CBCS SCHEME

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17ME44

Fourth Semester B.E. Degree Examination, June/July 2019
Fluid Mechanics

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. Define the following properties of fluids with their SI units:
(i) Mass Density (ii) Weight Density (iii) Dynamic viscosity (iv) Kinematic viscosity. **(08 Marks)**

b. Derive an expression for pressure intensity in case of a soap bubble. **(04 Marks)**

c. A cubical block of sides 1m and weighing 350 N slides down on inclined plane with a uniform velocity of 1.5 m/s. The inclined plane is laid on a slope of 5 vertical to 12 horizontal and has an oil film of 1.0mm thickness. Calculate the dynamic viscosity of oil in poise. **(08 Marks)**

OR

2 a. Define (i) Buoyancy (ii) Centre of Buoyancy (iii) Meta-centre (iv) Meta-centric height. **(08 Marks)**

b. Explain the method to find the Meta-centric height experimentally. **(04 Marks)**

c. A block of wood of specific gravity 0.7 floats in water. Determine te Meta-centric height of the block, if its size is 2m × 1m × 0.8m. **(08 Marks)**

Module-2

3 a. Explain different types of fluid flows with examples. **(08 Marks)**

b. Derive the continuity equation for the 3-Dimensional flow in Cartesian co-ordinates. **(08 Marks)**

c. A stream function is given by $\psi = 3xy$. Determine whether the flow is possible or not. **(04 Marks)**

OR

4 a. Derive an expression for force exerted by the jet on stationary flat vane. **(04 Marks)**

b. Derive Euler's equation of motion along a stream line and deduce Bernoulli's equation. State the assumptions made. **(10 Marks)**

c. A sub-marine moves horizontally in sea, A pitot static tube placed in front of sub-marine and along its axis is connected to the two limbs of U-tube manometer containing mercury. The difference of mercury level is found to be 200mm. Find the speed of the sub-marine in km/hr. take specific of gravity of mercury as 13.6 and sea water as 1.026, $C_V = 0.98$. **(06 Marks)**

Module-3

5 a. Derive Hagen-Poiseuille's equation for laminar flow through a circular pipe. **(10 Marks)**

b. Oil is to be transported from a tanker to the shore at the rate of 5 lt/sec, using a 300mm diameter pipe for 20km length. If $\mu = 0.1$ N-m/s^2 and $\rho = 900$ kg/m^3 for the oil, calculate the power required to maintain the flow. **(10 Marks)**

OR

6 a. Write a short note on Moody's diagram. **(04 Marks)**

b. Three pipes of lengths 800m, 500m and 400m and diameters 500mm, 400mm and 300mm respectively are connected in series. These pipes are replaced by a single pipe of 1700m length. Find the diameter of the single pipe. **(06 Marks)**

c. Water is supplied to the inhabitants of a college campus through a supply main. The following data is obtained:
- Distance of the reservoir from the campus = 4 km
- Number of inhabitants = 3000
- Consumption of water per day of each inhabitant = 180 litre.
- Loss of head due to friction = 18 m
- Co-efficient of friction for the pipe, f = 0.007

If half of the daily supply is pumped in 08 hours, determine the size (diameter) of the supply main. **(10 Marks)**

Module-4

7 a. Define the drag force and lift force. Also derive their expressions. **(10 Marks)**

b. Derive an expression for displacement thickness and momentum thickness of a flow over a plat. **(10 Marks)**

OR

8 a. Explain the dimensional homogeneity with examples. **(04 Marks)**

b. Check whether the following equations (with their usual notations) are dimensionally homogeneous or not:

(i) $V = \sqrt{2gh}$ (ii) $h_f = \frac{4f\,LV^2}{2gd}$ (iii) P = WQH **(06 Marks)**

c. Show by the method of dimensional analysis that, for a screw propeller, the relation between the thrust 'F', torque 'T', diameter 'D', speed of travel 'U', speed of rotation 'N', density 'ρ' and viscosity 'μ' may be put in the form

$$F = \rho D^2 U^2 \phi\left[\frac{\rho D^3 U^2}{T}, \frac{DN}{U}, \frac{\rho UD}{\mu}\right]$$

[Hint: take D, U and ρ as repeating variables.] **(06 Marks)**

Module-5

9 a. Define the following terms:
(i) Sub-Sonic flow (ii) Sonic flow (iii) Super-Sonic flow (iv) Mach Number **(08 Marks)**

b. Derive an expression for velocity of sound in terms of Bulk modulus. **(06 Marks)**

c. An aeroplane flying at a height of 15 km, where the temperature is – 50°C. The speed of the plane corresponding to Mach number is 2.0. Assuming K = 1.4 and R = 287 J/kg.K, find the speed of the plane. **(06 Marks)**

OR

10 a. Explain the necessity of CFD. Mention its applications and limitations. **(10 Marks)**

b. What are normal and oblique shocks? Explain. **(04 Marks)**

c. Find the velocity of a bullet fired in air, if the Mach angle is 30°. Temperature of air is 15°C. Assume K = 1.4 and R = 287.14 J/kg.K. **(06 Marks)**

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