CBCS SCHEME

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15ME44

Fourth Semester B.E. Degree Examination, Feb./Mar. 2022
Fluid Mechanics

Time: 3 hrs. Max. Marks: 80

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

Module-1

1 a. Distinguish between : i) Mass Density and Weight Density.
ii) Dynamic Viscosity and Kinematic Viscosity.
iii) Ideal Fluid and Real Fluid. **(06 Marks)**

b. State and prove Pascal's law. **(05 Marks)**

c. A circular plate of 2.5m diameter is immersed in water. Its greatest and least depth below the free surface of water being 3.5m and 1.5m respectively. Find i) Total pressure force on the face of plate ii) Position of centre of pressure. **(05 Marks)**

OR

2 a. An inverted U – tube manometer is connected to two horizontal pipes A and B through which water is flowing. The vertical distance between the axis of these pipes is 30cm. When an oil of specific gravity 0.8 is used as gauge fluid, the vertical heights of water columns in the two limbs of the inverted manometer (when measured from the respective centre lines of pipes) are found to be same and equal to 35cm. Determine the difference of pressure between the pipes. **(05 Marks)**

b. Derive an expression for total pressure force and depth of centre of pressure for a vertical surface submerged in water. **(07 Marks)**

c. Define the following : i) Buoyancy ii) Centre of Buoyancy iii) Metacentre iv) Meta Centric Height. **(04 Marks)**

Module-2

3 a. Differentiate between Lagrangian and Eulerian method of Fluid flow. **(04 Marks)**

b. Derive an expression for discharge through Venturimeter. **(06 Marks)**

c. A stream function is given by $\psi = 3xy$. Determine i) Whether flow is possible ii) Whether flow is rotational or irrotational iii) The potential function ϕ. **(06 Marks)**

OR

4 a. Define the following : i) Stream line ii) Streak line iii) Path line. **(03 Marks)**

b. Derive the Bernoulli's equation of motion along the stream tube. **(07 Marks)**

c. A non – uniform part of a pipeline 5m long is laid at a slope of 2 in 5. Two pressure gauges each fitted at upper and lower ends read $20 N/cm^2$ and $12.5 N/cm^2$. If the diameters at the upper end and lower end are 15cm and 10cm respectively, determine the quantity of water flowing per second. **(06 Marks)**

Module-3

5 a. Derive an expression for Hagen Poiseuille's formula. **(08 Marks)**

b. A fluid of viscosity $0.7 Ns/m^2$ and specific gravity 1.3 is flowing through a circular pipe of diameter 100mm. The maximum shear stress at the pipe wall is given as $196.2 N/m^2$, find i) The pressure gradient ii) The average velocity and iii) Reynold number of the flow **(08 Marks)**

OR

6 a. Derive Darcy's formula to calculate the frictional head loss in a pipe. **(08 Marks)**

b. At a sudden enlargement of water main from 0.24m to 0.48m diameter, the hydraulic gradient rises by 10mm. Estimate the rate of flow. **(08 Marks)**

Module-4

7 a. Differentiate between : i) Pressure Drag and Friction Drag. ii) Streamline body and Bluff body iii) Lift and Drag. **(06 Marks)**

b. Briefly explain the Boundary Layer Separation and its control. **(04 Marks)**

c. A square plate of side 2m is moved in stationary air of density $1.2 kg/m^3$ with a velocity of 50kmph. If coefficient of drag and lift are 0.2 and 0.8 respectively, determine
i) Lift force ii) Drag force iii) Resultant force iv) Direction of resultant force
v) Power required to keep the plate in motion. **(06 Marks)**

OR

8 a. The efficiency η of a fan depends on density ρ. The dynamic viscosity μ of the fluid, the angular velocity ω, diameter D of the rotor and discharge Q. Expression η in terms of dimensionless parameter. **(08 Marks)**

b. Assuming the viscous force 'F' exerted by a fluid on sphere of diameter 'd' depends on viscosity 'μ' , mass density 'ρ' and velocity of sphere 'v'. Obtain an expression for the viscous force. **(05 Marks)**

c. Explain Similitude's. **(03 Marks)**

Module-5

9 a. An air plane is flying at an altitude of 15km , where the temperature is -50°C. The speed of plane corresponds to Mach number 1.6. Assume r = 1.4 and R = 287 J/kg K for air. Find the Speed of plane and Mach angle. **(06 Marks)**

b. Derive the expression for Bernoulli's equation for compressible fluid undergoing.
i) Isothermal process ii) Adiabatic process. **(10 Marks)**

OR

10 a. Define and explain : i) Mach cone , Mach angle ii) Subsonic flow. **(06 Marks)**

b. Write note on CFD, emphasizing its necessity, limitations and applications. **(10 Marks)**

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