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

PAPER ID : 0021 Roll No. 1 1 0 9 1 0 0 0 4 9

B.Tech

(SEMESTER-III) THEORY EXAMINATION, 2012-13

FLUID MECHANICS

Time : 3 Hours] *[Total Marks : 100*

Note : (1) This question paper contains **three** Sections – A, B & C.
(2) Attempt questions from each section.
(3) Marks and numbers of questions to be attempted from the section is mentioned before each section.
(4) Assume missing data suitably. Illustrate the answers with suitable sketches.

Section – A

1. This question contains twenty short answer type questions. Attempt all questions. Each questions. Attempt all questions. Each part carries equal marks. $1 \times 20 = 20$

(a) Differentiate between Real fluids and Ideal fluids.

(b) State the Newton's law of viscosity & give examples of its application.

(c) Distinguish between Laminar & Turbulent Flow.

(d) What do you understand by
(i) Total acceleration
(ii) Convective acceleration
(iii) Local acceleration

(e) Define :
(i) Total pressure
(ii) Centre of pressure

(f) What do you understand by Hydrostatic law ?

(g) What is source and sink flow ?

(h) What do you understand by equipotential line and a line of constant stream function ?

(i) Name the different forces present in a fluid flow. For Euler's equation of motion, which forces are taken into consideration.

(j) What are advantages of triangular notch or weir over rectangular notch or weir ?

(k) Write expression for the discharge over a triangular weir in terms of head of water over crest of the weir. Write the meaning of each term of this expression.

(l) What do you mean by repeating variables ? How are the repeating variables selected for dimensional analysis ?

(m) Write down the Darcy's formula for determination of head loss due to friction.

(n) Define kinetic energy correction factor and momentum correction factor.

(o) What do you mean by 'viscous flow' ?

(p) Explain the term co-efficient of friction. On what factors does this coefficient depend ?

(q) Explain the boundary layer concept.

(r) Differentiate between stream-line body and bluff body.

(s) What is magnus effect ? Why is it known as magnus effect ?

(t) What do you understand by drag & lift ?

Section – B

2. Attempt **five** parts of following : Each part carries equal marks. **6 × 5 = 30**

(a) Enunciate Newton's law of viscosity. Explain importance of viscosity in fluid motion. What is effect of temperature on viscosity of water and that of air ?

(b) An open tank contains water upto a depth of 1.5 m and above it an oil of specific gravity of 0.8 for a depth of 2m. Find pressure intensity (i) at interface of two liquids (ii) at bottom of tank.

(c) The velocity potential function, ϕ is given as $\phi = x^3y - xy^3$. Find velocity components in x and y direction. Also show that ϕ represents a possible case of fluid flow.

(d) State Bernoulli's theorem. Mention assumptions made. How is it modified while applying in practice ? List out its engineering applications.

(e) Find the discharge through a trapezoidal notch which is 1.2 m wide at top and 0.5 m at the bottom and is 40 cm in height. The head of water on notch is 30 cm. Assume C_d for rectangular portion as 0.62 while for triangular portion = 0.60.

(f) Derive an expression for the velocity distribution for viscous flow through a circular pipe. Also sketch the velocity distribution and shear stress distribution across a section of a pipe.

(g) A thin plate is moving in still atmospheric air at velocity of 4 m/s. The length of plate is 0.5 m and width 0.4 m.

Calculate :

(i) Thickness of boundary layer at end of plate

(ii) Drag force on one side of plate. Take density of air as 1.25 kg/m^3 & kinematic viscosity 0.15 stokes.

(h) Prove that the coefficient of lift for a rotating cylinder placed in a uniform flow is given by $C_L = \frac{\Gamma}{RU}$

where Γ = circulation ; R-radius of cylinder ; U-free stream velocity.

Section – C

Question Nos. **3** to **7** contain **three** parts each. From each question, attempt any **two** parts only. Each question carries equal marks. **10 × 5 = 50**

3. (a) A square plate of size 1 m × 1 m and weighing 350 N slides down an inclined plane with uniform velocity of 1.5 m/s. The inclined plane is laid on a slope of 5 vertical to 12 horizontal and has an oil film of 1 mm thickness. Calculate dynamics viscosity of oil in poise.

   (b) Determine the total pressure on a circular plate of diameter 1.5 m which is placed vertically in water in such a way that centre of plate is 3m below the free surface of water. Find the position of centre of pressure also.

   (c) A metallic body floats at interface of mercury of sp. gr. 13.6 and water in such a way that 30% of its volume is submerged in mercury & 70% in water. Find density of metallic body.

