

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

**CLASS: M. TECH.
BRANCH: SER**

**SEMESTER : II
SESSION : SP/2025**

SUBJECT: SR578 COMPUTATIONAL FLUID DYNAMICS

TIME: 3 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.
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		CO	BL
Q.1(a) Explain the equilibrium and marching problems based on the physical behaviour of the fluid flow.	[5]	1	II
Q.1(b) Classify the equation $y\partial^2\Phi/\partial x^2 + \partial^2\Phi/\partial y^2 = 0$.	[5]	1	III
Q.2(a) Given the function $f(x) = x^3 - 5x$, compute $\partial^2 f/\partial x^2$ at $x = 0.5$ using second order central differencing. Compare the result with the exact analytical value. Use step size of 0.1.	[5]	2	III
Q.2(b) The finite difference scheme of the equation $\partial u/\partial t = \alpha \partial^2 u/\partial x^2$ (where $\alpha = \text{constant}$) is given by,	[5]	2	III
$\frac{u_j^{n+1} - u_j^n}{\Delta t} = \frac{\alpha}{(\Delta x)^2} (u_{j+1}^n - 2u_j^n + u_{j-1}^n)$			
Perform the von Neumann stability analysis and comment on the stability of the scheme.			
Q.3(a) Discuss the alternating direction implicit (ADI) method to solve the 2-D Laplace's equation $\partial^2 u/\partial x^2 + \partial^2 u/\partial y^2 = 0$ numerically.	[5]	3	II
Q.3(b) Write short notes on the monotone and total variation diminishing (TVD) schemes.	[5]	3	II
Q.4(a) Derive the Poisson equation for pressure in primitive variable formulation.	[5]	4	II
Q.4(b) Explain Marker and Cell (MAC) method for solving incompressible Navier-Stokes equations.	[5]	4	II
Q.5(a) Derive the finite volume state update formula for solving 2-D Euler equations.	[5]	5	II
Q.5(b) Define the global and local time steps. Discuss on the advantages and disadvantages of these methods.	[5]	5	II

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