Course No.	Course Name	L-T-P-Credits	Year of Introduction
CH368	COMPUTATIONAL FLUID DYNAMICS	3-0-0-3	2016

Prerequisite: Nil

Course Objectives

- To impart the expertise in computational flow modelling and solution of model equations.

Syllabus

Introduction to computational modelling of flows, Numerical methods for CFD, Application of numerical methods to selected model equations, Solution of Navier Stokes equation, Turbulence modelling, Introduction to reactive and multiphase flow modelling.

Expected Outcome

On completion of this course, students will have the

i. Ability to formulate simplified models of complex fluid flow systems by applying knowledge of mathematics and science.
ii. Ability to apply various numerical techniques in solving fluid flow models.
iii. Ability to assess the accuracy of numerical solutions by comparison to known solutions of simple test problems

References:

1. Anderson, D. A, Tanneheil, J. C. and Pletcher, R. H., "Computational Fluid Mechanics and Heat transfer", Hemisphere, New York, 1984.
2. Anderson, John David, "Computational Fluid Dynamics: The Basics with Applications". McGraw Hill, 1995.
3. Chung, T.J. "Computational Fluid Dynamics". Second Edition, Cambridge University press, Cambridge, UK, 2010.
4. Ferziger, J. H and Peric, M., "Computational methods for Fluid Dynamics". Third edition, Springer-Verlag, Berlin, 2003.
5. Patankar, Suhas, V., Numerical Heat Transfer and Fluid Flow, McGraw Hill, Washington, 1980
6. Ranade, V., Computational Flow Modelling for Chemical Reaction Engineering, Academic Press, 2002.
7. Versteeg, H. K. and Malalasekara, W." Introduction to Computational Fluid Dynamics: The Finite Volume Method". Second Edition (Indian Reprint) Pearson Education, 2008.

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Introduction to Computational Modelling of Flows:– Index notation of vectors and tensors Control volume-Reynolds Transport Theorem Governing equations - Non dimensional forms-Phenomenological models Boundary conditions-Classification	6	15%
II	Numerical methods for CFD:-Classification of PDEs Basic discretization methods- Mesh- iterative methods Stability, convergence and consistency of numerical schemes, Von-Neumann analysis for stability, Courant-Friedrich-Lewi criterion	6	15%

FIRST INTERNAL EXAMINATION			
III	Application of numerical methods to selected model equations: Wave equation, Heat equation, Laplace's equation, Burgers' equation First order, Second order and higher order upwind, Lax Wendroff, MacCormack methods.	6	15%
IV	Solution of the Navier- Stokes equations: Discretization of convective, viscous, pressure and body force terms- conservation properties- Structured and unstructured grids- Staggered and collocated grids, SIMPLE, PISO and PROJECTION algorithms	6	15%
SECOND INTERNAL EXAMINATION			
V	Turbulence Modelling: The Turbulence Problem, Algebraic and Differential Models, Direct Numerical Simulation, Turbulent viscosity models RANS models, Large Eddy Simulation	9	20%
VI	Introduction to Reactive and Multiphase Flow Modelling: Reactor modelling (RTD Studies),Combustion Modelling Multiphase Flow modelling - Fluid/Fluid, Fluid/Solid	9	20%
END SEMESTEREXAMINATION			

Question Paper Pattern

Maximum Marks: 100 Exam Duration: 3 Hours

Part A : There shall be **Three questions** uniformly covering Modules 1 and 2, each carrying 15 marks, of which the student has to answer any **Two questions**. At the most 4 subdivisions can be there in each main question with a total of 15 marks for all the subdivisions put together. (2 x15= 30 Marks)

Part B: There shall be **Three questions** uniformly covering Modules 3 and 4, each carrying 15 marks, of which the student has to answer any **Two questions**. At the most 4 subdivisions can be there in each main question with a total of 15 marks for all the subdivisions put together. (2 x15= 30 Marks)

Part C: There shall be **Three questions** uniformly covering Modules 5 and 6, each carrying 20 marks, of which the student has to answer any **Two questions**. At the most 4 subdivisions can be there in each main question with a total of 20 marks for all the subdivisions put together. (2 x20= 40 Marks)