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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.

1 (a) In a 1-D flow field, the velocity at a point may be given in the Eulerian system by u = x + t. Determine the displacement of a fluid particle whose initial position is x_0 at initial time t_0 in the Lagrangian system. (10)

(b) Given a velocity field $\vec{V} = (4 + xy + 2t)\vec{i} + 6x^3\vec{j} + (3xt^2 + z)\vec{k}$. Find the acceleration of a fluid particle at (2, 4, –4) and time t = 3. (10)

2. Attempt the following:

(a) Explain briefly the doublet

(b) Explain circulation and its theorem.

(c) What do understand by Rankine body? Draw stream lines to deposit a Rankine body.

(d) The stagnation points are located at –31.5° and –148.5° angular position on the periphery of a cylinder having 50 cm diameter rotating at some speed in the uniform flow of 15 m/s. Determine the speed of rotating cylinder. (5x4=20)

[P.T.O.]

3. (a) Starting from N.S equation derive an expression for velocity distribution, shear force and discharge for the laminar flow between two parallel plates (10)

(b) The normal depth of flow of water, in a rectangular channel 1.5m wide is 1m. The bed slope of the channel is 0.0006 and Manning's roughness coefficient n= 0.012. Find the critical depth.

At a certain section of the same channel the depth is 0.92 m while at a second section the depth is 0.86 m. Find the distance between the two sections (use one reach in the calculations). Also find whether the section is located downstream or upstream with respect to the first section. (10)

4. (a) Starting from energy equation derive Prandtl-Meyer relation. (10)

(b) Air flowing steadily in a nozzle experiences a normal shock at a Mach number of 2.5. If the pressure and temperature of air are 61.64 kPa and 262.15 K, respectively, upstream of the shock, calculate the pressure, temperature, velocity, Mach number, and stagnation pressure downstream of the normal shock. (10)

5. (a) Explain in detail the difference between Finite Difference Method and Finite Element Method. (10)

(b) Describe in detail the concept of Cholesky's decomposition, and banded skyline solutions to solve the simultaneous equations in matrix form. (10)