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

PAPER ID : 1261 Roll No. | | | | | | | | | |

B.Tech.

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

FLUID MECHANICS

Time : 3 Hours *Total Marks : 100*

Note :–Attempt all questions.

SECTION–A

1. Attempt all parts : **(10×2=20)**

   (a) Differentiate between Newtonian and Non-Newtonian fluids.

   (b) State the Pascal's law giving some example where this principle is applied.

   (c) What is the difference between compressible and incompressible flow ?

   (d) Define steady and unsteady flow giving examples.

   (e) State the momentum equation and some of its engineering applications.

   (f) What is the importance of dimensional analysis ?

(g) State and mention the significance of kinetic energy correction factor.

(h) Define turbulent flow and mention its types.

(i) What is CFD and state its applications.

(j) Define drag and lift.

SECTION–B

2. Attempt any **three** parts of the following : **(3×10=30)**

(a) What is meant by viscosity of a liquid, how does it manifest and in what units is it measured ? Does the viscosity of liquids and gases increase or decrease with temperature growth ? Suggest reasons for the behavior if any.

(b) Explain the term total pressure acting on a plane surface immersed in a fluid at an angle. Obtain an expression for this, and also for the corresponding depth of the center of pressure.

(c) Define the stream function and clearly bring out its physical significance. Enumerate some of the salient features of the stream function.

(d) A fireman holds a water hose ending into a nozzle that issues a 20 mm diameter jet of water. If the pressure of water in the 60 mm diameter hose is 700 kPa, find the force experienced by the fireman.

(e) Describe the governing equation of CFD. Comment on computational fluild dynamics as a design tool also discuss the impact of CFD.

SECTION–C

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

(a) A thin plate of very large area is placed in a gap of height h with oils of viscosities μ_1 and μ_2 on the two sides of the plate. The plate is pulled at constant velocity V. Calculate the position of plate so that :

(i) the shear force on the two sides of the plate is equal,

(ii) the force required to drag the plate is minimum. Assume viscous flow and neglect all end effects.

(b) A square door with side dimensions 30 cm is provided in the side wall of a water tank which is filled with water of specific weight 9790 N/m³. What force must be applied at the lower end of the gate so as to hold the hinged door closed ? The hinged end of the door lies at a depth of 3 m from the free surface of water. How does this force change if the water surface is subjected to a pressure of 0.5×10^5 N/m².

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

(a) The velocity components of a three dimensional, incompressible fluid flow are prescribed as :

$$u = x^2 + y^2 + 5 \; ; \; v = x^2 + z^2 - 3$$

Calculate the third component of velocity. Further check whether flow is irrotational.

(b) Deduce the general three dimensional equation in Cartesian coordinates for fluid flow and deduce from it the continuity equation for one dimensional frictionless flow.

(c) State the Cauchy-Riemann equation in Cartesian and in cylindrical coordinate systems. Check if the function $f = x^2 - y^2 + y$ represents the velocity potential for two dimensional irrotational flow and determine the corresponding stream function.

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

(a) Derive Euler's equation of motion along a stream line and hence derive the Bernoulli's theorem.

(b) Two reservoirs, whose surface levels differ by 30 m, are connected by a pipe line of 20 cm diameter and 2000 m long. The pipe line crosses a ridge whose summit is 8 m above the level of and 300 m distant from the higher reservoir. Find the minimum depth of pipe below the summit of ridge in order that the pressure at the apex (highest point of the pipeline) does not fall 7.2 m below the atmospheric pressure. Also calculate the discharge through the pipeline. Take f = 0.008 and atmospheric pressures as 10.2 m of water, and neglect the shock losses at the entry to and at the exit from the pipe.

(c) A fluid coupling transmitting torque T has a mean diameter D and contains a volume of fluid V. The primary and secondary runners are driven at speed N_P *and* N_S respectively and the slip equals S. The fluid has a viscosity μ and density ρ. Find a functional relational in terms of dimensionless parameters.

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

(a) Define and explain the significance of momentum correction factor. Show that when velocity distribution across a section is uniform, the momentum correction factor is unity.

(b) Describe Reynolds experiments to demonstrate the laminar and turbulent flows. What is the critical velocity of flow in a circular pipe ? What are the upper and lower critical velocity values ?

An oil having kinematic viscosity 1.35×10^{-5} m²/s flows through a 15 cm diameter pipe. Below what velocity will the flow be laminar ? For laminar flow, assume $R_e \leq 2000$.

(c) Rough turbulent flow occurs in a pipe of 30 cm diameter when it conveys water. Measurements indicate that the mean point velocity and the velocity gradient at a distance 3 cm from pipe wall are 2 m/s and 10.5 s^{-1} respectively. Make calculations for the wall shears stress, average height to surface projections, friction factor and the mean velocity of flow.

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

(a) What do you understand by the boundary layer ? Explain the development of boundary layer along a thin flat and smooth plate held parallel to uniform flow. Point out the salient features.

(b) A 2 mm diameter spherical metallic ball (specific weight 117.5 kN/m³) is dropped in a large mass of fluid of viscosity 15 poise and specific gravity 0.95. Proceeding from first principles, make calculations for the drag force exerted by fluid on metallic ball, pressure drag and skin friction drag and the terminal velocity of ball in fluid.

(c) Discuss the following applications of CFD :

(i) Automobile and Engine

(ii) Industrial Manufacturing

(iii) Environmental Engineering.