End-Semester Examination (Even Semester 2015-2016)

B.Tech. (Mechanical + Production)- 4th Semester

Fluid Mechanics (AM 1401)

Time: 3 hrs. **Max. Marks: 60**

Note: Attempt all questions. Assume data if necessary with proper justifications.

1. A turbine is to operate under a head of *25 m* at *200 rpm*. The discharge and overall efficiency of the turbine are *9 m^3/s* and *90%*, simultaneously. Determine: *(i)* specific speed of the turbine, *(ii)* power generated, and *(iii)* type of turbine.

(2+2+1=5)

2. ***Sketch*** the followings with proper labels (*don't give any theoretical explanation*):

   a) Modern Francis Turbine (Cross-sectional view)
   b) Centrifugal Pump (Cross-sectional view)
   c) Pitot Tube
   d) Superposition of Uniform flow parallel to *x*-axis + Source and Sink very near to origin.

(2+2+2+1=7)

3. Air is flowing over a smooth plate with a velocity of *10 m/s*. The length of the plate is *1.2 m* and width *0.8 m*. If laminar boundary layer exists up to a value of $Re = 2\times10^5$, find the maximum distance from the leading edge up to which laminar boundary layer exists. Also find the maximum thickness of laminar boundary layer if the velocity profile is given as:

$$\frac{u}{U} = 2\left(\frac{y}{\delta}\right) - \left(\frac{y}{\delta}\right)^2$$

(3+4=7)

4. Starting from the Navier-Stokes equation, derive the velocity distribution for a fully developed laminar flow in a circular pipe. Further, determine the radial distance from the pipe axis at which the velocity equals the average velocity.

(6+4=10)

5. When tested in water ($\rho=998\ kg/m^3$ *and* $\mu=0.001\ kg/m.s$) flowing at *2 m/s*, an *8 cm* diameter sphere has a measured drag of *5 N*. What will be the velocity and drag force on a *1.5 m* diameter weather balloon moored in sea-level standard air ($\rho=1.2255\ kg/m^3$ *and* $\mu=1.78\times10^{-5}\ kg/m.s$) ?

(3+4=7)

6. SAE 10 oil ($\rho=870\ kg/m^3$ *and* $\mu=0.104\ kg/m.s$) flows through the *4 cm* diameter vertical pipe of ***Figure: 1***. For the mercury manometer reading $h = 42\ cm$ shown, (*a*) calculate the volume flow rate in m^3/h, and (*b*) state the direction of flow with justification.

(5+2=7)

7. Find the magnitude and direction of the resultant water pressure acting on a curved face of a dam which is shaped according to the reaction $y = \frac{x^2}{9}$ as shown in ***Figure: 2***. The height of the water retained by the dam is *10 m*. Consider the width of the dam as unity. **(7)**

8. ***Fill in the blanks:*** **(1×10=10)**

i. For a Newtonian fluid, the plot of shear stress versus the rate of deformation is a ..... whose slope is the .....of fluid.

ii. For a horizontal surface, the centre of pressure always ..... with the centroid of the immersed surface.

iii. For uniform stream of flow moving at constant velocity *V* in the *x-direction*, the expression for velocity potential is given by ϕ= .....

iv. The shear stress in turbulent flow is mainly due to ..... of the flowing Fluid.

v. The Von-Karman momentum integral equation for a general body is .....

vi. The specific speeds of a Kaplan, Francis and Pelton turbines are in the ..... order.

vii. Draught tubes are provided only for ..... turbines and not for ....., turbines.

viii. Maximum speed of a reciprocating pump is determined from the fact that the pressure in the cylinder during suction and delivery stoke should not fall below the ..... of the liquid.

ix. The rotating part of a pump is called the ..... and that of turbine is called the .....

x. The leading edge of the blades in ..... and the trailing edge of the blades in ..... are susceptible to cavitation damage.

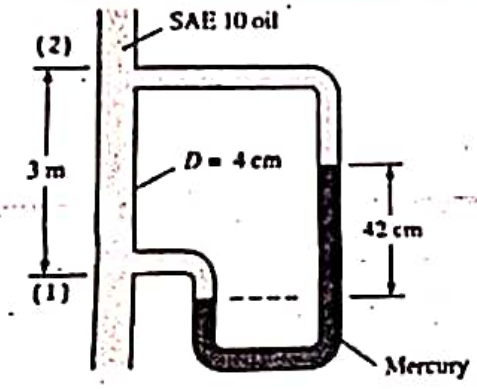

Fig. 1

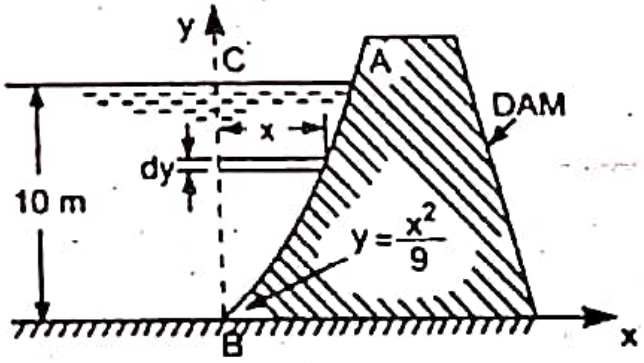

Fig. 2