CBCS SCHEME

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15ME44

Fourth Semester B.E. Degree Examination, June/July 2019
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. Define the following terms:
i) Mass density ii) Dynamic viscosity
iii) Capillarity iv) Surface tension **(04 Marks)**

b. State and prove Pascal's law. **(06 Marks)**

c. A steel shaft of 30 mm diameter rotates at 240 rpm, in a bearing of diameter 32 mm. Lubricant oils of viscosity 5 poise used for lubrication of shaft in the bearing. Determine the torque required at the shaft and power lost in maintaining the lubrication. Length of bearing is 90 mm. **(06 Marks)**

OR

2 a. Derive an expression for total pressure force and position of centre of pressure for a vertical surface submerged in water. **(08 Marks)**

b. A cylindrical buoy is 2m in diameter 2.5 m long and weighs 2.2 metric tonnes. The density of sea water is 1025 kg/m^3. Show that the body cannot float with its axis vertical. **(08 Marks)**

Module-2

3 a. Distinguish between:
i) Steady and unsteady flow
ii) Laminar and turbulent flow **(04 Marks)**

b. Derive the continuity equation in three dimensional Cartesian coordinates for a steady incompressible flow. **(06 Marks)**

c. A stream function for a 2D flow is given by $\psi = 8xy$. Calculate the velocity at a point P(4, 5). Find also the velocity potential function ϕ. **(06 Marks)**

OR

4 a. Derive the Euler's equation for ideal fluids and hence deduce Bernoulli's equation of motion. Mention the assumptions made. **(10 Marks)**

b. A rectangular channel 2m wide has a discharge of 0.25 m^3/s which is measured by a right angled V-Notch. Find the position of the apex of the notch from the bed of the channel, if maximum depth of water is not to exceed 1.3 m. Take $C_d = 0.62$. **(06 Marks)**

Module-3

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

b. Determine: (i) The pressure gradient along flow, (ii) The average velocity, (iii) The discharge for an oil of viscosity 0.02 N-S/m^2 flowing between two stationary parallel plates 1 m wide maintained 10 mm apart. The velocity midway between the plates is 2 m/s. **(06 Marks)**

OR

6 a. Derive the Darcy-Weisbach equation for the loss of head due to friction in a pipe. **(08 Marks)**

b. The diameter of a horizontal pipe which is 300 mm is suddenly enlarged to 600 mm. The rate of flow of water through this pipe is 0.4 m^3/s. If the intensity of pressure in the smaller pipe is 125 kPa. Determine:
i) Loss of head due to sudden enlargement
ii) Intensity of pressure in the larger pipe
iii) Power lost due to enlargement. **(08 Marks)**

Module-4

7 a. Define the following and write their equations:
i) Drag
ii) Lift
iii) Displacement thickness
iv) Momentum thickness. **(08 Marks)**

b. On a flat plate of 2m length and 1m width experiments were conducted in a wind tunnel with a wind speed of 50 km/hr, the plate is kept at such an angle that the coefficient of drag and lift are 0.18 and 0.9 respectively. Determine:
i) Drag force
ii) Lift force
iii) Resultant force
iv) Power exerted by the air stream on the plate.
Take density of air = 1.15 kg/m^3. **(08 Marks)**

OR

8 a. Define the following dimensionless numbers with equation:
i) Reynold's number
ii) Froude's number
iii) Euler's number
iv) Webber's number **(08 Marks)**

b. Torque developed by a disc of diameter D, rotating at a speed N is dependent on fluid viscosity μ and fluid density ρ. Obtain an expression for torque, $T = \rho N^2 D^5 \phi\left[\frac{\mu}{\rho N D^2}\right]$ using Buckingham's π - theorem. **(08 Marks)**

Module-5

9 a. Define the following:
i) Mach number
ii) Mach angle
iii) Mach cone
iv) Subsonic flow
v) Supersonic flow **(10 Marks)**

b. A projectile travels in air of pressure 100 kPa at 10°C at a speed of 1500 km/hr. Find the mach number and the mach angle. Take K = 1.4 and R = 287 J/kg°K. **(06 Marks)**

OR

10 a. Mention the applications and limitations of CFD (Computational Fluid Dynamics). **(08 Marks)**

b. Define the following terms and write the relevant equations for the same:
i) Stagnation temperature
ii) Stagnation pressure **(08 Marks)**

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