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K. N. I. T., SULTANPUR

(Paper code and roll No. to be filled in your answer book)

Paper code: KCE-301 Roll No. | | | | | | | | | |

B. Tech.
Third Semester Examination, 2014-15
Fluid Mechanics

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

Note: Attempt all the questions. Assume missing data, if required.

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

(a) Differentiate between the following with neat sketches, if required:

(i) Cohesion and adhesion
(ii) Centre of pressure and centre of buoyancy
(iii) Dynamic and kinematic viscosity
(iv) Capillarity and surface tension

(b) Assuming that the interstices in a clay soil are of size equal to one tenth the mean diameter of the grain, estimate the height to which water will rise in a clay soil of average grain diameter of 0.05 mm. Assume surface tension at air-water interface as 0.73 N/m.

(c) If a circular plate and a square plate of same diameter and side "D" m are lying vertically in such a way that their centers are "D" m below the free water surface. Find out the ratio between the total pressure and center of pressure between the circular plate and the square plate.

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

(a) Distinguish between the following:

(i) Distorted and undistorted models
(ii) Source and sink flow
(iii) Free and forced vortex flow
(iv) Uniform and unsteady flow

(b) Explain merits of Buckingham π theorem method over Rayleigh's method.

The capillary rise h depends on density 'ρ', acceleration due to gravity 'g', surface tension '(δ)' and radius of tube '(r)'.

Determine the dimensionless terms that will describe the above problem using Buckingham π theorem.

(c) Determine ϕ and ψ, if
$u = 8x^2y-(8/3)y^3$ and $v= -8xy^2+(8/3)x^3$. Also, show that it represents possible case of an irrotational flow.

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

a. An orifice meter with orifice diameter 15 cm is inserted in a pipe of 30 cm diameter. The pressure gauges fitted upstream and downstream of the orifice meter give readings of 14.715 N/cm^2 and 9.81 N/cm^2 respectively. Assuming C_d as 0.71, determine the rate of flow through the pipe in lpm.

b. (i) Define Vena contracta. A nozzle of diameter 20 mm is fitted to a pipe of diameter 40 mm. Find the force exerted by the nozzle on the water which is flowing at the rate of 0.02 m^3/sec.

(ii) Define the terms C_d, C_c and C_v and hence Prove that $C_d = C_c \times C_v$.

c. Explain the function and working of pitot static tube with neat sketch. A pitot static tube is used to measure the velocity in a pipe with water as the running fluid. The stagnation pressure head is 7m and static pressure head is 5m. Calculate the velocity of flow. Assuming constant of pitot static tube is 0.97.

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

(a) Explain any two of the following with neat sketches:

(i) Hydro-dynamic classification of boundaries smooth and rough boundaries

(ii) Velocity and shear stress distribution in a laminar flow through a circular pipe.

(iii) Couette flow: velocity and shear stress distribution

(iv) Surge tank and siphon working principle

(b) Explain Prandtl's mixing length theory for turbulent shear stresses. Hence determine the velocity profile expression for the turbulent flow in a circular pipe.

(c) (i) Derive the expressions for head loss due to sudden expansion or sudden enlargement.

(ii) Water is flowing through a pipe of 15cm diameter with f=0.06, where ($f=64/R_e$). The shear stress at a point 4 cm from the pipe wall is 0.1962 N/cm^2. Calculate the pressure gradient and shear at the pipe wall.

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

(a) What is boundary layer separation and how you will control it? Discuss with neat sketch.

(b) Derive relation between (a) drag forces & drag coefficient and (b) lift force & lift coefficient.

(c) Derive the Bernoulli's equation for adiabatic case of a compressible flow.

(d) What is a stagnation point? Show the stagnation points for the flow around a sphere. Draw C_d vs R_e diagram for a sphere and explain why C_d suddenly drops at $R_e = 3000$.

(e) In a pipe of 500 mm diameter and 2500 m length, provided with a valve at its end, water is flowing with a velocity of 1.5 m/s. Assuming velocity of pressure wave as 1460m/s, find rise in pressure (i) if the valve is closed in 22 and (ii) 12 seconds. Assume the pipe to be rigid one and bulk modulus of elasticity of water is 1.962 GN/m^2.

(f) The velocity distribution in the boundary layer is given as $u/U = 5/2\eta - 3/2\eta^2$, compute ($\delta^*/\theta$). Where δ^* and θ is displacement and momentum thickness respectively. Given $\eta = y/\delta$.