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B. Tech 3rd Semester Examination

Fluid Mechanics (O.S.)

ME-3005

Time : 3 Hours

Max. Marks : 100

The candidates shall limit their answers precisely within the answer-book (40 pages) issued to them and no supplementary/continuation sheet will be issued.

Note : Attempt Five Questions in all, select one question from each section A, B, C, D. Section E is compulsory. Assume any suitable missing data if any. Use of non-programmable calculator is allowed.

SECTION - A

1. (a) A piston 796 mm in diameter and 200 mm long works in a cylinder of 800 mm in diameter. If the annular space is filled with a lubricating oil of viscosity 5 centi-poise, calculate the speed of descent piston in vertical position. The weight of piston and the axial load are 9.8 N. **(10)**
- (b) A U-tube is made of two capillaries of diameter 1.0 mm and 1.5 mm respectively. The tube is kept vertically and partially filled with water of surface tension 0.0736 N/m and zero contact angle. Calculate the difference in the levels of miniscii caused by the capillarity. **(10)**
2. A cylindrical gate is 3.0 m long and having diameter of 2.0 m. Gate has water in its both sides; up to top i.e., 2.0 m in one side and upto 1.0 m in other side. Determine the magnitude, location and direction of the resultant hydrostatic force exerted on the gate, also calculate the minimum weight of the gate so that it will not float away from the floor. **(20)**

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SECTION - B

3. (a) The velocity distribution for a three dimensional flow is given by $u = -x$, $v = 2y$ and $w = 3 - z$. Find the equation of the streamline passing through (2, 2, 3). **(10)**
- (b) The rate at which water flows through a horizontal 25 cm diameter pipe is increased linearly from 30 to 150 lit/sec in 3.5 seconds. What pressure gradient must exist to produce this acceleration? What difference in pressure intensity will prevail between sections 8 m apart? Take $\rho = 100 \text{ kg/m}^3$. **(10)**
4. (a) In a two dimensional incompressible flow, the fluid velocity components are given by $u = x - 4y$ and $v = -y - 4x$. Show that velocity potential exists and determine its form as well as stream function. **(10)**
- (b) A Venturimeter is installed in a pipeline 30 cm in diameter. The throat-pipe diameter ratio is 1/3. Water flows through the installation. The pressure in pipeline is 137.7 kN/m^2 and vacuum in the throat is 37.5 cm of Mercury. If 4% of the differential head is lost between the gauges, find the flow in the pipeline. **(10)**

SECTION - C

5. (a) For sudden expansions in pipe flow, what is the optimum ratio between the diameter of the pipe before expansion and the diameter after expansion so that the pressure rises may be maximum? **(10)**
- (b) A streamlined train is 300 m long with a typical cross section having a perimeter of 8.0 m above the wheels. Evaluate the approximate surface drag (friction drag) of the train when running at 100 km/hr. The kinematic viscosity of air at the prevailing temperature is $1.49 \times 10^{-5} \text{ m}^2/\text{s}$ and its specific weight is 12.25 N/m^3 . **(10)**

6. For steady Poiseuille flow in a pipe of radius R , obtain an expression for ratio of Displacement thickness (δ^*) and Momentum thickness (θ) i.e., δ^*/θ . (20)

SECTION - D

7. The drag force F on a partially submerged body depends on the relative velocity V between the body and the fluid, characteristic linear dimension / height of surface roughness k , fluid density ρ , the viscosity μ and the acceleration due to gravity g . Obtain an expression for the drag force using the method of dimensional analysis. (20)
8. (a) A rough plastic pipe 50 cm in diameter and 300 m in length is carrying water with a velocity of 3 m/s, and has an absolute roughness of 0.25 mm and a kinematic viscosity of 0.9 centistokes. Is the flow turbulent or laminar? What is the head lost in friction? (10)
- (b) A model of spillway is made to test the flow. The discharge and the velocity of flow over the model were measured as 2.5 m³/s and 1.5 m/s respectively. Find the discharge and the velocity over the prototype which is 50 times larger than its model. (10)

SECTION - E

9. Answer the following:
- Is there any analogy of Hooke's law in fluids? If so, state the parallel law in fluids.
 - How we can express pressure in different ways?
 - Cite examples of unsteady flow. How can the unsteady flow be transformed to steady flow?
 - What are the limitations of the Bernoulli's equation?

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- (v) What precaution should normally be taken to obtain cavitation free flow in pipes?
- (vi) Cite two examples of dimensionally homogeneous and non-homogeneous equations.
- (vii) What are the causes which results in separation of boundary layer?
- (viii) Explain distinguishing characteristics of laminar flow
- (ix) Does the ratio of maximum to mean velocity in a pipe increases or decreases -
 - (a) with increasing Reynolds Number and (b) with increasing relative roughness.
- (x) What is a Siphon and under what conditions would it stop functioning? **(2×10=20)**