Course No	Course Name	L-T-P-Credits
MA 537	COMPUTATIONAL FLUID DYNAMICS	3-0-0:3

Prerequisite: Fluid Mechanics (MA410)

Course Objectives: The objective of the course is to provide a theoretical knowledge of second order partial differential equations and numerical solution of those equations using finite difference method(s) with special emphasis on fluid dynamics problems.

Course Outcomes: After successful completion of the course, students will be able to:

1. Classify second order PDEs and know various types of initial and boundary conditions.
2. Define and formulate the flow problem properly and obtain the numerical solution using finite difference methods.
3. Assess the accuracy of numerical solutions by comparing with known solution of simple problems and by mesh refinement studies.

SYLLABUS

Module	Contents	Hours
I	**Classification of Partial Differential Equations and Overview of Numerical Methods:** Classification of 2nd order PDEs: parabolic, elliptic and hyperbolic; boundary and initial conditions; role of characteristics, over view of numerical methods.	8
II	**Finite Difference Method:** Discretization, discretization error, upwind and downwind schemes, higher order methods, implicit and explicit methods, ADI Method, Stability of hyperbolic and elliptic equations, consistency, tri-diagonal systems.	14
III	**Grid Generation Method:** Definition and types of grid, Transformation of equation, Matrices and Jacobians, Stretched Grids, Elliptic Grids, Adaptive grids. QUICK and SIMPLE algorithms.	14

Essential Readings:

1. J. D. Anderson Jr.,"*Computational Fluid Dynamics*", McGraw-Hill International edition, 1995.
2. S.V. Patankar,"*Numerical Heat Transfer and Fluid Flow*", Hemisphere, 2017.

Supplementary Readings:

1. H. K. Versteeg and W. Malalasekera,"*An introduction to computational fluid dynamics: The finite volume method*", Pearson Education, 2nd edition, 2008.
2. T. J. Chung, "*Computational Fluid Dynamics*", Cambridge University Press, 2nd edition, 2014.
3. T R Chandraputla and A D Belegundu, "*Introduction to Finite Elements in Engineering*", Prentice Hall of India, 4th edition, 2015.