B.Tech.
THIRD SEMESTER EXAMINATION, 2005-2006
FLUID MECHANICS
Time: 3 Hours
Total Marks: 100

Note:
(i) Attempt ALL questions.
(ii) All questions carry equal marks.
(iii) In case of numerical problems assume data wherever not provided.
(iv) Be precise in your answer.

1. Attempt any two parts of the following: (10×2=20)
(a) (i) Discuss effect of temperature and pressure on the physical properties of the fluid.
(ii) Derive an expression for capillary rise or fall when a small dia tube dipped in to a liquid.
(b) (i) Prove that the centre of pressure is always below the centre of gravity for vertical or inclined plane surfaces.
(ii) A wooden cylinder of sp. gravity = 0.60 and circular in cross section is required to float in oil of sp. gravity = 0.80. Find the H/D ratio for the cylinder to float with its longitudinal axis vertical in oil, where H is the height of cylinder and D is its diameter?
(c) Describe Buckingham's -$\pi$-theorem. Why this theorem is considered superior over Rayleigh's method for dimensional analysis?

2. Attempt any two parts of the following: (10x2=20)

(a) Discuss geometric, kinematic and dynamic similarities. Are these similarities truly attainable? If not why?

(b) (i) Deduce an expression of continuity equation for three dimensional flow.

(ii) Distinguish between forced vortex and free vortex flow.

(c) (i) What is a Pitot tube? How is it used to measure velocity of flow at any point in a pipe or open channel?

(ii) Distinguish between the following with neat sketches.

Notches and weirs.

Orifices and mouthpieces.

3. Attempt any four parts of the following: (5x4=20)

(a) State the momentum equation. How it is used in determining the force exerted by a flowing liquid on a pipe bend?

(b) Explain the method for the determination of coefficient of velocity, coefficient of contraction and coefficient of discharge experimentally.

(c) Prove that for laminar flow through a circular pipe, momentum correction factor ($\beta$) = $\frac{4}{3}$.
(d) A fluid of viscosity \(0.72 \text{ Ns/m}^2\) and Sp. gravity 1.34 is flowing through a circular pipe of diameter 100 mm. The maximum shear stress at the pipe wall is given as 200 N/m\(^2\), find (i) the pressure gradient (ii) the average velocity and (iii) Reynold number of the flow.

(e) What do you understand by Prandtl’s mixing length theory? Find an expression for shear stress due to Prandtl.

(f) What do you understand by turbulent flow? What factor decides the type of flow in pipe?

4. Attempt any four parts of the following: (5x4 = 20)

(a) Show that the energy thickness for boundary layer flow is given by \(\delta_E = \int_0^\delta \frac{u}{U}(1-\frac{u^2}{U^2})\,dy\).

(b) What are the causes of loss of energy in a pipe.

(c) What do you mean by the separation of boundary layer? What is the effect of pressure gradient on boundary layer thickness?

(d) Discuss and derive an expression for equivalent pipe.

(e) Define and discuss Hydraulic gradient and total energy lines with neat sketches.

(f) The 30 cm diameter pipe 2340 m long is connected with a reservoir whose surface is 72 m above the discharging end of the pipe. If for the last 1170 m a second pipe of the same diameter be laid beside the first and connected to it, What would be the increase in the discharge? Take \(f = 0.02\).
5. Attempt any two parts of the following: (10x2=20)

(a) Explain the phenomenon of water hammer. Obtain an expression for the rise of pressure when the flowing water in a pipe is brought to rest by closing the valve gradually.

(b) Define and distinguish with neat sketches between source flow and sink flow.

(c) Differentiate between the following:
   (i) Stream lines body and bluff body.
   (ii) Friction drag and press drag.