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

CLASS: M.TECH **SEMESTER : II**
BRANCH: SER **SESSION : SP/19**

SUBJECT: SR578 COMPUTATIONAL FLUID DYNAMICS

TIME: 3.00 Hrs. **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) Explain domain of dependence and zone of influence of different class of partial differential equations. [5]

Q.1(b) Classify the following system of partial differential equations: [5]
a $\partial u/\partial x + c\ \partial v/\partial y = f1$
b $\partial v/\partial x + d\ \partial u/\partial y = f2$
Consider two cases where (i) a=b=c=d=1, f1=f2=0 and (ii) a=b=1, c = -d = -1, f1=f2=0.

Q.2(a) Given the following data, compute f'(7) and f'(9). Use finite differencing of order (Δx). Compare the results to the values obtained by finite differencing of order (Δx)¤. [5]

x	5	6	7	8	9
f(x)	25	36	49	64	81

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]

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

Obtain the modified partial differential equation (mpde) of the above scheme and comment on the nature of the error of the scheme based on the TE term of the mpde.

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

Q.3(b) Discuss the alternating direction implicit (ADI) method for the 2-D model equation, $\partial u/\partial t = \alpha\ [\partial^2 u/\partial x^2 + \partial^2 u/\partial y^2]$, where α = constant. [5]

Q.4(a) Explain Marker and Cell (MAC) method for solving incompressible Navier-Stokes equations. [5]

Q.4(b) Discuss the artificial compressibility method for solving incompressible flows. [5]

Q.5(a) Derive the semi-discrete form of the Euler equations $\partial U/\partial t + \partial f/\partial x + \partial g/\partial y = 0$ using finite volume method, where U=vector of conserved variables, f and g are flux vectors in x and y directions respectively. [5]

Q.5(b) Write briefly on cell-centered and vertex-centered finite volume methods. [5]

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