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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 $0.25 \text{ m}^3/\text{s}$ 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)

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

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 $0.4 \text{ m}^3/\text{s}$. 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 $R = 287 \text{ J/kg}^\circ\text{K}$. (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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