Ahmedabad University

Course	CHE309 Computational Fluid Dynamics	Semester	Monsoon Semester 2024
Faculty Name(s)	Arijit Ganguli	Contact	arijit.ganguli@ahduni.edu.in
School	SEAS	Credits	3
GER Category:	Not Applicable	Teaching Pedagogy Enable:YES	P/NP Course: Can not be taken as P/NP

Schedule

Section 1	02:00 pm to 03:00 pm	Sat	01-08-24 to 26-11-24
	03:00 pm to 04:00 pm	Sat	01-08-24 to 26-11-24
	04:00 pm to 05:00 pm	Sat	01-08-24 to 26-11-24

Prerequisite	CHE201 Fluid Mechanics & CHE203 Heat Transfer
Antirequisite	Not Applicable
Corequisite	Not Applicable
Course Description	Computational Fluid Dynamics (CFD) is a very important branch in aeronautical engineering, mechanical engineering, chemical engineering etc for the design and optimization of machines and equipments. The fluid dynamics in such equipments influences the heat and/or mass transfer occurring in these equipments. Knowledge of the fundamentals/basics of CFD helps in setting up of real-life industrial problems faced by the different industries and efficiently understanding and interpretation of results rather than using the commertial software packages like a black box The course would provide in a thorough and rigorous manner the solving of partial differential equations of momentum and energy by different numerical techniques, application of boundary conditions and interpretation of results

Course Objectives	The objectives of course are to teach, • Understanding of fundamental concepts of CFD like discretization for steady and unsteady flows • Application of discretization techinques to convection diffusion problems and obtain velocity and temperature distributions • Understanding and application of appropriate boundary conditions for steady and unsteady problems • Creating simple geometries, meshing and solving simple problems in commercial softwares like Ansys Fluent
Learning Outcomes	On successful completion of the course, students will be able to: • Discretize and solve one or two dimensional steady and unsteady problems to obtain velocity and temperature distributions for simple flow. • Set-up problems for simple geometries, apply boundary conditions and get velocity and temperature distributions.
Pedagogy	Lectures, Practical coding, Projects
Expectation From Students	Students must attend lectures, read the study material and books regularly. Solve the assignment problems and submit as per the time line.

Assessment/Evaluation	• Mid-Semester Examination:
	    ◦ Assignment - 10%
	    ◦ Online Exam - 15%
	• End Semester Examination:
	    ◦ Online Exam - 25%
	    ◦ Project - 50%

Attendance Policy	As per Ahmedabad University Policy.
Project / Assignment Details	Small matlab codes for coding problems solved in class will be given at the end of each unit and student has to submit as per the time line given. Projects will be real problems to be solved in commertial software Ansys Fluent or open source software
Course Material	Reference Book • Numerical Heat Transfer and Fluid Flow, S V Patankar, 2nd Edition, Hemisphere Publishing Corporation, ISBN: 0891165223, Year: 1980,
Additional Information	

Session Plan

NO.	TOPIC TITLE	TOPIC & SUBTOPIC DETAILS	READINGS,CASES,ETC.	ACTIVITIES	IMPORTANT DATES
1	Introduction	What is CFD and scope of the course	Introduction to Computational Fluid Dynamics, Versteeg and Malalashekera	Lecture	
2	Conservation laws of fluid motion and boundary conditions	Governing equations of fluid flow and heat transfer	Introduction to Computational Fluid Dynamics, Versteeg and Malalashekera, Chapter 2	Lecture	
3	Conservation laws of fluid motion and boundary conditions	Differential and integral forms of general transport equations; Classification of fluid flow equations	Introduction to Computational Fluid Dynamics, Versteeg and Malalashekera, Chapter 2	Lecture	
4	Turbulence and its modeling	What is trubulence and effect of turbulence on time averaged Navier-Stokes equations	Introduction to Computational Fluid Dynamics, Versteeg and Malalashekera, Chapter 3	Lecture	
5	Turbulence and its modeling	Charasteristics of simple turbulent flows and turbulence models	Introduction to Computational Fluid Dynamics, Versteeg and Malalashekera, Chapter 3	Lecture	
6	Practical examples on commertial CFD softwares (Ansys Fluent)	Velocity distribution in pipe flow	Ansys Fluent Help	Lab session	
7	Practical examples on commertial CFD softwares (Ansys Fluent)	Turbulent flow and heat transfer in tube	Ansys Fluent Help	Lab session + Term project Defined	
8	Finite volume method for diffusion problems	Finite volume method for one-dimensional steady state equations	Introduction to Computational Fluid Dynamics, Versteeg and Malalashekera, Chapter 4	Lecture + problem	

