| CHE - 433 | Subject: Computation al Fluid Dynamics in Process Engineering | 2CH<br>Theory (2) | |
|---|---|---|---|
| Pre- req. | Nil | Category | Elective |

**Course Contents as per PEC Guidelines 2023-2024**

- **CFD Fundamentals**: CFD and its significance, problem solving using CFD
- **Conservation laws of fluid motion and boundary conditions:** Scope and limitations of experimental, analytical and numerical methods in transport processes, The Continuity Equation and governing equations for Momentum, Heat and Mass Transport in a continuum; The General Transport Equation.
- **Turbulence and its modelling:** Characteristics of simple turbulent flows, The effect of turbulent fluctuations on properties of the mean flow, Reynolds-averaged Navier-Stokes equations, large eddy simulation, Direct numerical simulation. The finite volume method for convection and diffusion problems: Finite volume method for one-, two- and three-dimensional steady state diffusion, The power-law scheme, TVD schemes, The hybrid differencing scheme
- **Discretization: basic** concepts and methods, Discretized forms and solution methodologies for steady and unsteady- state one-dimensional heat conduction, Extension of discretization concepts to two- and three-dimensional domains, Modeling of Convection and Diffusion terms using various discretization schemes; Calculation of flow field using SIMPLE algorithm.
- **Case studies**: Simulation of various one-and two-dimensional laminar flow situations covered during Transport Phenomena using CFD software and comparison of results with analytical solutions.

**Weekly Plan**

| Week /Lecture | Topic |
|---|---|
| 1-2 | **CFD Fundamentals**: CFD and its significance, problem solving using CFD |
| 3-5 | **Conservation laws of fluid motion and boundary conditions:** Scope and limitations of experimental, analytical and numerical methods in transport processes, The Continuity Equation and governing equations for Momentum, Heat and Mass transport in a continuum; The General Transport Equation. |
| 6-8 | **Turbulence and its modelling:** Characteristics of simple turbulent flows, The effect of turbulent fluctuations on properties of the mean flow, Reynolds-averaged Navier-Stokes equations, large eddy simulation, Direct numerical simulation. The finite volume method for convection and diffusion problems: Finite volume method for one-, two-and three-dimensional steady state diffusion, The power-law scheme, TVD schemes, The hybrid differencing scheme |
| 9 | **MID TERM** |
| 10-13 | **Discretization:** basic concepts and methods, Discretized forms and solution methodologies for steady and unsteady-state one-dimensional heat conduction, Extension of discretization concepts to two- and three- dimensional domains, Modeling of Convection and Diffusion terms using various discretization schemes; Calculation of flow field using SIMPLE algorithm. |
| 14-16 | **Case studies**: Simulation of various one-and two-dimensional laminar flow situations covered during Transport Phenomena using CFD software and comparison of results with analytical solutions. |
| **17** | **Revision** |
| **18** | **End Semester Exam** |

**TEXT AND REFERENCE BOOKS:**


- Versteeg, H.and Malalasekra, W., An Introduction to Computational Fluid Dynamics:The FiniteVolume Method, 2nd Ed., Prentice Hall,2007.
- B. Andersson, R. Andersson, L. Håkansson, M. Mortensen, R. Sudiyo, and B. van Wachem, Computational Fluid Dynamics for Engineers. Cambridge University Press, 2011.
- Y. I. Lim, Computational Fluid Dynamics (CFD) of Chemical Processes. MDPI AG, 2021.
- H. Lu, D. Gidaspow, and S. Wang, Computational Fluid Dynamics and the Theory of Fluidization: Applications of the Kinetic Theory of Granular Flow. Springer Nature Singapore, 2021.
- ANSYS User Guide