VII Sem ME

Computational Fluid Dynamics
Assignment I
Unit - I

Due Date:**25 Aug 2025**

Note:

1. *Assignment should be hand-written on unrule sheet (A4 Size plain papers)*
2. *Write Questions (in black ink) and Answers (in blue). Figures, wherever required, should be drawn using pencil only.*
3. *Write Your Name, E.No, Course Name and Title, Date of Submission on Cover Page of Assignment. Cover Page can be typed. (see attached sample)*
4. *All pages of assignment should be properly stapled. You may also use a plastic folder.*
5. *Maximum marks for the entire assignment is 10.*
6. *No Marks will be awarded for incomplete / incorrect answers.Marks shall be deducted for illegible / untidy /rough Work.*
   *Due weightage will be given for **Neat work, good Handwriting and clear & labelled figures**.*
7. *Last Date of Submission is **25 Aug 2025***

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1. Write down the continuity and momentum equations for an incompressible Newtonian fluid.
2. Derive the heat conduction equation in three Cartesian coordinates.
3. For a given scenario of heat transfer through a composite wall, identify the relevant partial differential equation(s) that govern the temperature distribution.
4. Classify the following partial differential equation: $\partial u/\partial t = \alpha \, \partial^2 u/\partial x^2$.
5. Identify the type of partial differential equation governing steady-state heat conduction in a solid.
6. State the conditions under which the convective transport equation for momentum becomes hyperbolic.
7. Using a central difference scheme for the spatial derivative and a forward difference scheme for the temporal derivative, discretise the one-dimensional unsteady heat conduction equation.
8. Derive the finite difference approximation for the second-order spatial derivative ($\partial^2 u/\partial x^2$) using a three-point central difference formula on a uniform grid.
9. Explain how you would handle a non-uniform grid when discretizing a first-order spatial derivative using the finite difference method.
10. For the unsteady heat conduction in a rod with one end held at a constant temperature and the other end insulated, specify the appropriate boundary conditions in their discretized form.
11. Consider a fluid flow problem in a channel. Describe how you would implement a no-slip boundary condition at the walls using the finite difference method.
12. For a transient simulation of heat transfer starting from a known initial temperature distribution, describe how the initial condition is applied to the discretized equations.

13. Discuss the concept of truncation error in the finite difference method and how it relates to the order of accuracy of a scheme.
14. Explain the von Neumann stability analysis method for a discretized PDE.
15. What is the Courant-Friedrichs-Lewy (CFL) condition, and why is it important for the stability of certain finite difference schemes used in CFD?

Assignment I

of

Computational Fluid Dynamics

Paper Code: CADM-401P

VII Semester (BTech-ME)

Name of Student :

Enrollment Number :

Date of Submission :

Submitted on :

Grades :

Signature of Faculty :