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B. E. (Fourth Semester) Examination, ~~2020~~ APR-MAY 2022

(New Scheme)

(Mech., Production & Automobile Engg. Branch)

FLUID MECHANICS

Time Allowed : Three hours

Maximum Marks : 80

Minimum Pass Marks : 28

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

Unit-I

1. (a) Define Dynamic Viscosity and Kinematic viscosity. 2

   (b) Calculate the dynamic viscosity of an oil, which is used for lubrication between a square plate of size $0 \cdot 8\ m \times 0 \cdot 8\ m$ and an inclined plane with angle of inclination 30° to the horizontal. The weight of the

square plate is 300 N and it slides down the inclined plane with a uniform velocity of 0·3 m/s. The thickness of oil film is 1·5 m. 7

(c) A cubical tank has sides of 2 m. It contains an oil of density 850 kg/m^3 for the upper 1·2 m depth. The lower remaining part is filled with water. For one vertical side of the tank find the total pressure force and position of centre of pressure. 7

(d) A solid cylinder 2 m in diameter and 2 m high is floating in water with its axis vertical. If the specific gravity of the material of cylinder is 0·65 find its metacentric height. State also whether the equilibrium is stable or unstable. 7

Unit-II

2. (a) Distinguish between : 2

(i) Steady and unsteady flow

(ii) Uniform and non-uniform flows

(b) Derive an expression for continuity for three dimensional flow and reduce it for steady, incompressible two-dimensional flow. 7

(c) If for a two dimensional potential flow, the velocity

potential is given by $\phi = x(2y-1)$ determine the velocity at the point P (4, 5). Determine also the value of stream function ψ at the point P. 7

(d) Explain the following term in brief :

(i) Streamline

(ii) Velocity potential function

(iii) Circulation

(iv) Vorticity 7

Unit-III

3. (a) What is an impulse-momentum equation? 2

(b) Derive Euler's equation of motion along a stream line. 7

(c) A horizontal venturimeter with inlet diameter 200 mm and throat diameter 100 mm is employed to measure the flow of water. The reading of the differential manometer connected to the inlet is 180 mm of mercury. If the co-efficient of discharge is 0·98 determine the rate of flow. 7

(d) 360 litres per second of water is flowing in a pipe. The pipe is bent by 120°. The pipe bend measures

360 mm × 240 mm and volume of the bend is 0·14 m^3. The pressure at the entrance is 73 kN/m^2 and the exit is 2·4 m above the entrance section. Find the force exerted on the bend. 7

Unit-IV

4. (a) Define hydraulic gradient line and total energy line. 2

(b) Derive Darcy-Weisbach formula for calculating loss of head due to friction in a pipe. 7

(c) A crude oil of viscosity 0·9 poise and relative density 0·9 is flowing through a horizontal circular pipe of diameter 120 mm and length 12 m. Calculate the difference of pressure at two ends of the pipe, its 785 N of the oil is collected in a tank in 25 seconds. 7

(d) A piping system consists of thre pipes arranged in series, the lengths of the pipes are 1200 m, 750 m and 600 m and diameters 750 mm, 600 mm and 450 mm respectively.

(i) Transform the system to an equivalent 450 mm diameter pipe, and

(ii) Determine an equivalent diameter for the pipe, 2550 m long. 7

Unit-V

5. (a) Explain the principle of dimensional homogeneity. 2

(b) Using Buckingham's π -theorem, show that the velocity through a circular orifice is given by 7

$$V = \sqrt{2gH}\ \phi\left[\frac{D}{H}, \frac{\mu}{\varrho VH}\right]$$

where H = Head causing flow

D = Diameter of the orifice

μ = Coefficient of viscosity

ϱ = Mass density

g = Acceleration due to gravity

(c) Define and develop mathematical expression for the following dimensionless numbers :

(i) Reynolds number

(ii) Froude's number

(iii) Euler's number

(iv) Mach's number 7

(d) A 1 : 20 scale model of a submarine is tested in a wind tunnel to measure the drag on a proposed

design. A prototype speed of 5 m/s is designed. What speed should be used in the wind tunnel for the model study? What is the ratio of drag forces between the model and the prototype?

The density and viscosity of air are 1·22 kg/m^3 and 1×10^{-5} N-s/m^2, respectively and the corresponding values for sea water are 1025 kg/m^3 and $1{\cdot}5 \times 10^{-3}$ N-s/m^2 respectively. 7