GUJARAT TECHNOLOGICAL UNIVERSITY

MECHANICAL ENGINEERING
COMPUTATIONAL FLUID DYNAMICS
SUBJECT CODE: 2181925
B.E. 8th SEMESTER

Type of Course: Engineering Science

Prerequisite: Calculus, Vector Calculus and linear Algebra, Advanced Engineering Mathematics, Complex Variables and Numerical Methods and Fluid Mechanics

Rationale: The course is formulated to impart detailed study of computational techniques in field of fluid flow.

Teaching and Examinations Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
				Theory Marks			Practical Marks			
L	T	P	C	ESE (E)	PA (M)		ESE (V)		PA (I)	
					PA	ALA	ESE	OEP		
3	0	2	5	70	20	10	20	10	20	150

Content:

Sr No	Content	Total Hrs	% Weightage
1	Mathematics & Fluid Mechanics Review: Vector calculus, Vector algebra, Ordinary differential equations and Partial differential equations with engineering applications.	5	11
2	Integral and differential form of conservation equations, Viscous and inviscid flows. Laminar turbulent flows, Euler and Navier Stokes equations, Velocity and thermal boundary layers.	9	22
3	Finite difference method, discretization, discretization error, Upwind and downwind schemes, higher order methods, Implicit and Explicit method, steady and transient solutions, consistency, tri-diagonal matrix algorithm, convergence and stability.	10	24
4	Grid Generation Method: Definition and types of grid, Transformation of equation, Matrices and Jacobians, Stretched Grids, Elliptic Grids, Adaptive grids. QUICK and SIMPLE algorithm.	6	14
5	Finite Volume Method for one and two dimensional diffusion problem.	9	22
6	Introduction to CFD Software and applications.	3	7

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
7	15	19	15	7	7

Legends: R: Remembrance; U: Understanding; A: Application; N: Analyze, E: Evaluate, C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Computational Fluid Dynamics: The Basics with Applications by John D Anderson, Mc Graw Hill Book Company.
2. An Introduction to Computational Fluid Dynamics: The Finite Volume Method, Versteeg, H. K. & W. Malalasekera, Pearson Education, Ltd.
3. Numerical Heat Transfer and Fluid Flow, Suhas V Patankar, Hemisphere Publishing.

Course Outcome:

After successful completion of the course, the student will be able to

- Review the required underlying basic concepts in mathematics and Fluid Mechanics.
- Understand the basic concepts of Finite Difference and Finite Volume Methods.
- Comprehend the methodology and algorithms of CFD analysis.
- Apply concepts of CFD for problem solving

List of Experiments:

1. Perform numerical analysis on flow through pipe with varying Reynolds Number.
2. To calculate hydrodynamic length and boundary layer thickness for pipe flow numerically.
3. To calculate lift and drag co-efficient for a cylinder by using numerical analysis.
4. To calculate variation of lift and drag co-efficient for an airfoil with varying angle.
5. To understand the behavior of Creeping flow by numerical simulation.

Open Ended Problem:

1. Numerical study of lid driven cavity.
2. Numerical study of mixing of two fluids.

Equipment / Computational facility:

Practical aspect of the subject is based on computation work so high configuration / specification computer systems are mandatory.

Software Packages:

- OpenFOAM
- Scilab

Website:

- www.cfd-online.com

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters / parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College / Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.