GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master of Engineering

Level: PG

Subject Code: ME03072021

Subject Name: Computational Fluid Dynamics

w. e. f. Academic Year:	2024-25
Semester:	3
Category of the Course:	MOPEC

Prerequisite:	Strong foundation in core chemical engineering principles like thermodynamics, reaction kinetics, transport phenomena (fluid mechanics, heat transfer, mass transfer), and process design principles.
Rationale:	To provide a brief introduction of Computational Fluid Dynamics along with chemical engineering application specifically, analysis of fluid mechanics and heat transfer related problems. The students will understand the process of developing a geometrical model of the flow, applying appropriate boundary conditions, specifying solution parameters, and visualizing the results.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes
01	Explain the principles and applications of Computational Fluid Dynamics (CFD).
02	Demonstrate knowledge of fundamental equations governing fluid flow and heat transfer.
03	Apply appropriate grid generation techniques and boundary conditions to solve simple fluid flow and heat transfer problems.
04	Simulate fluid flow and heat transfer problems in various engineering systems using CFD.

Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
				Theory		Tutorial / Practical		
L	T	PR	C	ESE (E)	PA / CA (M)	PA/CA (I)	ESE (V)	
3	0	0	0	70	30	0	0	100

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**Introduction:** Philosophy of computational fluid dynamics (CFD), review of equations governing fluid flow and heat transfer, simplified flow models such as incompressible, inviscid, potential and creeping flow, flow classification, CFD application in Chemical Engineering, CFD software packages and tools.	8	15
2.	**Grid Generation:** Structured and unstructured grids, choice of suitable grid, grid transformation of equations, some modern developments in grid generation in solving the engineering problems	6	11
3.	**Finite Difference Method (FDM):** Discretization of ODE and PDE, approximation for first, second and mixed derivatives, implementation of boundary conditions, discretization errors, applications to the engineering problems	12	22
4.	**Finite Volume Method:** Discretization methods, approximations of surface integrals and volume integrals, interpolation and differential practices, implementation of boundary conditions, application to the engineering problems	12	22
5.	**Special Topics:** Case studies using FDM and FVM, flow and heat transfer in pipes and channels, square cavity flows, reactive flow, multiphase flow, rotary kiln reactors, packed and fluidized bed reactors, furnaces and fire systems. Overview of finite element method (FEM).	16	30
	Total	**54**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
10	10	10	10	5	5

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

1. Fletcher C.A.J., "Computational Techniques for Fluid Dynamics, Vol. 1: Fundamental and General Techniques", Springer-Verlag.

2. Fletcher C.A.J., "Computational Techniques for Fluid Dynamics, Vol. 2: Specific Techniques for Different Flow Categories", Springer-Verlag.
3. Anderson J.D., "Computational Fluid Dynamics", McGraw Hill..
4. Ghoshdastidar P.S., "Computer Simulation of Flow and Heat Transfer", Cengage
5. Ferziger J.H. and Peric M., "Computational Methods for Fluid Dynamics", 3 rd Ed., Springer.
6. Patankar S.V., "Numerical Heat Transfer and Fluid Flow", Taylor and Francis.

(b) Open source software and website:

1. www.openfoam.com (Free CFD software)

Suggested Activities for Students: Online NPTEL course on Computational Fluid Dynamics

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