Course Type	Course Code	Nameof Course	L	T	P	Credit
DC	NFMC526	CFD of Thermal and Fluid Systems	3	1	0	4

CourseObjective

The course will introduce the students to the

- Governing equations ofthermo-fluid systems and the modeling as well as numerical approaches required to solve these equations using the finite volume method.
- Prominent computational tools to solve thermo-fluid problems.

LearningOutcomes

At the end of this course, students will be able to

- Explain the closure of the system of governing equations for any thermo-fluid system.
- Code and obtain numerical solutions for turbulent reacting homogenous systems on structured grids.
- Obtain solutions for more complex reacting systems on complexgrids using open-sourceand commercial software.

Unit No.	Topics to be Covered	Lecture Hours	Tutorial Hours	Learning Outcome
1	Introduction to Fluid Mechanics, Turbulence, Heat transfer and Combustion. Classification of PDEs and their physical behavior, Overview of finite difference, finite element and finite volume methods (FVM).	8	2	Governing equations for the thermo-fluid systems and the behavior of these PDEs in space and time. Introduction to the different CFD approaches.
2	FVM: fundamentals, discretization of steady and unsteady state diffusion problems, explicit and implicit schemes, consistency, stability & convergence.	8	2	Diffusion problems and the FVM approach to code & solve these problems on structured grids.
3	Convection-diffusion problems: Central difference, upwind, exponential, hybrid & power law schemes, False diffusion, TVD scheme.	8	2	Convection-diffusion problems & the FVM approach to code & solve these problems on structured grids.
4	Numerical solution of systems of linear algebraic equations: Elimination and iterative methods, Gaussian elimination, TDMA, Gauss-Seidel iterations, conditions for convergence of iterative schemes, over & under relaxations.	8	2	Detailed idea about the various iterative methods of solving the algebraic equations linearized using the FVM.
5	Numerical solver for the real thermo-fluid systems: SIMPLE, SIMPLEC, SIMPLER, PISO algorithms.	7	3	Numerical approaches to solve the non-linear governing equations of real thermo-fluid systems & the associated numerical issues.

6	Introduction to the use of opensource and commercial CFD software	3	3	Knowledge about solving the practical reacting turbulent complex systems using open source or commercial software.
Total		**42**	**14**	

TextBooks:

1. An introduction to computational fluid dynamics (the finite volume method): Pearson, *Authors*: H.K. Versteeg and W. Malalasekera.

2. Computational fluid mechanics and heat transfer: CRC Press, *Authors*: D. Anderson, J.C. Tannehill and R.H. Pletcher.

ReferenceBooks:

1. A First Course in Turbulence: MIT Press, Authors: H. Tennekes and J.L. Lumley.
2. An Introduction to Combustion (Concepts and Applications): McGraw Hill, *Authors*: S.R. Turns.
3. Fundamentals of Heat and Mass Transfer: John Wiley and Sons, *Authors*: T.L. Bergman, A.S. Lavine, F.P. Incropera and D.P. Dewitt.
4. Fluid mechanics: McGraw Hill, *Authors*: F.M. White and H. Xue.