Course Code TEE 817	Credit Hours (Th-Pr) 3.0-0	**Computational Fluid Dynamics for Thermal Energy systems (Elective)**	Contact Hrs/Week (Th-Pr) 3.0-0	Total Contact Hrs (Th-Pr) 45-0

Course Outline:

This course will focus on obtaining the knowledge of the computational fluid dynamic for power plants. It provides an overview of fundamental mathematical governing for fluid flow and heat transfer and Navier-Stokes equation. The course will develop the concept of turbulence and its characteristics in random fluctuation flows. The course will cover the finite volume method for steady flow and discretization schemes. The course will enlighten the concept of boundary condition and errors in modeling and simulation. The course deliberates the mesh generation strategies, modeling capabilities and CFD post processing.

Eligibility Criteria:

B.E in Mech., Elect (Power), Chemical, Industrial, Process

B.S (4-years) Or M.Sc. degrees in Physics

Course Objectives:

Computational Fluid Dynamics (CFD) is a valuable field in research for engineers and researchers which is widely utilized within the industry to solve fluid flow and heat transfer problems. The aim of this course is to develop the concept of CFD and reflects it to the study of fluid flow and heat transfer in wide range of applications for designing and optimization of thermal power plants.

Recommended Books:

S. No.	Title	Author(s)	Assigned Code	Remarks
1.	An introduction to computational fluid dynamics, 2nd Edition	H. K. Versteeg and W. Malalasekaera	VM	Text Book
2.	Computational Fluid Dynamics- Principles and Applications	J. Blazek	JB	Reference

3.	Computational fluid dynamics	F. Magoules	FM	Reference
4.	Computational fluid dynamics: The basics with applications	Anderson J D	AJ	Reference
5.	ANSYS	ANSYS	AN	Reference

Learning outcome:

- The students will be familiarized with governing equations for fluid flow and heat transfer and Navier-Stoke equation
- The students have adequate knowledge about the turbulence and their models
- The students will learn finite volume method, discretization scheme and solution procedure for steady flow
- The students will define boundary condition and understand the errors in their modeling and how to validate their simulation results
- The students get command in geometry modeling, grid generation, turbulence modeling, solver strategy, and post-processing
- The students will model the problems of thermal processes

Topics Covered:

No.	Topics	Book	Contact Hours
1.	**Computational Fluid Dynamics** • What is CFD • How does a CFD code work? • Problem solving with CFD • Numeric Methods • Application of CFD in Energy	VM	2
2.	**Governing Equation of Fluid Dynamics** • Governing equations of fluid flow and heat transfer • Mass conservation • Rate of Change of Fluid Particle	VM AJ	7

	• Momentum Conservation • Energy Conservation • Navier–Stokes equations for a Newtonian fluid • Equations of state • Conservative form of the governing equations of fluid flow • Differential and integral forms of the general transport equations • Classification of physical behaviours • Classification method for simple PDEs		
3.	**Turbulence Models** • Turbulence • Transition from laminar to turbulence • Descriptors of turbulent flow • Characteristics of turbulent flows • Effect of turbulent fluctuations on properties of mean flow • Reynolds-averaged Navier–Stokes equations • Turbulence models	VM	8
4.	**Finite Volume Method** • Finite Volume Methodology • Finite Volume Method for Diffusion 1-D • Finite Volume Method for Diffusion 2-D • Finite Volume Method for Diffusion 3-D • Finite Volume Method for Convection-Diffusion 1-D • Central Differencing Scheme • Properties of Discretization Scheme • Upwind Differencing Scheme • Hybrid Differencing Scheme • Power law Scheme • QUICK Scheme	VM	8
5.	**Boundary Condition** • Boundary Condition for CFD model • Inlet boundary conditions	VM	3

	• Outlet boundary conditions • Wall boundary conditions • Symmetry boundary condition		
6.	**Errors and Uncertainty in CFD Modeling** • Errors and uncertainty in CFD • Numerical errors • Input uncertainty • Physical model uncertainty • Verification and validation • Guidelines for best practice in CFD	VM	3
7.	**Mesh Generation** • Geometry Generation • Mesh Generation Strategies • Boundary layer • Quality of Mesh	AN	5
8.	**Modeling** • Modeling capabilities • Boundary condition modeling • Turbulence and near wall modeling • Multiphase flow modeling • Particle transport modeling • Combustion modeling • Radiation modeling	AN	5
9.	**CFD Solver and Post** • CFD solver • Residual Plotting • CFD Post Processing	AN	2
10.	**CFD Problem**	-	1