(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 $\theta_1$ and $\theta_2$ 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 $\pi$ theorem.

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 ?