Ref. No.: Ex/IEE/ES/B/PE/T/216/2024 (S)

B. E. INSTRUMENTATION AND ELECTRONICS ENGINEERING

SECOND YEAR FIRST SEMESTER SUPPLEMENTARY EXAM - 2024

APPLIED FLUID MECHANICS

Time : 3 Hours **Full Marks : 100**

Answer Question No. 1 (compulsory) and Any 4 Questions from the rest.

Answer to all parts of a Question must be presented together.

Assume any data, if not furnished, consistent with the problem.

1. (a) Explain the formation of boundary layer over a flat plate when the same is introduced in a free stream flow with the help of a neat and labelled diagram. **[5]**

   (b) Describe the variation of vapour pressure of a fluid with change in temperature of the fluid. **[5]**

   (c) Define surface tension. What is the SI unit of surface tension? What assumptions are considered for a fluid flow when deriving Bernoulli`s equation? **[2 + 1 + 2]**

   (d) What is capillarity? Give an example of the same. Show a diagram of capillary rise with the necessary symbols. **[2 + 1 + 2]**

2. (a) Write short notes on any 5 (five) :- **[5 X 4 = 20]**

   (i) Fluid Continuum
   (ii) Hydrostatic Law
   (iii) Piezometer
   (iv) Absolute, Gauge and Vacuum Pressure
   (v) Lagrangian method of fluid motion
   (vi) Eulerian method of fluid motion
   (vii) Shockwaves

3. (a) A fluid flow is described using the following velocity field, $\vec{V} = (2x^2t)\hat{\imath} + (z^2ty)\hat{\jmath} + (z - 4zx)\hat{k}$. Find the acceleration vector and velocity magnitude at position coordinates (1,-2,1) and t = 2. **[10]**

   (b) A fluid flow is described using the following velocity field, $\vec{V} = (-xy)\hat{\imath} + (-3y^2 + zy)\hat{\jmath} + (x^2z - 2zx)\hat{k}$, at coordinates (1,0,-3). Find out (i) If the flow is compressible or incompressible? (ii) If the flow is rotational or irrotational? **[5 + 5]**

4. (a) Write short notes on streamlines and pathlines. **[5 + 5]**

   (b) Derive the Continuity Equation in its Three (3) – Dimensional Cartesian coordinate form. [Properly mention any assumptions or correlations taken during simplification] **[10]**

5. (a) An orifice meter with orifice diameter 10 cm is inserted in a pipe of 20 cm diameter. The pressure gauges fitted upstream and downstream of the orifice meter gives readings of 19.62 N/cm^2 and 9.81 N/cm^2 respectively. Co-efficient of discharge for the orifice meter is given as 0.6. Find the discharge of water through pipe. **[10]**

   (b) A pipeline of 500 mm in diameter is 1.2 km long. Sometime later another parallel line of the same diameter is introduced in the second half of the length. Neglecting minor losses, find the change in discharge if $f = 0.04$ and head at inlet is 20 m over that at the outlet. **[10]**

6. (a) Find the discharge through a trapezoidal channel of width 8 m and side slope of 1 horizontal to 3 vertical. The depth of flow of water is 2.4 m and value of Chezy`s constant $C = 50$. The slope of the bed of the channel is given 1 in 4000. **[10]**

   (b) Calculate the Mach number at a point on a jet propelled aircraft, which is flying at 1100 km/hr at sea level where air temperature is 20°C. [Take standard values for other parameters at the given conditions as required.] **[6]**

   (c) Differentiate between normal and oblique shocks. **[4]**

7. (a) The pressure difference Δp in a pipe due to turbulent flow depends on the velocity V, diameter D, length l, viscosity μ, density ρ and roughness (in metres) k. Using Buckingham`s π – theorem, obtain an expression for Δp. **[20]**