Subject Code: 01ME0832
Subject Name: Computational Fluid Dynamics
B. Tech. Year - IIII (Semester - 8)

Type of course : Programme core

Prerequisite : Higher Engineering Mathematics, heat transfer and Fluid Mechanics.

Rationale : This course aims to introduce numerical modeling and its role in automotive field; it will enable the students to understand the various discretisation methods and solving methodologies and to create confidence to solve complex problems in the automotive field with the knowledge of Heat transfer and fluid dynamics. Further students can able to develop finite difference and finite volume discretized forms of the CFD equations and to formulate explicit & implicit algorithms for solving the Euler Equations & Navier Stokes Equations.

Course Outcome :

After learning the course, the students will be competent

1. To develop perception of major theories, approaches and methodologies used in CFD.
2. To apply differential equations to Fluid Dynamic problems.
3. To gain the elementary knowledge of finite elements method for flow and heat transfer problems.
4. To analyze the numerical simulation to solve major engineering design problems involving fluid flow and heat transfer.
5. To build up the skills in the implementation of CFD methods (e.g. boundary conditions.) in actual engineering using commercial CFD codes

Teaching and Examination Scheme :

Teaching Scheme			Credits	Examination Marks					Total Marks
				Theory Marks			Practical Marks		
Theory	Tutorial	Practical	C	ESE(E)	IA	CSE	Viva (V)	Term Work (TW)	
4	2	0	5	50	30	20	25	25	150

Content :

Sr. No.	Content	Total Hrs
1	**Introduction and Basic Concepts:** Introduction of CFD, Types of fluids and basic equations of flow, Mass Conservation, Newton's second law of motion, Fluid flow governing equations, Navier– stokes equation, Boundary layer equations, Expanded form of Navier-stokes equations, Conservation of energy principle, Special form of energy equation, Classification of second order partial differential equations, Initial and Boundary conditions, Governing equations in generalized coordinates, Review of	**15**

	essentials of fluid dynamics.	
2	**Differential Equations and Discretisation** Elementary Finite Difference Equations, Basic aspects of finite difference equations, errors and stability analysis, discretization, Taylor's series expansion, difference equation: explicit and implicit approach, Application to heat conduction and convection, problems on one dimension steady state and unsteady state conduction.	**12**
3	**Grid Transformation** Introduction, general transformation equations, matrices and Jacobean, transformed version of governing equation particularly suited for CFD, compressed grids, elliptic grid generation, adaptive grids.	**05**
4	**Introduction to finite element philosophy** Basics of finite element method, stiffness matrix, Isoperimetric elements, Formulation of finite elements for flow and heat transfer problems.	**09**
5	**Introduction to finite volume philosophy** Integral approach, discretization and higher order schemes, Application to complex geometry.	**07**

Distribution of Theory Marks

R Level	**U** Level	**A** Level	**N** Level	**E`** Level	**C** Level
10	**20**	**25**	**25**	**10**	**10**

Legends: R: Remember**; U:** Understand**; A:** Apply**; N:** Analyze**; E:** Evaluate**; C**: Create

List of Experiments :

1. To perform numerical analysis on flow through pipe.
2. To perform numerical analysis on flat plate boundary layer.
3. To perform numerical analysis on compressible flow in nozzle.
4. To perform numerical analysis on convective heat transfer.
5. To perform numerical analysis on steady flow past a cylinder.
6. To perform numerical analysis on unsteady flow past a cylinder.
7. To perform numerical analysis on flow over an airfoil.
8. To perform numerical analysis on heat conduction through wall.

Major Equipment :

1. Computational facility.
2. Ansys software.

Reference books :

1. Computational Fluid Dynamics the Basics with Applications, John D Anderson, Jr., McGraw Hill Book Company.
2. An Introduction to Computational Fluid Dynamics: The Finite Volume Method, H K Versteeg, W Malalasekera, Pearson Education Ltd.
3. Introduction to Computational Fluid Dynamics, Anil W Date, Cambridge University Press.
4. Numerical Heat Transfer and Fluid Flow, Suhas V Patankar, Hemisphere Publishing Co.
5. Computational Fluid Dynamics: A Practical Approach, JiyuanTu, Guan HengYeoh, Chaoqun Liu, Elsevier.
6. Principles of Computational Fluid dynamics, Pieter Wesseling, Springer International Edition
7. Fundamentals of Computational Fluid Dynamics, Tapan K. Sengupta, Universities Press.
8. Introduction to Fluid Mechanics, Edward J Shaughnessy, Jr., Ira M Katz, Oxford University press.

List of Open Base Software/learning website :

1. Open FOAM and SCILAB
2. www. Cfd-online.com
3. https://fluids.ac.uk/talks
4. http://www.efluids.com/