BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI
SEMESTER I, 2016-17
CHE F212: FLUID MECHANICS
MID-SEMSTER EXAMINATION (CLOSED BOOK)

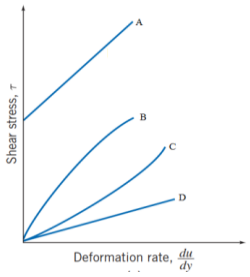
A

Date: 07/10/2016 **Duration: 90 min**
Day: Friday **Max. Marks: 75**

Instructions:
1. **Take suitable assumption wherever necessary.**
2. **Start a new answer on a new page.**
3. **Numbers in square bracket to the right indicate marks allotted to that question.**

Q.1) Choose the most appropriate answer among the given choices (0.25 Marks would be deducted for each wrong answer): **[10]**

1. Fluid following no-slip condition:
   a.) have zero velocity at the surface b.) have minimum velocity at the surface
   c.) is an experimental fact d.) both (a) and (b)
2. Which of the following statement is false:
   a.) The boundaries of the system may not necessarily be rigid, i.e., they may move.
   b.) A system has fixed quantity of mass at any given instant of time, but it may be different from mass present at other instant of time.
   c.) Heat and work may cross the boundaries of the system.
   d.) Newton's IInd law is applicable to system.
3. In British Gravitational unit system, which of the following is not a primary dimension:
   a.) Mass b.) Force c.) Time d.) Temperature
4. For steady flow which of the following is not identical to the other three:
   a.) Streamline b.) Pathline c.) Streakline d.) Timeline
5. Bulk compressibility modulus is given by:
   a.) $\frac{(dp/p)}{\rho}$ b.) $\frac{(d\rho/\rho)}{dp}$ c.) $\frac{\rho}{(dp/p)}$ d.) $\frac{dp}{(d\rho/\rho)}$
6. Suspension of starch/sand is an example of _____fluid.
   a.) Shear thickening b.) Shear thinning c.) Bingham plastic d.) Thixotropic
7. Which of the following statement is false about streamlines:
   a.) Are always tangent to the direction of flow.
   b.) There can be no flow across streamlines.
   c.) They are hypothetical lines in the flow field.
   d.) They are always parallel to each other.
8. In the fig. 8, B and C are respectively:



   a.) Bingham plastic and Dilatant b.) Pseudo plastic and Dilatant
   c.) Bingham plastic and Pseudo plastic d.) Dilatant and Pseudoplastic
9. A liquid can be defined as "wetting" a surface when the contact angle is:
   a.) 90^o b.) $<90^o$ c.) $>90^o$ d.) ∞
10. _____suggested the existence of a thin boundary layer in which the friction is significant.
    a.) d'Alembert b.) Osborne Reynolds c.) Ludwig Prandtl d.) Daniel Bernoulli

Q.2) Fill the blanks with the appropriate answers: **[10]**

1. A velocity field is given by $\vec{V} = axi - btyj$, where a=1 s^{-1} and b=1 s^{-2}. The equation of streamline at any time t is given by_____.
2. For laminar boundary layer flow Reynold's number should be_____.
3. The change in height, h due to capillary effect in a circular tube of radius, R with surface tension, σ and contact angle θ is_____.
4. Conversion factor to convert a specific heat of kJ/kg.K to Btu/lbm.^{o}R is_____.
5. The x component of velocity in a steady, incompressible flow field in the xy plane is u=A/x, where A=2 m^2/s, and x is measured in meters. The simplest y component of velocity for this flow field is_____.

Q.3) Answer the following questions (maximum words: 30): **[15]**

1. What is the relation between gas compressibility and Mach number?
2. Discuss d'Alembert's paradox?
3. Draw a neat schematic of Boundary layer flow over a flat plate.
4. What do you understand by creeping flow? Draw its neat schematic.
5. Briefly explain the local and convective acceleration.

Q.4) Prove that pressure at any point within a static fluid is the same in all directions. **[10]**

Q.5) **Solve the following problem on the basis of Integral form of Momentum equation for inertial control volume.** **[12]**

The police are using fire hoses to disperse an unruly crowd. The fire hoses deliver 0.01 m^3/s of water a velocity of 30 m/s. One member of the crowd has picked up a garbage can lid and is using it as a shield to deflect the flow. She is holding it vertically [Fig. 4(a)], so the jet splits into a series of jets going off in the y and z directions, with no x-component of the velocity. What force must she exert to hold the garbage can lid?

She realized that she has to apply great force in deflecting the flow while holding the lid vertically. She then turns the lid so that it deflects the stream off at a 45^{o} angle to the vertical [Fig. 4 (b)] without changing its velocity. Now what force must she exert?

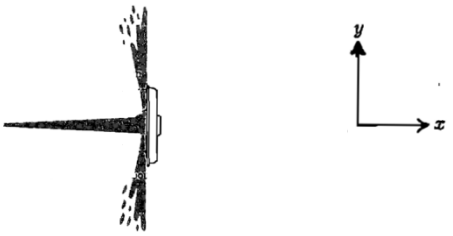


Fig. 4(a)

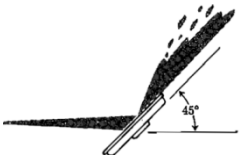


Fig. 4(b)

Q.6) Discuss the limitations of Bernoulli's equation. **[6]**

Q.7) Water is being steadily fed from a large storage tank to an open tank mixer through a short length pipe by gravity. The level of water in the storage tank is 5 m above the center of the discharge pipe. To increase the velocity at discharge a nozzle of 1-in diameter is fitted to the pipe. It is required to preheat the water before feeding into the mixer. For this purpose a well-insulated 12 kW heater is surrounded to the pipe. How much would be the rise in temperature of water. **[12]**

Note: Make use of energy equation to solve this problem.

----------The End----------