Devi Ahilya University, Indore, India Institute of Engineering & Technology				IV Year B.E. (Mechanical Engg.) (Full Time)			
Subject Code & Name	**Instructions Hours per Week**			**Credits**			
7MERE5 **Computational Fluid Dynamics**	**L**	**T**	**P**	**L**	**T**	**P**	**Total**
	3	**1**	**2**	**3**	**1**	**1**	**5**
Duration of Theory Paper: **3 Hours**							

Course Objectives: The objective of the subject is to

1. Introduce the students about the new and advanced methods in fluid dynamics

2. Enable the students to use computer systems and related software for fluid dynamics.

3. Simulate the various flow conditions involving heat transfer and fluid flow.

4. Simulate the real life problems.

Pre requisite(s): Fluid Mechanics, Thermodynamics, Engineering Mathematics, Engineering Graphics

COURSE CONTENTS

UNIT I

Introduction to Fluid Dynamics: Review of conservation equations, Continuum concept, control volume equations, Ideal fluid flow and hydraulic singularities, Navier-stokes equations, and their use. Concept of compressible flow, one dimensional isentropic flow, normal shock, flow with-friction, heat transfer, boundary-Layer theory and applications

UNIT II

Boundary Layer Theory: Basic concepts, Boundary Layer Parameters, Boundary Layer on flat plate, Hiemenz flow, flow near rotating disc. Von-Karman Momentum Equation. General Properties of Boundary Layer equations, Theory of stability. Theory of similarity in heat transfer and exact solutions. Turbulence, correlation coefficient.

UNIT III

Numerical Methods: Fluid Dynamics Equations in Eulerian systems, the characteristic method, finite element methods and application in fluid dynamics, solution of physical flow problems. Scaling and nondimensionalisation Order of Magnitude method.

UNIT IV

Computational Methods: Algebraic equations, ordinary differential equations, Numerical solutions of non-linear equation. Problems leading to system of linear equations. Techniques for solving system of linear equations (direct and iterative). Linear and non linear regression techniques to correlate experimental data. Numerical Integration, application to flow processes. Solution to partial differential equations, Difference forms, implicit and explicit methods for steady state and transient problems.

UNIT V

Optimisation Methods: Classical optimization methods, unconstrained minimization. Univariate, conjugate direction, gradient and variable metric methods, constrained minimization, feasible direction and projections. Integer and Geometric programming, genetic algorithms.

Course Outcomes:

CO1. Understand the various flow situations numerically
CO2. Analyse the flow patterns studied in fluid mechanics
CO3. Simulate the various flow situations
CO4. Apply optimisation methods to find most optimum solution.

BOOKS RECOMMENDED:

[1] Anderson, J. D., *Computational Fluid Dynamics: The Basics with Applications*, Pearson Education, 2005.
[2] Veerstig, H and W. Malasekra, E. B., *An Introduction to Computational Fluid Dynamics : The Finite Volume Method*, Pearson, 2e, 2009.
[3] Streeter, V. L and Wylie, E. B., *Fluid Dynamics*, McGraw-Hill Co, 2003.
[4] White F., *Fundamentals of Fluid mechanics*, McGraw-Hill Co, 2003.
[5] Wirz H.J. and Smolderen J.J., *Numerical Methods in Fluid Dynamics,* McGraw-Hill, 1978.

LIST OF PRACTICAL ASSIGNMENTS

1. Introduction to CFD software.
2. To simulate flow over the flat plate.
3. To simulate flow over the cylinder.
4. To simulate flow over an airfoil.
5. To simulate flow through nozzles and diffusers.
6. To simulate flow through Pipe of various cross-section.
7. To simulate flow through convergent-divergent nozzle.
8. To simulate flow across structural element.

Course Objectives: The objective of the subject is to

1. Introduce the students about the new and advanced methods in fluid dynamics
2. Enable the students to use computer systems and related software for fluid dynamics.
3. Simulate the various flow conditions involving heat transfer and fluid flow.
4. Simulate the real life problems.

Course Outcome:

Students earned credits will develop ability to

CO. No.	CO	PO
CO1	Understand the various flow situations numerically	PO1, PO2, PO3
CO2	Analyse the flow patterns studied in fluid mechanics	PO1, PO4, PO7, PO11
CO3	Simulate the various flow situations	PO1, PO2, PO4, PO12
CO4	Apply optimisation methods to find most optimum solution.	PO1, PO2, PO5, PO12

CO-PO Relationship

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO1	3	3	3									
CO2	3			3			2				2	
CO3	3	3		3								2
CO4	3	3			3							2
CO5												

* CO (rows) mention nil/very small/insignificant contribution to the PO(column)
1→ relevant and small significance 2 → medium or moderate and 3 →strong