Computational Fluid Dynamics for Turbomachinery - Web course

COURSE OUTLINE

The course is aimed at providing simple and unified treatment to solve flow and heat transfer problems associated with turbo machinery using CFD tools for the post graduate students specializing in this area.

The description of governing equations, boundary conditions and possible simplifications for modeling the fluid flow problems of turbo machinery are dealt with. Development methodologies for pre processing tools, namely, solid modeling and mesh generation are described.

Solvers for transient diffusion and convection problems with application to turbomachinery problems are provided. Euler's and Navier Stokes solvers for complex geometries, including rotor-stator combination, are detailed for incompressible, subsonic, transonic and supersonic flows. Turbulence models and heat transfer problems are presented with the help of case studies.

COURSE DETAIL

Sl. No	Topic	Hours
	Module 1: Governing equations	
1.	**Governing equations in stationary frame of reference** • Inviscid flows • Viscous flows	 1 2
2.	**Governing equations in rotating frame of reference** • Inviscid flows • Viscous flows	 1 1
3.	Reynolds averaged Navier–Stokes and Energy equations.	1
4.	Turbulence modeling.	2
	Module 2: Solids modelling	
5.	Plane and space curve.	2
6.	Generation of surface and volumes.	2

NP-TEL

NPTEL

http://nptel.iitm.ac.in

Mechanical Engineering

Pre-requisites:

Courses on

- Thermodynamics
- Fluid Mechanics
- Heat Transfer
- Turbo machinery

Additional Reading:

1. Von Karman Institute for Fluid Dynamics Lecture series 1998-2002.
2. Hirsch, C. Numerical Computation of Internal and External Flows, Vols. I & II, John Wiley, N.Y.

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7.	Algorithms for solid modelling.	4
	Module 3: Mesh generation	
8.	**Structured mesh generation** • Algebraic methods • Methods using Partial Differential Equations • Clustering of mesh	 1 2 1
9.	**Unstructured mesh generation** • Methods of elemental sub-division	 2
10.	Adaptive mesh generation.	2
	Module 4: Computational methods	
11.	**General formulation for transient - convection - diffusion equations** • Finite difference methods • Finite volume methods • Issues related convergence, consistency and stability	 2 4 2
12.	Treatment of complex geometries.	1
13.	Treatment of incompressible flows, supersonic flows and transonic flows.	2
	Module 5: Solvers	
14.	• Matrix solvers • Iterative solvers	2 2
	Module 6: Case studies	
15.	Case study 1: Internal flows • Incompressible flows • Supersonic flows • Transonic flows	3
16.	Case study 2: Cascade flows • Euler solver	4

	• N.S. Solver	
17.	Case study 3: Rotor / stator simulation.	2
18.	Case study 4: Simulation of blade cooling.	2
	TOTAL NUMBER OF LECTURES	50

References:

1. Fluid Dynamics and Heat Transfer of Turbo machinery by B. Lakshminarayana, John Wiley, N.Y.
2. Computational Fluid Dynamics by John D. Anderson, Jr, McGrawHill Int. ed.
3. Computational Fluid Flow and Heat Transfer by K Muralidhar and T. Sundararajan, Narosa Pub. N. Delhi.