4. (a) Derive an expression of continuity equation of fluid flow in 3D, with neat sketches.

   (b) A pipe (1) 450 mm in diameter branches into two pipes of diameters (2) 300 mm and (3) 200 mm respectively as shown in fig1.0, given below. If average velocity in 450 mm diameter pipe is 3 m/s, find (1) Discharge through 450 mm diameter pipe and (ii) velocity in 200 mm diameter pipe if average velocity in 300 mm pipe is 2.5 m/s.

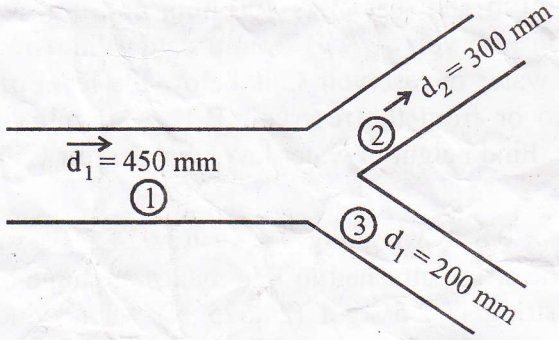

Fig. 1.0

   (c) A cylindrical vessel 15 cm in diameter & 40 cm long is completely filled with water. The vessel is open at top. Find the quantity of water left in the vessel, when it is rotated about its vertical axis with a speed of 300 r.p.m.

5. (a) Define an orifice-meter. Prove that discharge through an orifice-meter is given by relation

$$Q = C_d \cdot \frac{a_0 a_1 \sqrt{2gh}}{\sqrt{a_1^2 - a_0^2}}$$

Where a_1 = area of pipe in which orifice-meter is fitted $a_0 \rightarrow$ Area of orifice

C_d = coefficient of discharge.

(b) The discharge through an orifice-meter depends on diameter D of orifice, head H over the orifice, density S of liquid, viscosity u of the liquid and acceleration g due to gravity. Using dimensional analysis, find an expression for the discharge. Hence find dimensionalless parameters on which the discharge coefficient of an orifice-meter depend, using Buckingham's theorem of dimensional analysis.

(c) A pipeline carrying oil of sp. gr. 08 changes in diameter from 300 mm at a position A to 500 mm diameter to a position B which is 5 m at higher level. If pressure at A & B are 19.62 N/cm^2 & 14.91 N/cm^2 respectively, and discharge is 150 litres/s, determine loss of head and direction of flow.

6. (a) Calculate (i) pressure gradient along flow, (ii) the average velocity and (iii) the discharge for an oil of viscosity 0.02 NS/m^2, flowing between two stationary parallel plates 1 m wide maintained 10 mm apart. The velocity midway between plates is 2 m/s.

(b) Show that velocity distribution for turbulent flow through rough pipe is given by

$$\frac{u}{u^*} = 5.75 \log_{10} (y/k) + 8.5$$

where $u^* \rightarrow$ shear velocity

$y \rightarrow$ distance from pipe wall

$k \rightarrow$ roughness factor

(c) Three reservoir A, B & C are connected by a pipe system having length 700 m, 1200 m & 500 m and diameters 400 mm, 300 mm & 200 mm respectively. The water levels in reservoir A & B from a datum line are 50 m & 45 m respectively. The level of water in reservoir C is below the level of water in reservoir B. Find discharge into or from the reservoir B & C if rate of flow from reservoir A is 150 litres/sec. Find height of water level in reservoir C. Take $f = 0.005$ for all pipes.

7. (a) A kite 0.8 m × 0.8 m weighing 0.4 kg f(3.924 N) assumes an angle of 12° to the horizontal. The string attached to kite makes an angle of 45° to the horizontal. The pull on the string is 2.5 kg f (24.525 N) when wind is flowing at a speed of 30 km/hr. Find corresponding co-efficient of drag and lift. Density of air is given as 1.25 kg/m^3.

(b) For velocity profile for laminar boundary layer flows given as

$$\frac{u}{v} = 2(y/\delta) - (y/\delta)^2$$

Find an expression for boundary layer thickness (δ), shear stress (τ_0) & co-efficient of drag (C_D) in terms of Reynold's no.

(c) 250 litres/sec of water is flowing in a pipe having a diameter of 300 mm. If pipe is bent by 135°(that is change from initial to final direction is 135°), find magnitude and direction of resultant force on the bend. The pressure of water flowing is 39.24 N/cm^2.