Course Code	Course/subject Name	Credits
MEDLO7034	**Computational Fluid Dynamics**	**4**

Objectives:
1. To study basic principles of Computational Fluid Dynamics
2. To study grid generation and discretization methods

Outcomes: Learner will be able to…
1. Demonstrate methodology to work with CFD
2. Illustrate principles of grid generation and discritisation methods
3. Identify and apply specific boundary conditions relevant to specific application
4. Decide solution parameters relevant to specific application
5. Analyze the results and draw the appropriate inferences
6. Demonstrate basic principles of FVM

Module	Detailed Contents	Hrs.
01	**Introduction:** What is CFD, Scope and Application of CFD, Methods of Predictions like Experimental and theoretical, Working of Commercial CFD Software, Solution methodology-Preprocessing, Solver, Post processing.	04
02	**Mathematical description of Physical Phenomenon:** Governing Differential Equations, Meaning of Differential equation, The Continuity Equation, A Momentum equation, The Energy Equation, The General Differential Equation, Boundary Conditions, Initial and Boundary Conditions, Initial and Boundary Value problems.	06
03	**Grid Generation and Discretization Methods:** Structured and unstructured Grids: O-type, H-type, C-type of Structured Grid Generation, Mesh Adaptation. The Nature of Numerical Methods: The Discritization Concept, The Structure of the Discritization Equation. Basic discretization techniques applied to model equations and systems of equations: finite difference, finite volume and finite element methods. Methods of Deriving the Discretization Equations, Taylor-Series Formulation, Variational Formulation, Method of Weighted Residuals, Control Volume Formulation	08
04	**Heat Conduction, Convection and Diffusion:** Steady One-dimensional Conduction, Unsteady One-dimensional Conduction, Two and Three-dimensional Situations, Over relaxation and Under relaxation, Steady One-dimensional and Two Dimensional Convection-Diffusion, Unsteady One-dimensional Convection.	
05	**Incompressible Fluid Flow:** Governing Equations, Stream Function-Vorticity Method, Determination of Pressure for Viscous Flow, The SIMPLE, SIMPLER Algorithm, Introduction to Turbulence Modeling, Basic Theories of Turbulence, The Time-Averaged Equations for Turbulent Flow.	
06	**Finite Volume Methods**: FVM solutions to steady one, two and three dimensional diffusion problems and unsteady one and two dimensional diffusion problems, FVM solutions to convection-diffusion problems - one and two dimensional, steady and unsteady; Advection schemes; Pressure velocity coupling	08

Assessment:

Internal Assessment for 20 marks:
Consisting **Two Compulsory Class Tests**
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

References:

1. An introduction to computational fluid dynamics-The finite volume method, Versteeg.H.K. , Malalasekera.W., Prentice Hall
2. Computational Fluid Mechanics and Heat Transfer, Anderson, D.A., Tannehill, I.I., and Pletcher, R.H., Hemishphere Publishing Corporation, New York, USA, 1984
3. Introduction to Computational Fluid Dynamics, Niyogi P. ,Laha M.K., Chakrabarty S.K., Pearson Education, India
4. Computational Fluid Flow and Heat Transfer, Muralidhar, K.,andSundararajan,T., Narosa Publishing House ,New Delhi
5. Computer Simulation of flow and heat transfer, Ghoshdasdidar, P. S., Tata McGraw-Hill Publishing Company Ltd
6. Finite Element Programming of the Navier Stock Equation, Taylor, C and Hughes J.B., Pineridge Press Ltd.U.K.
7. Computational Techniques for Fluid Dynamics: Fundamental and General Techniques, Fletcher, C.A.J., Springer-Verlag
8. Numerical Fluid Dynamics, Bose, T. K., Narosa Publishing House
9. T. J. Chung, Computational Fluid Dynamics, Cambridge University Press
10. Anderson, J.D. Computational Fluid Dynamics, McGraw Hill