Reg. No.										

Manipal Institute of Technology, Manipal

(A Constituent Institute of Manipal University)

III SEMESTER B.TECH (AUTOMOBILE ENGINEERING)

END SEMESTER EXAMINATIONS, NOV/DEC 2015

SUBJECT: FLUID MECHANICS [AAE 2105]

REVISED CREDIT SYSTEM

Time: 3 Hours. MAX.MARKS: 50

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitably assumed.

1A. If it is known that the air velocity in the duct is $750\ ft/s$, use that mercury manometer measurement in Fig. P9.25 to estimate the static pressure in the duct, in psia. **(05)**

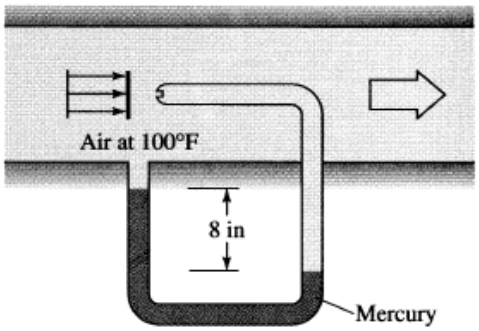


Fig. P9.25

1B. Explain about Mach number and speed of sound? Find the speed of sound of air at 0^0C. **(03)**

1C. Describe the unsteady and convective effects shown by the material derivative formula. **(02)**

2A. Consider a sphere of radius R immersed in a uniform stream U_0, as shown in Fig. P4.7. According to the fluid kinematics, the fluid velocity along streamline AB is given by **(05)**

$$V = ui = U_0 \left(1 + \frac{R^3}{x^3}\right) i$$

Find (a) the position of maximum fluid acceleration along AB and (b) the time required for a fluid particle to travel from A to B.

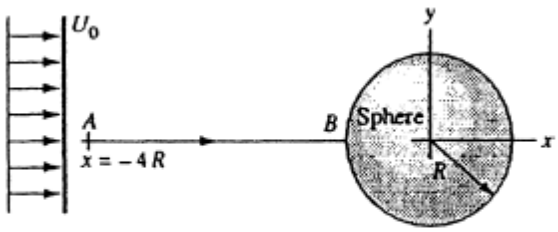
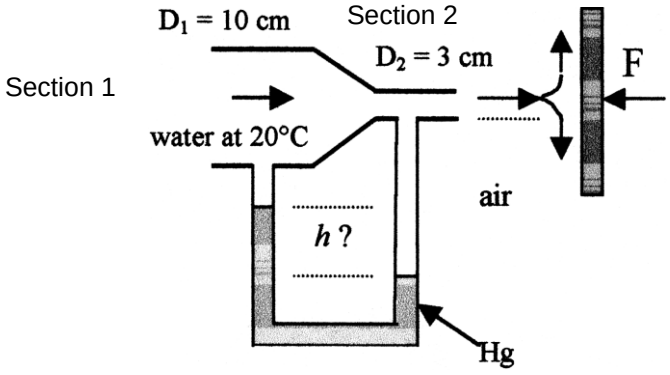


Fig. P4.7

2B. Consider the two-dimensional incompressible velocity potential $\Phi = xy + x^2 - y^2$. (a) Is it true that $\nabla^2\Phi = 0$, and, if so, what does this mean? (b) If it exists, find the stream function $\Psi(x, y)$ of this flow. (c) Find the equation of the streamline which passes through $(x, y) = (2, 1)$. **(03)**

2C. If the velocity of a flow field is given as $V = (0.66 + 1.3x)i + (-2.7 - 1.3y)j$. Find the location of its stagnation point. **(02)**

3A. Water flows through a circular nozzle, exits into the air as a jet, and strikes a plate. The force required to hold the plate steady is $70\ N$. Assuming frictionless one dimensional flow, estimate (a) the velocities at sections 1 and 2; (b) the mercury manometer reading h. **(05)**



3B. Isosceles triangle gate AB in Fig. P2.68 is hinged at A and weighs $1500\ N$. What horizontal force P is required at point B for equilibrium? **(03)**

