NIHARIKA INSTITUTE OF COMPUTATIONAL ENGINEERING

84, 2nd Main, 4th Cross, Gowreeshwara complex, New Thippasandra, HAL 3rd Stage, Bangalore – 560075, Karnataka State, India, Phone: 91-80-40931242,
Mobile: +91 9916266179, E-mail: nicecfd@rediff.com nicecfd@gmail.com
Website: www.nicecfd.com www.cfdonline.in

Advanced diploma in CFD

Syllabus- Level -01

1. Computational Fluid Dynamics-CFD

Navier Stokes equations and its simplified forms, discussion on their physical meaning. Basic aspects of discretisation schemes, finite volume methods. Application of finite volume methods to simple equations like one dimensional steady state conduction equation and there by demonstrating how a CFD software works, impact of grid size on accuracy of results, solution matrix etc. Stability, convergence and consistency, CFL condition. Pressure correction techniques (Simple and simpler algorithms), compressible and incompressible solvers, detailed explanation of all types of boundary conditions and their importance in CFD analysis, discretisation techniques like upwind methods(First order and second order), Quick methods and Power law. Relaxation parameters. Structured and unstructured grids, mesh quality parameters and their impact on numerical solution. Reynolds averaged Navier Stokes (RANS) equations, K-epsilon model, Spalart allmaras model, near wall flow modelling, Wall functions.

2. Fluid Dynamics

Significance of dynamic viscosity, laminar boundary layer, laminar-Turbulent transition, turbulent boundary layer, Structure of a turbulent boundary layer (laminar sub layer, buffer layer and log-law layer), Thermal boundary layer, boundary layer control, effect of adverse Pressure gradient, boundary layer separation.

3. Gas Dynamics

Fundamental physical quantities of a flowing gas. The source of aerodynamics forces, equation of state. Concept of Mach number and classification of flow regimes in to Incompressible, Subsonic, Transonic, Sonic, Supersonic and Hypersonic based on Mach number. Stagnation properties (stagnation pressure, stagnation enthalpy and stagnation temperature). Effect of Mach number on compressibility, mass flow rate in terms of pressure ratio, mass flow rate in terms of Mach number, flow through convergent nozzle, flow through convergent-divergent nozzle, flow through diffusers, Mach number variation in nozzle and diffuser, concept of shock wave. Use of gas tables.

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4. Heat Transfer

Significance of heat transfer in engineering design, Heat conduction equation, boundary conditions, thermal contact resistance. Laminar free convection, effect of turbulence on free convection, external free convection flows and free convection in enclosures. Significance of heat transfer coefficient, local and average convective heat transfer coefficient, heat transfer correlations in internal and external flows. Mechanism of radiation heat transfer, radiation intensity, radiation properties, concept of black body, radiation shape factor, radiation shield.

5. Aerodynamics

Introduction, Airfoil nomenclature,Lift,Drag and moment coefficients, Airfoil data, Infinite and finite wings, Pressure coefficient,Compressibilty correction for lift coefficient,Crtitical Mach number and critical pressure coefficients, Drag divergence mach number, Wave drag at supersonic speeds, summary of airfoil drag, calculation of induced drag, change in lift slope, swept wings, Mechanisms for higher lift.

6. ANSYS ICEMCFD Software

Blocking and Hexahedral mesh generation for, important tutorial geometries, Gas turbine compressor Impeller, Radial flow pump impeller, aircraft wing.

7. ANSYS FLUENT and ANSYS CFX Software

- ✓ CFD analysis of subsonic diffuser of a turbojet engine
- ✓ CFD analysis of airfoils
- ✓ CFD analysis of liquid cooled electronic system
- ✓ CFD analysis of centrifugal pump