(Following Paper ID and Roll No. to be filled in your Answer Book)

PAPER ID : 1238 Roll No.

B.Tech.

(SEM. III) ODD SEMESTER THEORY EXAMINATION 2013-14

FLUID MECHANICS

Time : 3 Hours *Total Marks : 100*

Note :–Attempt **all** the Sections.

SECTION–A

1. Attempt **all** parts. Write in brief : **(2×10=20)**

   (a) Define Newton's law of viscosity.

   (b) With neat sketch, explain the condition of equilibrium for sub-merged bodies.

   (c) Define Sonic and Subsonic flow.

   (d) Explain Source and sink with the help of its suitable sketches.

   (e) Write down the various assumptions involved in the Bernoulli's equation.

   (f) Explain the principle of venturimeter with a neat sketch.

   (g) Discuss the loss of energy in sudden expansion in pipe flow.

   (h) What do you mean by the water hammer ?

   (i) Explain the momentum thickness related to boundary layer flow.

   (j) Briefly describe the concept of separation of boundary layer with neat sketch.

SECTION–B

2. Attempt any **six** of the following : **(5×6=30)**

(a) On a certain planet a correctly calibrated spring balance shows the weight of a body as 12 N, the mass of which is 4.893 kg. Find the value of gravity on this planet.

(b) Two large plane surfaces are 2.4 cm apart. The space between the surfaces is filled with oil with dynamic viscosity 0.810 Ns/m^2. What force is required to drag a very thin plate of surface area 0.5 m^2 between the two large surfaces at speed of 0.6 m/s when the thin plate is at the distance of 0.8 cm from one of the plane surfaces ?

(c) Define the following terms : Velocity potential function and Stream function.

(d) In a steady fluid flow, the velocity components are : $u = 2kx$; $v = ky$ and $w = -4kz$. Find the equation of streamline passing through the point (1,0,1).

(e) A pipe AB branches into two pipes C and D. The pipe has diameter of 45 cm at A, 30 cm at B, 20 cm at C and 15 cm at D. Determine the discharge at A if the velocity at A is 2 m/s. Also determine the velocities at B and D, if the velocity at C is 4 m/s.

(f) The efficiency η of a fan depends on the density ρ, dynamic viscosity μ of the fluid, angular velocity ω, diameter D of the rotor and the discharge Q. Express η in terms of dimensionless parameters.

(g) A fluid of viscosity 0.7 Ns/m^2 and specific gravity 1.3 is flowing through a circular pipe diameter 100 mm. The maximum shear stress at the pipe wall is given as 196.2 N/m^2; find the pressure gradient.

(h) Explain the phenomenon of drag on a sphere; and draw a graph for C_D at various values of R_e.

SECTION–C

3. Attempt any **two** parts of the following : **(5×2=10)**

   (a) Derive an expression for centre of pressure and total pressure for an inclined surface submerged in a fluid.

   (b) A pressure gauge, calibrated to read volume of fuel, is used gauge. It is connected at the bottom of a fuel tank of area 267 cm^2. The gauge is calibrated to read maximum volume of 8 litres. If there accumulates 1 cm layer of water fuel in tank, how much fuel is measured when the gauge shows full scale reading ? Assume density of fuel 730 kg/m^3.

   (c) Find the percentage volume of an iceberg above the water surface if it floats in sea water. Assume density of sea water 1010 kg/m^3 and density of iceberg 920 kg/m^3.

4. Attempt any **two** parts of the following : **(5×2=10)**

   (a) For steady – incompressible flows derive the continuity using 3 – D rectangular co – ordinate systems.

   (b) The following cases represent the two velocity components, determine the third component of velocity such that they satisfy the continuity equation :

   (i) $u = x^2 + y^2 + z^2$; $v = xy^2 - yz^2 + xy$

   (ii) $v = 2y^2$; $w = 2xyz$.

   (c) The velocity potential function φ is given by an expression $\varphi = -\frac{xy^2}{2} - x^3 + \frac{x^2y}{2} + y^3$; find the velocity components u and v.

5. Attempt any **one** part of the following : **(10×1=10)**

   (a) Prove that the velocity distribution for viscous flow between two parallel plates when both plates are fixed across a section is parabolic in nature. A horizontal venturimeter with inlet diameter 20 cm and throat diameter 10 cm is

used to measure the flow of water. The pressure at inlet is 17.658 N/cm^2 and the vacuum pressure at the throat is 30 cm of mercury. Find the discharge of water through venturimeter. Take $C_d = 0.98$.

(b) The pressure drop 'Δp' in a pipe of diameter 'D' and length 'l' due to viscous flow depends on the velocity 'v', dynamic viscosity 'μ' and mass density 'ρ' using Buckingham's theorem, obtain an expression for 'Δp'.

6. Attempt any **two** parts of the following : **(5×2=10)**

(a) Sketch the shear stress and velocity profile across a section of a circular pipe, for the viscous flow. Derive the expression governing the shear stress and velocity profile.

(b) Derive Hagen Posiuille's equation for laminar flow through a circular pipe.

(c) What do you mean by the Prandtl mixing length theory ? Find an expression for shear stress due to Prandtl.

7. Attempt any **two** parts of the following : **(5×2=10)**

(a) What are the boundary conditions that must be satisfied by a given velocity profile in laminar boundary layer flows ?

(b) A flat plate 1.5 m × 1.5 m moves at 50 km/hr in stationary air of density 1.15 kg/m^3. If the coefficients drag and lift are 0.15 and 0.75 respectively. Determine :

(i) The lift force

(ii) The drag force

(iii) The resultant force

(iv) The power required to keep the plate in motion.

(c) A pipe line 50 m long, connects two reservoirs, having water level water level difference of 10 m, diameter of the pipe is 300 mm. Find the rate of water flow, considering all the losses. Coefficient of friction for pipe material is 0.01.