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Total Number of Pages: 02

M. Tech.
HTPC101

1st Semester Back Examination 2017-18

ADVANCE FLUID MECHANICS

BRANCH: HEAT POWER & THERMAL ENGG, THERMAL POWER ENGG

Time: 3 Hours

Max Marks: 70

Q.CODE: B812

Answer Question No.1 which is compulsory and any five from the rest.
The figures in the right hand margin indicate marks.

- Q1 Answer the following questions :** (2 x 10)
- Water temperature in an open container changes from $T=20^{\circ}\text{C}$ at top to $T=10^{\circ}\text{C}$ at bottom. Is the water continuous with respect to temperature and density?
 - For steady, inviscid, incompressible and irrotational flow, Bernoulli's equation is applicable only along stream line. True/False? Explain.
 - Is it necessary to invoke stokes hypothesis for incompressible flow? Explain.
 - For a two dimensional flow $\vec{V} = 2x^2yi - 2yx^2j$. Does it represent a possible flow? Is velocity potential defined here?
 - The elements of stress tensor at a point is given as $\begin{bmatrix} 1 & 4 \\ 4 & 3 \end{bmatrix}$. Can the continuum in which this tensor exists be a fluid? Explain.
 - Define stagnation pressure for incompressible and compressible flow.
 - For incompressible flow, $\frac{D\rho}{Dt} = 0$. Does it mean that ρ is constant in the flow? Explain.
 - In most of the cases flow is viscous. In this regard, does the study of potential flow (inviscid flow) theory have any relevance?
 - A cylinder is dragged sidewise towards right and is made to rotate clockwise in a fluid medium. What will be the direction of the Lift force i.e. upward or downward? Explain.
 - In a fully developed laminar flow through a pipe, the shear stress on the centerline is zero. Can Bernoulli's equation be applied along the pipe centre line?
- Q2**
- Explain the Eulerian and Lagrangian description of flow. (5)
 - Show that the deformation tensor **D** is a second rank tensor. Here (5)

$$d_{ij} = \frac{1}{2} \left(\frac{\partial u_i}{\partial x_j} + \frac{\partial u_j}{\partial x_i} \right)$$
 Note that transformation rules for vectors are: $a_i = l_{ij} a'_j$
 and $a'_i = l_{ji} a_j$. For tensors $T_{ij} = l_{im} l_{jn} T'_{mn}$ and $T'_{ij} = l_{im} l_{nj} T_{mn}$.
- Q3**
- Explain the stream function and velocity potential. (5)
 - A long pipe is connected to a large reservoir that initially is filled with water to a depth of 3m. The pipe is 150mm in diameter and 6m long. Determine the flow velocity leaving the pipe as a function of time after the cap is removed from its free end. Assume the flow to be frictionless and incompressible. State any other assumptions clearly. (5)

- Q4** a) Derive the Navier Stokes equations for compressible flow. (5)
 b) What is Prandtl's mixing length theory? Explain (5)
- Q5** a) Explain the Hiemenz flow. (5)
 b) What is Hagen-Poiseuille flow? Explain (5)
- Q6** a) Explain Karman's velocity defect law. (5)
 b) What is Karman's velocity defect law? Explain. (5)
- Q7** Derive an equation for the speed of the sound in a medium and show that for an ideal gas, $C = \sqrt{\gamma RT}$, where C is the speed of sound and γ is the ratio of specific heats. (10)
- Q8** **Write short answer on any TWO :** (5 x 2)
 a) Strain rate tensor
 b) Hydrodynamic lubrication
 c) Stokes and Oseen's approximation
 d) Universal velocity distribution