination is 30%.

GRADING SCALE
A $\geq 70\%$
B $\geq 60\%$
C $\geq 50\%$
D $\geq 40\%$
F $< 40\%$
For more information see:
https://www.dundee.ac.uk/governance/policies/policy-taught-provision/

REFERENCES
Textbooks

- Newman, John N. (1977), Marine Hydrodynamics, The MIT Press, 432 pp., ISBN: 978-0262140263.
- Batchelor, G.K. (2000), An Introduction to Fluid Dynamics, Cambridge University Press, 658 pp., ISBN: 978-0521663960
- Kundu, Pijush K., Cohen, Ira M., Dowling, David R. (2011), Fluid Mechanics, Academic Press; 5 edition, 920 pp., ISBN: 978-0123821003.

Available on:

(i) My Dundee portal

(ii) https://sites.dundee.ac.uk/masoud/

Communications

- My Dundee portal
- https://sites.dundee.ac.uk/masoud/
- Office Hours:

  Monday, Wednesday, Friday

  3-4 PM, J10 Fulton Building

  And by appointment

- Email: MHayatdavoodi@dundee.ac.uk