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

PAPER ID : 0021 Roll No.

B. Tech.

(SEM. III) ODD SEMESTER THEORY EXAMINATION 2010-11

FLUID MECHANICS

Time : 3 Hours *Total Marks : 100*

Note : (1) Attempt **all** questions.

(2) All questions carry equal marks.

(3) In case of numerical problems assume data wherever not provided.

(4) Be precise in your answers.

1. Attempt any **two** parts of the following : **(10×2=20)**

(a) (i) Draw and explain the Rheological diagram.

(ii) What is Capillarity ? What is its significance in fluid flow problems ?

(b) (i) A circular plate 4 m in diameter is placed in such a way that its top vortex is at 2 m below free water surface and bottom vertex is 5 m below the free water surface. Find out the total pressure acting on the plate.

(ii) A rectangular wooden block 2 m long, 1 m wide and 1 m deep floats in water. Find the weight of the body and its metacentric height if depth of immersion is 0·75 m. Take the specific gravity of the wooden block = 0·6. State whether the body is stable or not.

(c) (i) A closed cylindrical vessel of 80 cm diameter and 160 m height contains water upto 100 cm. Find the speed of rotation so that water depth at axis becomes zero.

(ii) An open rectangular tank 1·5 m × 1 m × 1·2 m high is completely filled with water when at rest. Determine the volume spilled after the tank acquired a linear uniform acceleration of 0·6 m/s² in the horizontal direction.

2. Attempt any **two** parts of the following : **(10×2=20)**

(a) (i) Explain the terms—path line, stream line, stream tube, streak line and potential line.

(ii) If source and sink are located at finite distance along x-axis, show that stream function $\psi = \frac{Q}{2\pi}(\theta_1 - \theta_2)$ where Q is discharge and θ_1 and θ_2 are angles of any point P(x, y) from x-axis at source and sink.

(b) (i) Check whether the flow defined by the stream function $\psi = 2xy$ is irrotational ? If so, determine the corresponding velocity potential.

(ii) What is flownet ? Describe any one method of drawing flownet.

(c) (i) Explain with example Compressible-Incompressible flow and Uniform-Non uniform flow.

(ii) If the velocity field is given by $u = (16y - 8x)$, $v = (8y - 7x)$ find the circulation around the closed curve defined by $x = 4$, $y = 2$, $x = 8$, $y = 8$.

3. Attempt any **four** parts : **(5×4=20)**

(a) What is the difference between distorted and undistorted models ? Explain the uses of distorted models.

(b) Derive the Bernoullis equation and also explain the assumption considered.

(c) A 45° reducing bend is connected to a pipeline whose inlet and outlet diameters are 60 cm and 30 cm respectively. The water flow through the pipe is 0·6 m^3/s. The pressure of the water at the inlet of the bend is 90 kN/m^2. Find the total force exerted on the bend. The pipeline rests on ground.

(d) Find out the depth and top width of a U Notch discharging 0·7 m^3/s. The head over the notch is 10 cm when the discharge is 0·009 m^3/s. Take cd = 0·6.

(e) A model boat, $\frac{1}{50}$ of its prototype experienced 0·2 N of resistance when simulating a speed of 5 m/s of prototype. Find the corresponding resistance of the prototype considering resistance at free surface only. Water is used for model as well as prototype also.

(f) The discharge over a spillway provided on the dam depends upon v, (velocity of flow), L (depth of throat), H (water head on spillway) and g (acc due to gravity). Show that it is given by $\frac{Q}{vL^2} = f\left(\frac{\sqrt{gL}}{v}, \frac{H}{L}\right)$.

Use Buckingham π theorem.

4. Attempt any **four** parts : **(5×4=20)**

(a) What do you understand by TEL and HGL ? Explain their importance in the pipe design.

(b) Three pipes of 800 m, 500 m and 300 m of diameters 50 cm, 30 cm and 40 cm respectively are connected in series. If these pipes are to be replaced by a single pipe of 2000 m long, find the required diameter. Consider f is same for all pipes and all minor losses are neglected.

(c) What is eddy viscosity ? Explain mixing length concept for turbulent flow.

(d) What do you understand by water hammer ? Derive an expression for the sudden closure of the valve.

(e) Show that in a turbulent flow through a pipe of radius R, the variation between the maximum velocity U and local velocity at any distance y from the wall of the pipe follows the same variation with respect to the relative distance (y/R) in both the smooth and rough pipes.

(f) Using Stoke's law derive an expression for terminal velocity for a sphere falling in a liquid. Also state the assumptions.

5. Attempt any **two** parts : **(10×2=20)**

(a) (i) What do you understand by momentum thickness and displacement thickness ?

(ii) Oil with ($\rho = 900$ kg/m^3 and $\nu = 10^{-5}$ m^2/s) is flowing over a plate of 3 m long and 2 m wide with a velocity of 3 m/s parallel to 3 m side. Find the Boundary layer thickness at the point of transition and at the end of plate.

(b) (i) What is Mangus effect ? Explain with an example.

(ii) A kite 60 cm × 60 cm is size weighing 3 N makes an angle of 10° with the horizontal. The thread attached to it makes an angle of 45° to the horizontal and pull on the string is 25 N. The wind is flowing over the kite 15 m/s. Find C_D and C_L for the kite.

(c) What do you understand by :

(i) Coefficient of lift

(ii) Coefficient of drag

(iii) Resultant force on body

(iv) Aerofoil ?