(d) Explain water hammering in pipes. [7]

UNIT-V

5. (a) Define Froude number. [2]

(b) Show by dimensional analysis, that the power P developed by hydraulic turbine is

$$P = \rho N^3 D^5 f\left(\frac{N^2 D^2}{gH}\right)$$ [7]

(c) The efficiency η of a fan depends on the density ρ, the dynamic viscosity μ of the fluid, the angular velocity ω, diameter D of the rotor and the discharge Q. Express η in terms of dimensionless parameter. [7]

(d) Show by the use of Buckingham's Pi-theorem, that the velocity through an orifice is

$$V = \sqrt{2gh} f\left(\frac{D}{H}, \frac{\mu}{\rho VH}, \frac{\sigma}{V^2 H}\right)$$

where H = Head causing flow

D = Diameter

μ = Coefficient of viscosity

ρ = Mass density

σ = Surface tension

g = Gravitational acceleration [7]

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337451(37)

BE (4th Semester) Examination, Nov.-Dec., 2017

(New Scheme)

Fluid Mechanics

Time Allowed : 3 hours *Maximum Marks* : 80

Minimum Pass Marks : 28

Note : (i) Part *(a)* of each question is compulsory. Solve any **two** parts from *(b)*, *(c)* and *(d)*.

(ii) The figures in the right-hand margin indicate marks.

UNIT-I

1. (a) Define surface tension. [2]

(b) Define and derive the equation of Pascal's Law. [7]

(c) A square plate 4m × 4m hangs in water from one of its corners and its centroid lies at a depth of 8m from the free water surface. Work out the total pressure on the plate and locate the position of centre of pressure with respect to the plate centroid. [7]

(d) A trapezoidal channel 4m wide at the base and 3m high has sides inclined at 45° to the horizontal (side slopes 1:1). Make calculation for the depth of centroid and centre of pressure and the hydrostatic thrust when the channel is full of water. [2]

UNIT-II

2. (a) Define compressible and incompressible flow. [2]

(b) Derive the continuity equation. [7]

(c) A stress function is given by

$$\psi = 3x^2y + (2+t)y^2$$

Find the velocity and determine its value at a point defined by the position vector $\vec{r} = 1i + 2j - 3k$, where $t = 2$ [7]

(d) The velocity potential for a two-dimensional flow is $\phi = x(2y-1)$. Determine the velocity at the point $P(4,5)$. Also obtain the value of stress function at this point P. [7]

UNIT-III

3. (a) Define Pitot tube. [2]

(b) A pipeline carrying oil of specific gravity 0.87 changes in diameter from 200mm at a position A to 500mm at another position B which is 4 meter at a higher level. If the pressure at A and B are 1 bar and 0.6 bar respectively and the discharge is 0.2 m³/s, determine the loss of head and the direction of flow. [7]

(Continued)

(c) A 30 cm diameter horizontal pipe terminates in a nozzle with the exit diameter of 7.5cm. If the water flows through the pipe at a rate of 0.15 m³/s, what force will be exerted by the fluid on the nozzle? [7]

(d) A 30 cm diameter pipe carries water under a head of 20 metres with a velocity of 3.5 m/sec. If the axis of the pipe turns through 45°, find the magnitude and direction of the resultant force on the head. [7]

UNIT-IV

4. (a) State the formula of Reynolds' number. [2]

(b) A straight stretch of horizontal pipe of 5cm diameter was used in the laboratory to measure the viscosity of a crude oil (sp. weight 9000 N/m³). During the test run, a pressure differential of 18000 N/m² was recorded 6m apart on the pipe. The oil was allowed to discharge into a weighing tank and 5000 N of oil was collected in 3 minutes duration. Work out dynamic viscosity of the oil. [7]

(c) A horizontal pipe, 10cm in diameter, is joined by sudden enlargement to a 15cm diameter pipe. Water is flowing through it at the rate of 2 m³/min. Find the loss of head due to abrupt expansion and the pressure difference in the two pipes. If the change of section is gradual without any loss, what would be the change in pressure? [7]

(Continued)