Printed Pages : 11 **ECE-301**

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

PAPER ID : 0021 Roll No. | | | | | | | | | | |

B.Tech.

Third Semester Examination, 2011-12

FLUID MECHANICS

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

Note : (i) This question paper contains three Sections A, B and C.

(ii) Attempt questions from each Section.

(iii) Marks and number of questions to be attempted from the Section is mentioned before each section.

(iv) Assume missing data suitably. Illustrate the answers with suitable sketches.

Section-A

1. This question contains twenty short-answer type subquestions. Attempt *all* subquestions. 1×20=20

(a) Based on Newton's law of viscosity distinguish Newtonian and non-Newtonian fluids.

(ii) Explain atmospheric pressure, gauge pressure and absolute pressure with suitable sketch.

(iii) Describe principle of manometer.

(iv) What are the advantages of mechanical pressure gauges over the manometer ?

5. (v) The centre of pressure is always below the centroid of the area, immersed vertically. Comment.

(vi) Describe meta-centre and meta-centric height.

(vii) Stream lines, path lines and streak lines are identical for steady flow. Explain.

(viii) Write the continuity equation for 3-D flow in polar-cylindrical coordinates.

(ix) Distinguish between source and sink pattern of flow.

(x) Explain the criteria to set the size of throat diameter in a venturi meter.

(xi) What is energy correction factor ?

(xii) Distinguish between a mouthpiece and an orifice.

(xiii) What are the minor losses and major losses in a pipe flow ?

(xiv) Write the formulae for the discharge flowing over a rectangular and triangular notch.

(xv) Distinguish between laminar and turbulent flow in a pipeline.

(xvi) Draw the velocity profile over a section for the laminar flow in a pipe.

(xvii) List the three general types of similarities to be established for complete similarity between the model and its proto-type.

(xviii) Describe boundary layer thickness and define displacement thickness.

(xix) Explain the phenomena of viscous sub-layer.

(xx) Distinguish between stream line and bluff body shapes for the flow passing over the immersed solid bodies.

5.

Section-B

2. Attempt any *five* parts of the following : 6×5=30

(a) Through a very narrow gap of height '*h*' a thin plate of large extent is pulled at velocity '*v*'. On one side of the plate is oil of viscosity 'μ_1' and on the other side of the plate the oil of the viscosity 'μ_2' lie. Calculate the position of the plate so that (i) the shear force on the two sides of the plate is equal (ii) the pull required to drag the plate is minimum.

(b) A wooden block of rectangular section 1.25 m wide, 2 m deep and 4 m long floats horizontally in sea water. If the specific weight of wood is 0.64 and water weighs 1.025 kg (f)/ m^3, find the volume of the water displaced and the position of the centre of buoyancy.

(c) Derive the continuity equation for 3-D flow in rectangular coordinates.

(d) A stream function in a 2-D flow $\psi = 2xy$. Show that the flow is irrotational and determine the velocity potential φ.

(e) A venture-meter having a diameter of 75 mm at the throat and 150 mm diameter at the enlarged end is installed in a horizontal pipeline 150 mm

in diameter carrying oil of SG 0.9. The difference of pressure in between enlarged end and the throat is 175 mm mercury as recorded by a U-tube differential manometer. Determine the discharge through the pipe. Assume the coefficient of discharge of the meter as 0.97.

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(f) How will you determine C_c, C_v and C_d for an orifice provided in the wall of a constant head vertical tank.

(g) Explain the Prandtl mixing length concept to describe the turbulent flow.

(h) The velocity distribution in the boundary layer is given by :

$$\frac{v}{V} = \frac{3}{2}\eta - \frac{1}{2}\eta^2.$$

In which $\eta = (y/\delta)$. Compute (δ^*/δ) and (θ/δ).

Section-C

Question No. 3 to 7 contains 3 parts each. From each question attempt *two* parts only. 10×5=50

3. (a) A trapezoidal plate having its parallel sides equal to '20' and '0' at a distance of 'h' apart; is immersed vertically in a liquid with '20' side uppermost and at a distance 'h' below the surface of the liquid. Find the thrust on the surface and depth of centre of pressure.

(b) A wooden cylinder of circular section and uniform density, specific gravity of 0.6 is required to float in oil of specific gravity 0.8. If the diameter of the cylinder is 'd' and its length is 'l', show that 'l' cannot exceed about 0.817 d for cylinder to float its longitudinal axis vertical.

(c) What is meant by stability of a floating body ? Explain with reference to its meta centre height with the help of its neat sketches.

4. (a) In a steady flow two points 'A' and 'B' are 0.5 m apart on a straight stream line. If the velocity of flow varies linearly between 'A' and 'B' ; what is the acceleration at each point if the velocity at A is 2 m/s and at B is 6 m/s.

5. (b) Calculate the velocity component 'u' and 'v' for the following velocity potential function ; $\varphi = x^2+y^2$. Also show that it satisfies continuity equation for two-dimensional flow.

(c) If the stream function $\psi = x^3-3xy^2$, indicate the flow is irrotational flow. Determine φ.

5. (a) Velocity distribution for laminar flow of real fluid in a pipe is given as $v = V_{max}\left[1-\left(\frac{r}{R}\right)^2\right]$, where V_{max} is velocity at the centre of the pipe, R is pipe radius, and v is velocity at radius r from the centre of pipe. Determine momentum correction factor.

(b) Find the form of equation for discharge Q through a sharp edged triangular notch; assuming Q depends upon the central angle α of the notch, head H, gravitational acceleration 'g' and on the mass density ρ, viscosity μ and surface tension σ of the fluid.

(c) Explain :

(i) Reynolds number

(ii) Froude number

(iii) Mach number.

6. (a) For laminar flow of an oil having dynamic viscosity $\mu = 1.766$ Pa.s in a 0.3 m diameter pipe flows with a maximum central line velocity of 3 m/s. Calculate shearing stresses at the pipe wall and within the fluid 50 mm from the pipe wall.

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(b) Derive the following relationship for rough pipe, for the turbulent flow :

$$\frac{u-V}{V^*} = 5.75\log_{10}\left(\frac{y}{R}\right) + 3.75.$$

(c) What do you understand by hydrodynamically smooth and rough pipe ?

7. (a) Define boundary layer and explain the fundamental causes of boundary layer development with suitable sketches.

(b) How will you control the separation of boundary layers ?

(c) A semi-tubular cylinder of 75 mm radius with concave side up-stream (C_D =2.3) is submerged in water at velocity 0.6 m/s. If the length of cylinder is 7.2 m, calculate the drag. Take $\rho_{water} = 1000\ kg/m^3$.