FACULTY OF ENGINEERING & TECHNOLOGY

First Year Master of Engineering

Semester II

Course Code: 102330206

Course Title: Computational Fluid Dynamics

Type of Course: Core Course IV

Course Objectives: To familiarize on design methodologies of thermal systems and facilitate analysis and optimization for performance enhancement.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Internal		External		Total
Lecture	Tutorial	Practical		Theory	J/V/P*	Theory	J/V/P*	
3	0	2	4	40 /16	20/08	60 /24	30/12	150/60

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	INTRODUCTION TO CFD What is Computational fluid dynamics (CFD) and how it works? CFD as design and research tool, impact of CFD in Engineering, governing equations of fluid dynamics, Analytical vs Numerical Approach, classification of partial differential equations and physical behavior, parabolic, elliptic and hyperbolic equations, validation of numerical results: Numerical error and accuracy – Round off error, accuracy of numerical results – Iterative convergence – Condition for convergence, Rate of convergence, Termination of iteration: Tridiagonal Matrix algorithm.	7
2	COMPUTATIONAL APPROACH Finite difference method, forward, backward and central difference schemes, explicit and implicit methods, Taylor's series approach, stability analysis, and error estimation, difference between FDM and FVM, approximation of surface integrals, approximation of volume integrals, interpolation practices, types of boundary conditions. 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	10
3	CFD TECHNIQUES Lax - Wendroff technique, MacCormack's technique, relaxation technique, artificial viscosity, ADI technique, pressure correction technique, Boundary condition for pressure correction techniques.	8
4	TURBULENCE MODELING AND CFD APPLICATIONS Turbulence energy equation, one-equation model, two-equation models (k-ω and k- ε models), review on advanced turbulence models, applications to fluid flow and heat transfer problems.	8

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5	FINITE VOLUME METHOD Introduction to finite volume method (FVM), FVM for diffusion and convection–diffusion problems, Solutionprocedure for unsteady flow calculations: SIMPLE, SIMPLEC, PISO, and MAC algorithms.	**6**
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Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks						**R**: Remembering; **U**: Understanding; **A**: Application, **N**: Analyze; **E**: Evaluate; **C**: Create
R	**U**	**A**	**N**	**E**	**C**	
10%	20%	20%	25%	20%	05%	

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 Flow and Heat Transfer, Muralidhar K and Sundararajan T, Narosa Publications.
2	Computational Fluid Dynamics, Chung T J, Cambridge University Press.
3	Computational Methods for Fluid Dynamics, Joel H Ferziger and Milovan Peric, Springer Publications.
4	Computational Fluid Dynamics – The Basics with Applications, John D Anderson, McGraw Hill.
5	An Introduction to Computational Fluid Dynamics - The Finite Volume Method, Versteeg H K and Malalasekara W, Longman.
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Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	Apply the principles to develop governing equations for fluid flow and solve them computationally.	**33**
CO-2	Demonstrate an understanding of the numerical methods and apply them to solve CFD problems.	**35**
CO-3	Understanding of the turbulence modelling and its application in CFD.	**32**
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CO-5	Click or tap here to enter text.	**Click**
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CO-9	Click or tap here to enter text.	Click
CO-10	Click or tap here to enter text.	Click

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List of Practicals / Tutorials:

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1	Study of tridiagonal matrix
2	Hexa Mesh Generation for a 2D & 3D Pipe Junction in ICEM
3	Hexa Mesh Generation for an Elbow Part in ICEM
4	Introduction to Using ANSYS FLUENT in ANSYS Workbench: Fluid Flow and Heat Transfer in a Mixing Elbow
5	Analysis of the heat transfer in a heat exchanger using ANSYS FLUENT.
6	Analysis of the fluid flow over Aerofoil surface.
7	Analysis of the heat pipe using ANSYS FLUENT.
8	Role of User Defined Function (UDF) in fluid flow and heat transfer analysis.
9	Analysis of the turbulent flow using CFD
10	Analysis of the multiphase flow using CFD.
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Supplementary learning Material:	
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Curriculum Revision:	
Version:	**1**
Drafted on (Month-Year):	Apr-20
Last Reviewed on (Month-Year):	Jul-20
Next Review on (Month-Year):	Apr-22

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