Imperial College London

Module Outline

# Fluid Mechanics 2

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| Module Code | CIVE50005 | FHEQ Level | Level 5 |
| Pre-requisites | N/A | Co-requisites | N/A |
| Teaching Term | Autumn and Spring | | |
| Primary Department | Civil & Environmental Engineering | | |
| Module Leader | Swan, Chris | | |
| Additional Teaching Departments | N/A | | |
| Teaching Staff | Swan, Chris (CS); Burridge, Henry (HB) and Ma, Li (LM) | | |

| Programmes on which the Module is delivered | Core/Elective |
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| MEng Civil Engineering (H201) | Core |
| MEng Civil Engineering with a Year Abroad (H202) | Core |
| Civil Engineering (H21E) | Core |

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| Module Overview | This module builds on the core fluid mechanics module of the First Year, seeking to introduce the additional complexities associated with unsteady fluid flows, two-dimensional flows and the description of real (rather than an ideal) fluids; the latter introducing the concepts of laminar and turbulent flows.<br>These developments will be introduced in the context of modelling surface gravity waves, the loads on offshore structures, steady flow in pipes, pipe systems and open channel flows; the latter including gradually varied flow.<br>The course includes a two-day design class held towards the end of January. |
| Learning Outcomes | Upon successful completion of this module students will be able to:<br>• Explain the fundamental physics of fluid flows, particularly in the context of unsteady flows, two-dimensional flows and the description of real (rather than an ideal) fluids<br>• Explain the governing flow equations and employ these in the description of several important Civil Engineering flows.<br>• Understand the simplifying assumptions on which these equations rely, when they can be applied and when they should not.<br>• Specific examples will concern gravity waves, and the flow in pipes and open channels. Prepare simplified outline designs for a wide range of hydraulic structures. |

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| | • Explain the physical origins of the fluid loads acting on a broad range of offshore structures<br>• Appreciate how the magnitude of the various loading components varies with the flow regime and the extent to which they are dependent upon steady and unsteady fluid flows. |
| Description of Content | 1. Introduction to ocean engineering; waves, 2-D unsteady flows (CS).<br>2. Mass continuity and irrotationality (CS).<br>3. Potential flows and the unsteady energy equation (CS).<br>4. Small amplitude wave theory (CS).<br>5. Waves advancing into shallow water (CS).<br>6. Wave energy and group velocity (CS).<br>7. Flow around a vertical column; Reynolds number effects (CS).<br>8. Fluid loads in steady flow (CS).<br>9. Fluid loads in unsteady flow (CS).<br>10. Morison's equation; design applications (CS).<br>11. Real fluids: Newton's law of viscosity (HB).<br>12. The Governing Equations: Review of the Euler equation (HB).<br>13. The Governing Equations: Introduction to Navier-Stokes (HB).<br>14. Laminar flows and turbulent flows (HB).<br>15. Steady pipe flow; boundary resistance and the Moody diagram (HB).<br>16. Boundary layer profiles (HB).<br>17. Pipe systems: energy losses (HB).<br>18. Pipe systems: pumps and networks (HB).<br>19. Gradually varied flow: governing equations, natural channels, and uniform flow (HB).<br>20. Gradually varied flow: surface profiles (HB).<br>21. A two-day design project concerning the fluid loads acting on a fixed jacket structure installed as part of an offshore wind farm. (LM). |
| Assessment | |
| Assessment information will be provided separately. | |

| Learning & Teaching Hours | Independent Study Hours | Placement Hours | Total Hours |
|---|---|---|---|
| 40 | 131.5 | 0 | 187.5 |
| ECTS Credit | 7.5 | CATS Credit | 15 |
| Date of introduction | 1/10/2020 | Date of Last Revision | 2/9/2020 |

## Reading Lists:

Category as defined by Central Library:
C = Core, S = Supplementary

| | |
|---|---|
| C | Water Wave Mechanics for Engineers and Scientists. Dean, R.G. and Dalrymple, R.A. (1984). World Scientific. |
| C | Fundamentals of Fluid Mechanics. Gerhart P.M., Gross, R.J., Hochstein, J.I. (1992). Addison-Wesley. |
| C | Elementary Fluid Mechanics. Street, R.L., Watters, G.Z. and Vennard, J.K. (1996). John Wiley & Sons. |
| S | Water waves. Stoker, J.J. (1992). Wiley |
| S | Dynamics of offshore structures. Patel, MH. (1990). Butterworth-Heinemann |
| S | Mechanics of wave forces on offshore structures. Sarpkaya, T. and Isaacson, M. (1981). Van Nostrand Reinhold |
| S | Open Channel Flow. Henderson, F.M. (1966). MacMillan. |
| S | Mechanics of Fluids. Massey, B. (1998). Stanley Thornes. |
| S | Fluid Mechanics for Civil Engineers, Webber, N.B. (1971). Chapman & Hall |
| S | Boundary Layer Theory. Schlichting, H. (1979). McGraw-Hill |
| S | Mechanics of Fluids, Potter, M.C. & Wiggert D.C. (2002). Brooks/Cole |
| S | An Album of Fluid Motion, van Dyke, M. (1982). The Parabolic Press |