GUJARAT TECHNOLOGICAL UNIVERSITY

AERONAUTICAL ENGINEERING (01)
COMPUTATIONAL FLUID DYNAMICS II
SUBJECT CODE: 2150104
B.E. 5thSEMESTER

Type of course: Engineering Science.

Prerequisite: Fluid Mechanics and Aerodynamics

Rationale: Computational Fluid Dynamics (CFD) is concerned with the numerical solution of the heat transfer and fluid flow problems. It solves basic governing equations by applying the different numerical techniques on them. CFD solutions are in terms of change in basic fluid flow properties like pressure, temperature and velocity for the flow over the objects and for the flow through the objects.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks			Practical Marks			
				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	Topics	Teaching Hrs.	Module Weightage
1.	**Implementation of Boundary conditions:** Introduction to common boundary conditions, inlet boundary conditions, outlet boundary conditions, wall boundary conditions, constant pressure boundary conditions, symmetry and periodic boundary conditions.	**03**	**10 %**
2.	**Pressure correction methods: incompressible viscous flows:** Introduction, the momentum equation, staggered grid, the SIMPLE Algorithm, the SIMPLER Algorithm, the SIMPLEC Algorithm, the PISO Algorithm,	**08**	**20 %**
3	**Advanced topics in Modern CFD:** The tri-diagonal matrix algorithm, application of the TDMA to 2-D problem, the Beam and Warming Method, the Multidimensional Problem, introduction to Upwind schemes, Flux- Vector Splitting, Godunov Approach, second ordered Upwind scheme, High Resolution schemes TVD and Flux limiters	**12**	**30 %**
4	**The Finite Volume Method:** Introduction, finite volume method (FVM) for two dimensional diffusion problems, introduction to FVM for convection-diffusion problems, steady one dimensional convection and diffusion problem, the central differencing scheme, FVM for One-Dimensional unsteady heat conduction problem, Crank-Nicolson Scheme	**12**	**30 %**
5	**Introductions to algorithms for Numerical solution to Navier-Stokes**	**05**	**10%**

	equation: Introduction to supersonic viscid flow over the flat plate with shock, physical problem and governing equations, governing equation in difference terms, calculation of step size and boundary conditions, flow chart for main program, flow chart for Mac-Cormark subroutine, flow chart for TAUXY function subprogram.		

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
40%	**35%**	**15%**	**05%**	**05%**	**-**

Text Books:

1. Computational Fluid Dynamics: The Basics With Applications by J D Anderson Jr., McGraw Hill, Inc
2. an introduction to computational fluid dynamics: The Finite Volume Method by H.K.Versteeg and W Malalasekera, Longman Group Limited

Reference Books:

1. Numerical Heat Transfer And Fluid Flow by Suhas V. Patankar, McGraw Hill
2. computational fluid dynamics by T J Chung, Cambridge University Press
3. computational fluid flow and heat transfer by K Murlidhar and T Sundararajan, Narosa Publishing House

Course Outcome:

After learning the course the students should be able to

1. Understand to apply physics of boundary conditions related to given problem.
2. Understand the basics of numerical schemes applied to heat transfer problems.
3. Carried out algorithms and can develop his/her own code to fluid flow problems and heat transfer problems.

List of Experiments:

1. Introduction to CFD software.
2. To simulate flow through forward facing step
3. To simulate flow through backward facing step
4. To simulate flow through nozzles and diffusers
5. To simulate flow through convergent divergent nozzle
6. To simulate flow through T-shape duct
7. To simulate flow over the flat plate
8. To simulate flow over the cylinder
9. To simulate flow over an airfoil
10. To simulate flow over double wedge airfoil

Open Ended Problems

Solve the followings:

1. Consider the flow is expanded through sharp corner and forms an expansion wave. Solve the mentioned problem analytically and numerically.

2. develop the code for the 1-D, unsteady state heat conduction problem

Major Equipments needed:

CFD Tutor, Ansys, Matlab

List of Open Source Software/learning website: http://nptel.iitm.ac.in/courses.php

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.