

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

PAPER ID : 1238

Roll No.

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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 Re .

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 cm². 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/m³.
- (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/m³ and density of iceberg 920 kg/m³.

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

$$\phi = -\frac{xy^2}{2} - x^3 + \frac{x^2y}{2} + y^3$$

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 : $(5 \times 2 = 10)$

- (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 : $(5 \times 2 = 10)$

- (a) What are the boundary conditions that must be satisfied by a given velocity profile in laminar boundary layer flows ?
- (b) A flat plate $1.5 \text{ m} \times 1.5 \text{ m}$ 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 :
- The lift force
 - The drag force
 - The resultant force
 - The power required to keep the plate in motion.
- (c) A pipe line 50 m long, connects two reservoirs, having 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 .