COURSE CODE	COMPUTATIONAL FLUID DYNAMICS	L	T	P	C
1152ME105		3	0	0	3

1. **Preamble**
This course explains the evaluation of thermal problems and their possible solutions using computational methods. It enables the student to amalgamate their knowledge of fluid mechanics, mathematics, heat transfer, with computational techniques to solve problems.

2. **Prerequisite**
Heat and Mass Transfer 1151ME115

3. **Links to other courses**
CAD and Applied FEA 1151ME116

4. **Course Educational Objectives**
Students undergoing this course are expected to
   - Explain about governing equations, discretization schemes, numerical methods, turbulence modeling, mesh quality and independence test, numerical errors, computational techniques and boundary conditions.
   - Analyse various types of flow and their control methods for solving them.

5. **Course Outcomes**
The students would be benefitted with the following outcomes:

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Solve the initial and boundary value problems using finite difference method.	K3
CO2	Solve steady state and transient heat conduction problems.	K3
CO3	Solve the incompressible flow problems using SIMPLE algorithm and finite difference method.	K3
CO4	Solve the convective heat transfer problems using finite volume method and solve heat conduction and incompressible flow problems using FEA.	K3
CO5	Solve turbulence problems using various models	K3

(K3 – Apply)

6. **Correlation of COs with Programme Outcomes**

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	L			L							L	M	H
CO2	M	L	L	L	L							L	M	H
CO3	M	L	L	L	L							L	M	H
CO4	M	L	L	L	L							L	M	H
CO5	M	L	L	L	L							L	M	H

H- High; M-Medium; L-Low

7. Course Content

Unit I: Governing Differential Equation and Finite Difference Method **L- 9**
Classification, Initial and Boundary conditions – Initial and Boundary Value problems – Finite difference method, Central, Forward, Backward difference, Uniform and non-uniform Grids, Numerical Errors, Grid Independence Test.

Unit II: Conduction Heat Transfer **L- 9**
Steady one-dimensional conduction, two and three dimensional steady state problems, Transient one-dimensional problem, Two-dimensional Transient Problems. Conduction equation transient problems (one/ two/ three dimensional problems), adaptive grid, Introduction to upwind.

Unit III: Incompressible Fluid Flow **L- 9**
Governing Equations, Stream Function – Verticity method, Determination of pressure for viscous flow, SIMPLE Procedure of Patankar and Spalding, Computation of Boundary layer flow, finite difference approach

Unit IV: Convection Heat Transfer and FEM **L- 9**
Steady One-Dimensional and Two-Dimensional Convection – diffusion, unsteady one-dimensional convection – diffusion, unsteady two-dimensional convection – Diffusion – Introduction to finite element method – solution of steady heat conduction by FEM – Incompressible flow – simulation by FEM.

Unit V: Turbulence Models **L-9**
Algebraic Models – One equation model, K – ε Models, Standard and High and Low Reynolds number models, Prediction of fluid flow and heat transfer using standard codes.

TOTAL: 45 Periods

8. Text Books

1. Anderson, J. D., Computational Fluid Dynamics, McGraw Hill International, New York, 1995
2. Malalasekhara, "Computational Fluid Dynamics", PHI,

9. References

1. Muralidhar, K., and Sundararajan, T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, 1995.
2. Subas, V.Patankar "Numerical heat transfer fluid flow", Hemisphere Publishing Corporation, 1980.
3. Anderson, D.A., Tannehill, J.I., and Pletcher, R.H., "Computational fluid Mechanics and Heat Transfer " Hemisphere Publishing Corporation, New York, USA,1984.
4. Fletcher, C.A.J. "Computational Techniques for Fluid Dynamics 1" Fundamental and General Techniques, Springer – Verlag, 1987.