CBCS SCHEME

USN | | | | | | | | | | |

15ME44

Fourth Semester B.E. Degree Examination, Dec.2018/Jan.2019
Fluid Mechanics

Time: 3 hrs. Max. Marks: 80

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

Module-1

1 a. Define the following properties of fluids with their units:
(i) Weight density.
(ii) Dynamic viscosity.
(iii) Bulk modulus **(06 Marks)**

b. An oil film of 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 an inclined plane having an inclination of 20° with the horizontal. The weight of square 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 the oil is 0.7 **(05 Marks)**

c. A simple U-tube manometer containing mercury is connected to a pipe in which a fluid of Sp.gravity 0.8 and having vacuum pressure is flowing. The other end of manometer is open to atmosphere. Find the vacuum pressure in pipe, if difference of mercury level in two limbs is 40 cm and height of fluid in the left from the centre of pipe is 15 cm below. **(05 Marks)**

OR

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

b. Derive expression for total pressure and centre of pressure for a plane surface immersed vertically in a static mass of fluid. **(06 Marks)**

c. A uniform body of size 3m long $\times 2\text{m}$ wide $\times 1$ m deep floats in water. What is the weight of the body if depth of immersion is 0.8 m? Determine the meta centric height also. **(04 Marks)**

Module-2

3 a. Explain different types of fluid flow. **(06 Marks)**

b. The stream function for a two dimensional flow is given by $\psi = 2xy$, calculate the velocity at the point P(2, 3). Find the velocity potential ϕ. **(04 Marks)**

c. Obtain the Euler's equation of motion along a stream line and hence derive Bernoulli's equation for a steady incompressible fluid flow. State the assumptions made. **(06 Marks)**

OR

4 a. Derive an expression for discharge through a triangular notch. **(05 Marks)**

b. A jet of water of diameter 50 mm having velocity 40 m/s, strikes a curved fixed symmetrical plate at its centre. The jet is deflected through an angle 120° at the outlet of the curved plate. Calculate the force exerted by jet of water in the direction of jet and perpendicular to jet. **(05 Marks)**

c. Find the discharge of water flowing through a pipe 30 cm diameter placed in an inclined position where a venturimeter is inserted, having a throat diameter of 15 cm. The difference of pressure between the main and throat is measured by a liquid of specific gravity 0.6 in an inverted U-tube which gives a reading of 30 cm. The loss of head between the main and throat is 0.2 times the kinetic head of the pipe. **(06 Marks)**

Module-3

5 a. Prove that the ratio of maximum velocity to average velocity for laminar flow between two stationary parallel plates is 1.5. **(10 Marks)**

b. A fluid of viscosity 0.7 NS/m^2 and specific gravity 1.3 is flowing through a circular pipe of diameter 100 mm. The maximum shear stress at the pipe wall is given as 196.2 N/m^2. Find (i) the pressure gradient (ii) Average velocity (iii) Reynold's number of the flow. **(06 Marks)**

OR

6 a. What are the energy losses that occur in pipes? Give the expressions for different minor energy losses. **(04 Marks)**

b. An oil of specific gravity 0.9 and viscosity 0.06 poise is flowing through a pipe of diameter 200 mm at the rate of 60 lit/sec. Find the head lost due to friction for a 500 m length of pipe. Find the power required to maintain this flow. **(06 Marks)**

c. Three pipes of lengths 800 m, 500 m and 400 m and 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 single pipe. **(06 Marks)**

Module-4

7 a. Define the terms:
   (i) Boundary layer thickness.
   (ii) Energy thickness
   (iii) Lift
   (iv) Drag **(04 Marks)**

b. Write a short note on boundary layer separation and methods to control it. **(06 Marks)**

c. A long plate of size $5\text{m} \times 2\text{m}$ is moving in air with velocity of 9 km/hr parallel to its length. Calculate the drag force on both sides of plate if, (i) Boundary layer is laminar over the complete plate. (ii) Boundary layer is turbulent over the complete plate.
Take $\rho_{air} = 1.2 \text{ kg/m}^3$ and $\mu = 1.8 \times 10^{-4}$ poise **(06 Marks)**

OR

8 a. The pressure difference Δp in a pipe of diameter D and length l due to viscous flow depends on the velocity V, viscosity μ and density ρ. Using Buckingham's π-theorem. Obtain an expression for Δϕ. **(10 Marks)**

b. Explain (i) Geometric similarity (ii) Kinematic similarity (iii) Dynamic similarity **(06 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. **(10 Marks)**

b. A projectile travels in air of pressure 15 N/cm^2 at 10°C at a speed of 1500 km/hr. Find the Mach number and Mach angle. Assume r = 1.4 and R = 287 J/kgK **(04 Marks)**

c. What are normal and oblique shocks? **(02 Marks)**

OR

10 a. Show that velocity of propogation of elastic wave in an adiabatic medium is given by $C = \sqrt{rRT}$ starting from fundamentals. **(08 Marks)**

b. Calculate the stagnation temperature on nose of plane which is flying at 800 km/hr through still air having a pressure 8 N/cm^2 and temperature -10°C. Take R = 287 J/kgK and r = 1.4 **(02 Marks)**

c. Define computional fluid dynamics. Mention the applications of CFD. **(06 Marks)**

* * * * *