9	Finite volume method for diffusion problems	Finite volume method for two and three dimensional steady state equations	Introduction to Computational Fluid Dynamics, Versteeg and Malalashekera, Chapter 4	Lecture + problem	
10	Discretization methods	Discretization concept and structure of discretization technique	Numerical Heat transfer and Fluid Flow, Patankar, Chapter 3	Lecture	
11	Discretization methods	Illustrative example of discretization technique	Numerical Heat transfer and Fluid Flow, Patankar, Chapter 3	Problem solving	
12	Finite volume method for convection-diffusion problems	Steady one dimensional convection-diffusion problem: central difference scheme and its properties	Introduction to Computational Fluid Dynamics, Versteeg and Malalashekera, Chapter 5	Lecture + Assignment 1 due	
13	Finite volume method for convection-diffusion problems	Steady one dimensional convection-diffusion problem: central difference scheme	Introduction to Computational Fluid Dynamics, Versteeg and Malalashekera, Chapter 5	Problem solving	
14	Finite volume method for convection-diffusion problems	Steady one dimensional convection-diffusion problem: upwind, hybrid and power-law schemes	Introduction to Computational Fluid Dynamics, Versteeg and Malalashekera, Chapter 5	Lecture + Quiz	
15	Pressure-velocity concept in steady flows	The staggered grid applied to momentum equations	Introduction to Computational Fluid Dynamics, Versteeg and Malalashekera, Chapter 6	Lecture	
16	Pressure-velocity concept in steady flows, The SIMPLE method	SIMPLE method for Navier-Stokes equations, Concepts of different variations of SIMPLE methods	Introduction to Computational Fluid Dynamics, Versteeg and Malalashekera, Chapter 6	Lecture	
17	Solution of discretized equations	Tri-diagonal Matrix Algorithm (TDMA) Illustration of TDMA in one dimension	Introduction to Computational Fluid Dynamics, Versteeg and Malalashekera, Chapter 6	Lecture Assignment 2 due	

18	Solution of discretized equations	Illustration of TDMA in two dimension	Introduction to Computational Fluid Dynamics, Versteeg and Malalashekera, Chapter 6	Lecture	
19	Finite volume methods for unsteady flows	One dimensional Unsteady heat conduction	Introduction to Computational Fluid Dynamics, Versteeg and Malalashekera, Chapter 8	Lecture + Assignment 3 due	
20	Finite volume methods for unsteady flows	Explicit scheme, Implicit and Crank Nicholson Scheme	Introduction to Computational Fluid Dynamics, Versteeg and Malalashekera, Chapter 8	Lecture	
21	Finite volume methods for unsteady flows	One dimensional Unsteady heat conduction: Illustrative example with Implicit and explicit methods	Introduction to Computational Fluid Dynamics, Versteeg and Malalashekera, Chapter 8	Problem solving	
22	Finite volume methods for unsteady flows	One dimensional Unsteady heat conduction: Illustrative example with fully implicit methods	Introduction to Computational Fluid Dynamics, Versteeg and Malalashekera, Chapter 8	problem solving	
23		Project			
24		Project			
25		Project			
26		Project			
27		Project			
28		Reflections and review			
29		Quiet reading			
30		End Semester Exam			