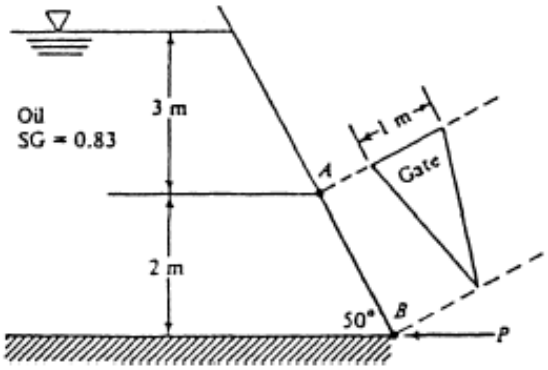
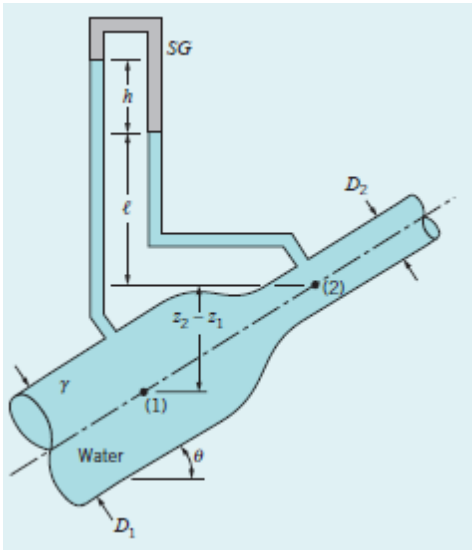


Fig. P2.68

3C. For a certain two dimensional flow field, if the velocity is given by the equation $V = (x^2 - y^2)i - 2xyj$. Is the flow rotational? **(02)**

4A. Water flows through a pipe reducer as is shown in Fig. below. The static pressures at 1 and 2 are measured by the inverted U-tube manometer containing oil of specific gravity, SG, less than one. Show that the manometer reading h is given by **(05)**

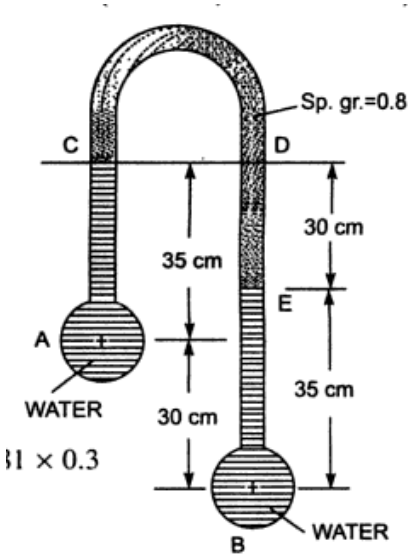
$$h = (Q/A_2)^2 \frac{1 - (A_2/A_1)^2}{2g(1 - SG)}$$



4B. In addition to the customary horizontal velocity components of the air in the atmosphere (the "wind"), there often are vertical air currents (thermals) caused by buoyant effects due to uneven heating of the air. Assume that the velocity field in a certain region is approximated by $u = u_0, v = v_0(1 - y/h)\ for\ 0 < y < h, and\ u = u_0, v = 0\ for\ y > h$. Plot the shape of the streamline that passes through the origin for values of $u_0/v_0 = 0.5, 1$, and 2. **(03)**

4C. What is boundary layer? How flow separation happens at separation location past a body? **(02)**

5A. An inverted U-tube manometer is connected to two horizontal pipes A and B through which water is flowing. The vertical distance between the axes of these pipes is $30\ cm$. when an oil of sp. Gravity 0.8 is used as a gauge fluid, the vertical heights of the water columns in the two limbs of the inverted manometer (when measured from the respective centerlines of the pipes) are found to be same and equal to $35\ cm$. Determine the difference of pressure between the pipes. **(05)**



5B. A thin flat plate 55 by 110 cm is immersed in a $6\ m/s$ stream of SAE 10 oil at 20^0C. Compute the total friction drag if the stream is parallel to (a) the long side and (b) the short side. For SAE 30 oil at 20^0C, take $\rho = 891\ kg/m^3$ and $\mu = 0.29\ kg/ms$. **(03)**

5C. What is a pitot static tube? On what principle it is based on? **(02)**