Introduction to CFD

Swayam Prabha Course Code – M69

PROFESSOR'S NAME	Prof.M. Ramakrishna
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INSTITUTE	Indian Institute of Technology Madras
COURSE OUTLINE	Representation of mathematical ideas on the computer: numbers, functions, derivative, differential equations. Simple problems: Solution to Laplace's equation, one-dimensional first order wave equation, heat equation, Finite difference schemes - stability and consistency, dissipation dispersion, finite volume method. One-dimensional Euler's equation: Discretisation, Delta form, application of boundary conditions. Advanced topics: Roe's averaging, Multigrid Methods, SOR and variational techniques.

COURSE DETAILS

S. No	Module ID/ Lecture ID	Lecture Title/Topic
1.	**L1**	Introduction, Why and How We Need Computers
2.	**L2**	Representing Arrays and Functions on Computers
3.	**L3**	Representing Functions - Box Functions
4.	**L4**	Representing Functions - Polynomials & Hat Functions
5.	**L5**	Hat Functions, Quadratic & Cubic Representations
6.	**L6**	Demo - Hat Functions, Aliasing
7.	**L7**	Representing Derivatives - Finite Differences
8.	**L8**	Finite Differences, Laplace Equation
9.	**L9**	Laplace Equation - Jacobi Iterations

10.	**L10**	Laplace Equation - Iteration Matrices
11.	**L11**	Laplace Equation - Convergence Rate
12.	**L12**	Laplace Equation - Convergence Rate (Continued)
13.	**L13**	Demo - Representation Error, Laplace Equation
14.	**L14**	Demo - Laplace Equation, SOR
15.	**L15**	Laplace Equation - Final, Linear Wave Equation
16.	**L 16**	Linear Wave Equation - Closed Form & Numerical Solution, Stability Analysis
17.	**L17**	One Dimension Wave Equation - Generating A Stable Scheme & Boundary Conditions
18.	**L18**	Modified Equation
19.	**L19**	Effect Of Higher Derivative Terms On Wave Equation
20.	**L20**	Artificial Dissipation, Upwinding, Generating Schemes
21.	**L21**	Demo - Modified Equation, Wave Equation
22.	**L22**	Demo - Wave Equation / Heat Equation
23.	**L23**	Quasi-Linear One-Dimensional. Wave Equation
24.	**L24**	Shock Speed, Stability Analysis, Derive Governing Equations
25.	**L25**	One-Dimensional Euler Equations - Attempts To Decouple
26.	**L26**	Derive Eigenvectors, Writing Programs
27.	**L27**	Applying Boundary Conditions
28.	**L28**	Implicit Boundary Conditions
29.	**L29**	Flux Vector Splitting, Setup Roe's Averaging
30.	**L30**	Roes Averaging
31.	**L31**	Demo - One Dimensional Flow
32.	**L32**	Accelerating Convergence - Preconditioning, Dual Time Stepping
33.	**L33**	Accelerating Convergence, Intro to Multigrid Method

34.	**L34**	Multigrid Method
35.	**L35**	Multigrid Method - Final, Parallel Computing
36.	**L36**	Calculus Of Variations - Three Lemmas and A Theorem
37.	**L37**	Calculus of Variations - Application to Laplace Equation
38.	**L38**	Calculus of Variations -final & Random Walk
39.	**L39**	Overview and Recap of the course

List of reference material/ books:

Elements of CFD. M. Ramakrishna.

Name and contact details of two referees for the course: