

CBCS SCHEME

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18ME43

Fourth Semester B.E. Degree Examination, Jan./Feb. 2023 Fluid Mechanics

Time: 3 hrs.

Max. Marks: 100

*Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.
2. Any missing data assumed suitably.*

Module-1

- 1 a. Define the following terms with SI units:
(i) Mass density (ii) Kinematic viscosity
(iii) Capillarity (iv) Compressibility (10 Marks)
- b. An oil film thickness 1.5 mm is used for lubrication between a square plate of size $0.9 \text{ m} \times 0.9 \text{ m}$ slides down as a inclined plane having an inclination of 20° with horizontal. The weight of the squire plate is 392.4 N and it slides down the plane with a uniform velocity of 0.2 m/s. Find the kinematic viscosity of oil. Specific gravity of oil is 0.7. (10 Marks)

OR

- 2 a. State and prove Pascal's law. (06 Marks)
- b. Derive an expression for total pressure torque and depth of centre of pressure for an inclined plane surface submerged in liquid. (06 Marks)
- c. A simple U-tube manometer containing mercury is connected to a pipe in which a fluid of specific gravity 0.8 and having vacuum pressure is flowing. The other end of manometer is open to atmosphere. Find the vacuum pressure in a pipe, if the difference of mercury level in two limbs is 40 cms and height of the fluid in the left from the centre of pipe is 15 cm below. (08 Marks)

Module-2

- 3 a. Define the following terms:
(i) Buoyancy
(ii) Centre of buoyancy
(iii) Meta centric height
(iv) Meta centre (08 Marks)
- b. Explain different types of fluid flow. (04 Marks)
- c. Derive continuity equations in Cartesian coordinated for a fluid flow 3 dimensional steady incompressible flow. (08 Marks)

OR

- 4 a. Write an expression for acceleration of fluid in x, y and z directions. Differentiate between local and convective acceleration. (06 Marks)
- b. The velocity potential function (ϕ) is given by the expression $\phi = -2 \ln(x^2 + y^2)$. Show that it represents a possible case of fluid flow. (06 Marks)
- c. A solid cylinder of diameter 4 m has a height of 3m. Find the meta centre height when it is floating with its axis vertical. The specific gravity of cylinder is 0.6. (08 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.

Module-3

- 5 a. With a suitable assumption, derive a Bernoulli's equation. (07 Marks)
 b. A pipe line is carrying an oil of specific gravity 0.87, the diameter of pipe changes from 200 mm at section A to 500 mm at section 'B' which is 4 m higher than A. If the pressure at 'A' and 'B' is 100 kPa and 60 kPa respectively and if the discharge is 200 kg/s. Determine:
 (i) Loss of head (ii) Flow direction. (06 Marks)
 c. Obtain the Euler's equation of motion along a stream line. State the assumptions made. (07 Marks)

OR

- 6 a. Derive Hagen Poiseuille equation for laminar flow through a circular pipe. (06 Marks)
 b. Three pipes of length 800 m, 500 m and 400 m of diameters 500 mm, 400 mm and 300 mm respectively are connected in series, these pipes are replaced by a single pipe of 1700 m. Find the diameter of the single pipe. (10 Marks)
 c. Write a note on venture-meter. (04 Marks)

Module-4

- 7 a. Explain boundary layer separation and discuss methods of controlling boundary layer separation. (10 Marks)
 b. What is a similitude's? Explain the following:
 (i) Geometric similarity (10 Marks)
 (ii) Dynamic similarity

OR

- 8 a. The frictional torque of a disc of diameter 'D' depends on speed 'N' in a fluid dynamic viscosity μ and density of fluid ρ in a turbulent fluid flow by Buckingham's PI method develop a frictional torque T. (10 Marks)
 b. The resisting force 'F' of a plane during flight can be considered as dependent upon length of aircraft 'l' velocity V, air viscosity μ , air density ρ and bulk modulus of air K. Express the functional relationship between these variable and the resisting force using dimensional analysis. Explain the physical meaning of these groups. (10 Marks)

Module-5

- 9 a. Define stagnation properties. Obtain an expression for stagnation pressure of a compressible fluid in terms of Mach number and pressure. (08 Marks)
 b. A projectile travels in air of pressure 15 N/cm² at 10°C at a speed of 1500 km/hr. Find the Mach number and Mach angle. Take $\gamma = 1.4$ and $R = 287$ J/kgK. (08 Marks)
 c. What is normal shock and oblique shocks? (04 Marks)

OR

- 10 a. Define the following terms:
 (i) Mach number
 (ii) Zone of action
 (iii) Subsonic flow
 (iv) Supersonic flow
 (v) Transonic flow (10 Marks)
 b. Explain CFD and mention its applications. (06 Marks)
 c. Explain one dimensional flow. (04 Marks)
