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M. Tech 1st Semester Examination

Advanced Fluid Mechanics

WRE-101

Time : 3 Hours

Max. Marks : 100

The candidates shall limit their answers precisely within the answer-book (40 pages) issued to them and no supplementary/continuation sheet will be issued.

Note : Attempt all questions. All questions carry equal marks.

1. (a) What is the Lagrangian description of the fluid motion? How does it differ from Eulerian description? (12)
- (b) Consider the following steady, two dimensional velocity fields:
 - (i) $\vec{V} = (u, v) = [a^2 - (b - cx)^2]\vec{i} + (-2cby + 2c^2xy)\vec{j}$
 - (ii) $\vec{V} = (u, v) = (0.5 + 1.2x)\vec{i} + (-2.0 - 1.2y)\vec{j}$ (8)
2. (a) Describe acceleration of an ideal fluid element in Cartesian and cylindrical polar coordinates, given $\vec{q} = \vec{u}_i + \vec{v}_j + \vec{w}_k$ as velocity vector, where u, v and w are functions of x, y, z and t , where $u = x_i + 2y_j + 3z_k$; $v = 2x_i + 3y_j + 4z_k$; $w = 3x_i + 4y_j + 5z_k$. (10)
- (b) Determine the resultant of an uniform flow of an ideal fluid superimposed on a doublet. Determine the relationship between this flow and that of an ideal fluid past a circular cylinder. (10)
3. (a) Describe a normal shock on h-s diagram. Obtain the governing relation for a normal shock to evaluate Mach number M_2 downstream of a normal shock for a given upstream condition of M_1 . (12)

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- (b) How do you estimate the effects of a moving shock wave with the help of relative velocity method (i) when the observer is stationary and (ii) when the observer is located on the shock wave itself. (8)
4. (a) Derive the Navier-Stokes equation of motion for an incompressible viscous fluid in Cartesian coordinate system. (10)
- (b) What do you understand by an exact solution of Navier-Stokes equation? Discuss briefly with suitable example of a fully developed in a pipe/ between parallel plates. (10)
5. (a) Explain the significance of divergence of velocity and substantial derivative. How substantial derivative different than derivative in differential calculus? (12)
- (b) Explain any two types of errors encountered in numerical methods and indicate how the error occurs? (8)