# VEERMATA JIJABAI TECHNOLOGICAL INSTITUTE

[Central Technological Institute, Maharashtra State]

**Matunga, Mumbai-400 019**

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| SEMESTER EXAMINATION | | DATE OF EXAM | 5-5-2014 |
| SEMESTER & PROGRAM | IV B. Tech (Mechanical) | TIME | 1.30 - 4.30 p.m. |
| TIME ALLOWED | 3 HRS. | MARKS | 100 |
| COURSE (Course Code): | Fluid Mechanics-I (ME0209) | | |

Instructions
1. **All Questions are compulsory.**
2. Figures to the right indicate full marks.
3. Assume suitable data if necessary.
4. Illustrate your answers with neat sketches wherever necessary.

1. Answer in brief. (any 5) **20**
   a) Explain the relations between atmospheric pressure, absolute pressure, gauge pressure and vacuum pressure.
   b) Explain streamline, streamtube, pathline and streakline.
   c) Flow of air at 50°C is measured by a pilot-static tube. The differential reading in a water manometer is 24 mm. Determine the velocity of air if the coefficient of tube is 0·95. Assume the density of air to be constant at 1·2 kg/m$^3$
   d) State the conditions under which prototype behavior can be predicted from model tests. What is scale effect?
   e) Explain hydraulic grade line and total energy line.
   f) Explain flow rate measurement in pipe using orifice meter.

2. a) The space between two large flat and parallel walls 20 mm apart is filled with a liquid of absolute viscosity 0.8 Pa.s. Within this space a thin flat plate 200 mm × 200 mm is towed at a velocity of 200 mm/s at a distance of 5 mm from one wall. The plate and its movement are parallel to the walls. Assuming a linear velocity distribution between the plate and the walls, determine the force exerted by the liquid on the plate. **6**

   b) For the system shown in Fig.1,determine the air pressure $p_A$ which will make the pressure at N one fourth of that at M. **4**

   **or**

   Calculate the atmospheric pressure at the end of troposphere, which extends upto a height of 9 km from sea level. Consider a temperature variation in the troposphere as $T = 288 - 0.006$, where $y$ is the elevation in m and $T$ is temperature in K. The atmospheric pressure and temperature at sea level are 101.3 kN/m$^2$ and 288 K respectively. The characteristic gas constant for air is 287 J/kg-K.

   c) The profile of the inner face of a dam takes the form of a parabola with the equation $18y = x^2$ , where y is the height above the base and x is the horizontal distance of the face from the vertical reference line. The water level is 27 m above the base. Determine the thrust on the dam (per meter with) due to the water pressure, its inclination to the vertical and the point where the line of action of this force intersects the free water surface. **10**

3. a) i) Write the differential form of conservation of mass in rectangular coordinates and state the physical meaning of each term in the equation. **6**
   ii) Write the differential form of the momentum equation for viscous flow and state the physical meaning of each term in the equation.

   b) For a steady two-dimensional incompressible flow through a nozzle, the velocity field is given by $\vec{V} = u_0(1 + 3x/L)\vec{\imath}$ where x is the distance along the axis of the nozzle from its inlet plane and L is the length of the nozzle. Find i) an expression of the acceleration of a particle flowing through the nozzle. ii) the time required for a fluid particle to travel from the inlet to the exit of the nozzle. **6**

P.T.O.

c) Water flows as two free jets from the tee attached to the pipe shown in Fig.2. The exit speed is 15 m/s. If viscous effects and gravity are negligible, determine the x and y components of the force that the pipe exerts on the tee. **8**

4. a) Calculate the thrust required to run a motor-boat 5 m long at 100 m/s in a lake if the force required to tow a 1: 30 model in a reservoir is 5 N. Neglect the viscous resistance due to water in comparison to the wave making resistance. Derive the dimensionless parameters used for the solution of the problem. **10**

b) Two reservoirs are connected by three cast iron pipes in series, $L_1$ = 600 m, $D_1$ = 0.3 m, $L_2$ = 900 m, $D_2$ = 0.4 m, $L_3$ = 1500 m and $D_3$ = 0.45 m. When the discharge is 0.11 $m^3/s$ of water at $15^0$C, determine the difference in elevation between the reservoirs. Take $\varepsilon$ = 0.26 mm for cast iron. Neglect minor losses. **10**

**or**

Three pipes of 200 mm, 400 mm and 200 mm diameters and having lengths of 200 m, 400 m and 200 m, respectively are connected in series to make a compound pipe. The ends of this compound pipe are connected with two tanks whose difference in water levels is 15 m. If the friction factor f, for all the pipes is same and equal to 0.02, determine the discharge through the compound pipe by first neglecting the minor losses and then including them. Take coefficient of contraction as 0.6.

5. a) Consider a short cylindrical duct whose cross-section enlarges abruptly from a diameter $D_1$ to a diameter $D_2$. Find the ratio $D_1/D_2$ so that the pressure drop for a given flow rate of a fluid through the duct is independent of the direction of flow. Neglect the losses due to skin friction. (Take co efficient of contraction $C_c$ = 0.6) **8**

b) An oil with density 900 $kg/m^3$ and viscosity 0.16 $Ns/m^2$ is flowing through a 20 cm diameter pipe. The maximum shear stress at the pipe wall is 2.5 $N/m^2$. Determine (a) the pressure gradient, (b) the average velocity of flow and (b) the maximum velocity of flow. **6**

c) What do you mean by the separation of a boundary layer? How boundary layer separation can be reduced? **6**

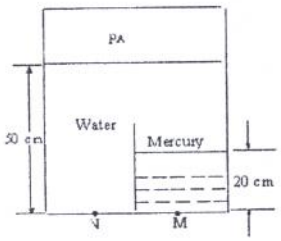


**Fig.1**

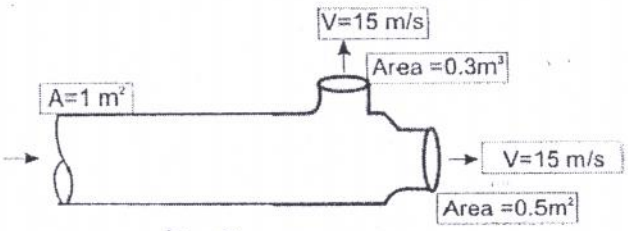


**Fig.2**