CBCS SCHEME

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18AE/AS35

Third Semester B.E. Degree Examination, Dec.2023/Jan.2024
Mechanics of Fluids

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. Discuss the following properties of fluids
   i) Density or Mass density
   ii) Specific weight or weight density
   iii) Specific volume
   iv) Specific gravity
   v) Viscosity. **(10 Marks)**

b. A vertical gap 2.2cm wide of infinite extent contains a fluid of viscosity 2.0Ns/m^2 and specific gravity 0.9. A metallic plate 1.2m × 1.2m × 0.2cm is to be lifted up with a constant velocity of 0.15m/esc, through the gap. If the plate is in the middle of the gap, find the force required. The weight of the plate is 40N. **(10 Marks)**

OR

2 a. The diameters of a small piston and a large piston of a hydraulic jack are 3cm and 10cm respectively. A force of 80N is applied on the small piston. Find the load lifted by the large piston when
   i) The pistons are at the same level
   ii) Small piston is 40cm above the large piston
   The density of the liquid in the jack is given as 1000kg/m^3. **(10 Marks)**

b. A caisson for closing the entrance to a dry dock is of trapezoidal form 16m wide at the top and 10m wide at the bottom and 6m deep. Find the total pressure and centre of pressure on the caisson, if the water on the outside is just level with the top and dock is empty. **(10 Marks)**

Module-2

3 a. With a neat sketch, explain the following:
   i) Linear translation or pure translation
   ii) Linear deformation
   iii) Angular deformation
   iv) Rotation. **(12 Marks)**

b. Two discs are placed in a horizontal plane, one over the other. The water enters at the centre of the lower disc and flows radially outward from a source of strength 0.628m^2/s. The pressure, at a radius 50mm, is 200kN/m^2. Find:
   i) Pressure in kN/m^2 at a radius of 500mm
   ii) Stream function at angles of 30° and 60° if $\psi = 0$ at $\theta = 0°$ **(08 Marks)**

OR

4 a. With a neat sketch, explain models of the fluid control volumes and fluid elements. **(08 Marks)**

b. For a finite control volume fixed in space derive momentum equation in integral and differential form. **(12 Marks)**

Module-3

5 a. Derive an expression for discharge through orifice meter. **(10 Marks)**

b. The water is flowing through a pipe having diameters 20cm and 10cm at section 1 and 2 respectively. The rate of flow through pipe is 35 litres/s. The section 1 is 6m above datum and section 2 is 4m above datum. If the pressure at section 1 is 39.24N/cm^2, find the intensity of pressure at section 2. **(10 Marks)**

OR

6 a. Find the expression for the power P, developed by a pump when P depends upon the head H, the discharge Q and specific weight W of the fluid using Rayleigh's method. **(06 Marks)**

b. Derive on the basis of dimensional analysis suitable parameters to present the thrust developed by a propeller. Assume that the thrust P depends upon the angular velocity W, speed of advance V, diameter D, dynamic viscosity μ, mass density ρ elasticity of the fluid medium which can be denoted by the speed of sound in the medium C. **(14 Marks)**

Module-4

7 a. Derive Von Karman momentum integral equation for a flat plate due to boundary layer. **(10 Marks)**

b. Find the displacement thickness, the momentum thickness and energy thickness for the velocity distribution in the boundary layer given by $\frac{u}{U}=\frac{y}{\delta}$, where u is the velocity at a distance Y from the plate and u = U at y = δ, where δ = boundary layer thickness. Also calculate the value of δ^*/θ. **(10 Marks)**

OR

8 a. A kite weighing 0.8kgf (7.848N) has an effective area of 0.8m^2. It is maintained in air at an angle of 10° to the horizontal. The string attached to the kite makes on angle of 45° to the horizontal and at this position the value of co-efficient of drag and lift are 0.6 and 0.8 respectively. Find the speed of the wind and the tension in the string. Take the density of air as 1.25kg/m^3. **(10 Marks)**

b. Experiments were conducted in a wind tunnel with a wind speed of 50km/hour on a flat plate of size 2m long and 1m wide. The density of air is 1.15kg/m^3. The coefficients of lift and drag are 0.75 and 0.15 respectively. Determine:

i) The lift force
ii) The drag force
iii) The resultant force
iv) Direction of resultant force
v) Power exerted by air on the plate. **(10 Marks)**

Module-5

9 a. Derive the expression for velocity of sound wave in a fluid. **(10 Marks)**

b. Derive Bernoulli's equation for

i) Isothermal process
ii) Adiabatic process in a steady compressible flow. **(10 Marks)**

OR

10 Derive expression for

i) Stagnation Pressure (P_s)
ii) Stagnation density (ρ_s)
iii) Stagnation Temperature (T_s) **(20 Marks)**

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