COMPUTATIONAL FLUID DYNAMICS AND HEAT TRANSFER

PROF. GAUTAM BISWAS
Department of Mechanical Engineering
IIT Kanpur

TYPE OF COURSE : New | Both | UG/PG
COURSE DURATION : 12 Weeks (18 Jan' 21 - 09 Apr' 21)
EXAM DATE : 24 Apr 2021

PRE-REQUISITES : First and Second year Mathematics Courses. The basic core course in Fluid Mechanics and a basic core course in Heat Transfer

INTENDED AUDIENCE : BTech (UG) in Mechanical. Chemical and Aerospace; MSc in Mathematics; MTech (PG) in Mechanical (Fluids and Thermal), MTech in Aerospace Engineering

INDUSTRIES APPLICABLE TO : DRDO Labs, Some CSIR Labs, BHEL, Thermax, GE etc

COURSE OUTLINE :

This course is an effort to cover a range of topics, - from elementary concepts for the uninitiated students to state-of-the-art algorithms useful for the practitioners. The contents begin with preliminaries, in which the basic principles and techniques of finite difference (FD), finite volume (FV) and finite element (FE) methods are described using detailed mathematical treatment. The methodologies are explained using step-by-step calculations. The popular CFD solvers, such as SIMPLE and MAC have been discussed in a detailed manner so that the learners can handle such programming paradigms with confidence.

ABOUT INSTRUCTOR :

Dr. Gautam Biswas is presently a Professor of Mechanical Engineering at the Indian Institute of Technology Kanpur. Earlier, he has been the Director of Indian Institute of Technology Guwahati, and Director of the CSIR-Central Mechanical Engineering Research Institute at Durgapur. He was the G.D. and V.M. Mehta Endowed Chair Professor, and Dean of academic affairs at IIT Kanpur. The research group of Professor Biswas at IIT Kanpur identified the phenomenon of Rayleigh-Taylor Instability during the bubble formation in film boiling. This was a significant addition to the classical theory, based on Taylor Helmholtz instability. Another seminal contribution of his group is identification of zone of large bubble entrapment and underlying physics during the complete coalescence of a falling drop on a liquid surface. Professor Biswas is the author of more than 150 publications in the International Journals. He has completed guidance of 23 PhD theses.

COURSE PLAN :

Week 1: Introduction about the Course; Finite Difference Method (preliminaries); Explicit, Implicit, ADI Formulation

Week 2: Stability Analysis; Conservative and Transportive Properties

Week 3: Upwinding, Artificial Viscosity, Second Upwind; Higher order Upwinding and some Important Issues

Week 4: Applications of Knowledge and Setting up an Algorithm; Finite Volume Method (FVM-preliminary concepts)

Week 5: FVM-Equations with First Derivatives; FVM-Equations with Second Derivatives

Week 6: Finite Element Method (FEM-Preliminary Concepts); FEM-Galerkin Weighted Residual Method

Week 7: FEM-Elemental contributions and formation of Global Matrix; Vorticity Stream Function Approach (Formulation and Algorithm)

Week 8: Vorticity Stream Function Approach (Application to Curvilinear Geometry); SIMPLE Algorithm (Continuity and Momentum Equations)

Week 9: SIMPLE Algorithm (Momentum Equations and Pressure Solver) MAC Algorithm (The MAC Method and Discretization of the Equations)

Week 10: MAC Algorithm (Pressure - Velocity Iteration and the Solution); MAC Algorithm (Solution of Energy Equation)

Week 11: A Finite Volume Method to solve NS Equations in 3D Complex Geometry

Week 12: FVM-3DC (Convective and Diffusive Fluxes); FVM-3DC (Solution for Pressure and the Algorithm)