The Hong Kong Polytechnic University

Subject Description Form

Subject Code	CSE6017
Subject Title	Turbulent Flow and Modelling
Credit Value	3
Level	6
Pre-requisite/ Co-requisite/ Exclusion	Recommended background knowledge: Students should have a basic study background of fluid mechanics and/or hydraulics; and elements on coding using Matlab, Python, Fortran or equivalent programming languages.
Objectives	1. To provide students a better understanding of the main aspect of turbulent flows in terms of momentum, energy and mass transport. 2. To provide students a rational basis for devising turbulent flow analysis strategies. 3. To provide students with the knowledge about the different numerical modelling & data analysis approaches. 4. To provide students with in-depth analysis ability of turbulent flows in different contexts.
Intended Learning Outcomes	Upon completion of the subject, students will be able: a. to formulate and develop mathematical models for turbulent flow prediction. b. to apply knowledge in the analysis of vorticity and energy budgets for turbulent flows; and c. to perform critical thinking on design/research methods and solutions to be applied to their research fields
Subject Synopsis/ Indicative Syllabus	**Keyword Syllabus** 1) Fundamentals (6 hrs) The nature of turbulence and its origin, lengths scales in turbulent flows, the statistical description of turbulence 2) Turbulent transport of momentum and energy (9 hrs) Reynolds equation, Kinetic energy budget and the energy cascades, vorticity dynamics, Free shear flows, wall bounded flows 3) Turbulence modelling and simulations (9 hrs) Introduction to the different turbulent modelling approaches (DNS, LES, RANS); turbulent viscosity models (one-equation; two-equations models); Reynolds stress models

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<tr><td></td><td>4) Turbulent flows analysis (6 hrs)
Coherent flow structures, 2D turbulence; spectral analysis of turbulent flows

5) Applications (9 hrs)
Showcase of different turbulent flows applications: geophysical turbulence; indoor turbulent air circulation; aerodynamic applications (wind turbine; hydraulic and gas turbines)</td></tr>
<tr><td>Teaching/Learning Methodology</td><td>1. Lectures to deliver teaching materials. Lectures will provide fundamental methods and practical approaches to the students.
2. Students should explore journal papers on new methods, advanced techniques or basic theory related to the subject content and their study background & research field.
3. Tutorials will provide chances to the students to discuss their individual applications in detail with the lecturer in person. This is useful for best fitting the needs for the students with different backgrounds. The reports will relate to the subject contents and students' background.
4. The students will be asked to directly apply the methodologies of analysis presented during the lectures by preparing their own scripts and codes (Matlab, python, Fortran, or others proposed by the students).</td></tr>
<tr><td>Assessment Methods in Alignment with Intended Learning Outcomes</td><td>
<table>
<tr><td rowspan="2">Specific assessment methods/tasks</td><td rowspan="2">% weighting</td><td colspan="6">Intended subject learning outcomes to be assessed (Please tick as appropriate)</td></tr>
<tr><td>a</td><td>b</td><td>c</td><td></td><td></td><td></td></tr>
<tr><td>1. Assignments</td><td>50%</td><td>√</td><td>√</td><td>√</td><td></td><td></td><td></td></tr>
<tr><td>2. Project report</td><td>50%</td><td>√</td><td>√</td><td>√</td><td></td><td></td><td></td></tr>
<tr><td>Total</td><td>100 %</td><td colspan="6"></td></tr>
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Explanation of the appropriateness of the assessment methods in assessing the intended learning outcomes:

Continuous assessment is based on

1) Assignments on simple turbulent flows modelling and data analysis (50%).

2) Report on individual student project (50%).</td></tr>
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Student Study Effort Expected	Class contact:	
	▪ Lectures and Tutorials	39 Hrs.
	▪ Examination	-
	Other student study effort:	
	▪ Reading of reference materials	36 Hrs.
	▪ Assignments	30 Hrs.
	▪ project	30 Hrs.
	Total student study effort	135 Hrs.
Reading List and References	**<u>Books</u>** Pope, S. B. (2000). Turbulent Flows. Cambridge: Cambridge University Press. Wilcox, D. C. (1998). Turbulence modeling for CFD (Vol. 2, pp. 103-217). La Canada, CA: DCW industries. Tsinober, A. (2001). An informal introduction to turbulence (Vol. 63). Springer Science & Business Media. **<u>Journals</u>** Journal of Fluid Mechanics Water Resources Research Physical Review Letters Physical Review Fluids	