BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)

CLASS: M.TECH **SEMESTER : I**
BRANCH: CHEM, MECH **SESSION : MO/19**

SUBJECT: SR578 COMPUTATIONAL FLUID DYNAMICS

TIME: 3:00 HOURS **FULL MARKS: 50**

INSTRUCTIONS:
1. The question paper contains 5 questions each of 10 marks and total 50 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
***4*. Before attempting the question paper, be sure that you have got the correct question paper.**
5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

Q.1(a) Define and give examples of elliptic, parabolic and hyperbolic partial differential equations. [5]

Q.1(b) The governing nondimensional equations of fluid motion for steady, inviscid and incompressible flow in two-dimensions are given by, [5]

$$\partial u/\partial x + \partial v/\partial y = 0$$

$$u\,\partial u/\partial x + v\,\partial u/\partial y + \partial p/\partial x = 0$$

$$u\,\partial v/\partial x + v\,\partial v/\partial y + \partial p/\partial y = 0$$

Classify the system of equations.

Q.2(a) Given the function $f(x) = \sin(2\pi x)$, determine $\partial f/\partial x$ at $x=0.3$ using central difference representation of order $(\Delta x)^2$. Use step size of 0.01 and 0.25. Compare it with the analytical value and discuss the results. [5]

Q.2(b) The finite difference scheme of the linear convection equation $\partial u/\partial t + c\,\partial u/\partial x = 0$ $(c>0)$ is given by, [5]

$$\frac{u_j^{n+1} - u_j^n}{\Delta t} = -\frac{c}{\Delta x}\left(u_j^n - u_{j-1}^n\right)$$

Perform the Von Neumann stability analysis and comment on the stability of the scheme.

Q.3(a) Explain line Gauss-Seidel iteration method for the solution of 2-D Laplace's equation [5]
$\partial^2 u/\partial x^2 + \partial^2 u/\partial y^2 = 0$.

Q.3(b) What do you understand by explicit and implicit schemes? Explain with suitable examples. [5]

Q.4(a) Derive the incompressible Navier-Stokes equations in vorticity-stream function formulations. [5]

Q.4(b) What do you understand by staggered grid? Why it is required for solving incompressible Navier-Stokes equations? [5]

Q.5(a) Discuss briefly on global and local time steps. [5]

Q.5(b) Explain the farfield and periodic boundary conditions. [5]

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