



B.E. DEGREE EXAMINATIONS: NOV/DEC 2023

(Regulation 2018)

Third Semester

AERONAUTICAL ENGINEERING

U18AEI3201: Fluid Mechanics

COURSE OUTCOMES

- CO1:** Apply the basic equation of fluid statics to determine forces on planar and curved surfaces that are submerged in a static fluid.
- CO2:** Apply conservation laws to determine velocities, pressures, and accelerations for incompressible and inviscid fluids.
- CO3:** Apply principles of dimensional analysis to identify non-dimensional parameters
- CO4:** Explain the concepts of viscous boundary layers
- CO5:** Apply principles of impacts of jets in fluid machinery

Time: Three Hours

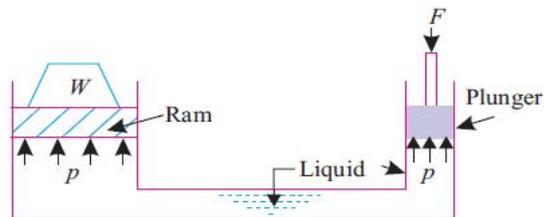
Maximum Marks: 100

Answer all the Questions:-

PART A (10 x 2 = 20 Marks)

(Answer not more than 40 words)

1. State the Pascal's Law. Explain how it is applied in a simple hydraulic press with plunger area "a" and the area of Ram "A" as shown in the Figure. CO1 [K₃]



2. Two horizontal plates are placed 14 mm apart, the space between them being filled with oil of viscosity 1.4 Ns/m^2 . Calculate the maximum shear stress (assuming linear velocity profile) in the oil if the upper plate moved at 3 m/s. CO1 [K₂]
3. Distinguish between Streamlines, Pathlines and streaklines. CO2 [K₂]
4. The diameters of a tapering pipe at sections 1-1 and 2-2 are 100 mm and 150 mm respectively. If the velocity of water flowing through the pipe at section 1-1 is 5 m/s, determine the discharge in the pipe and the velocity of water at section 2-2. CO2 [K₂]

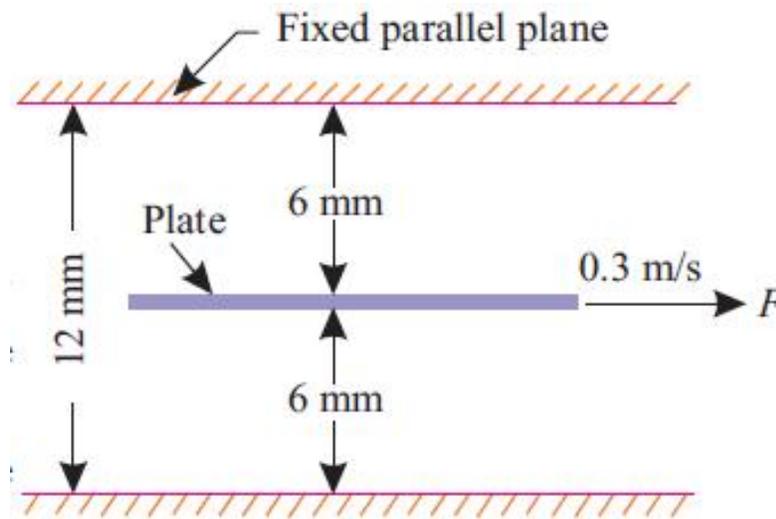
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| 5. | Define Reynolds Number and its significance in determining the nature of the fluid flow. | CO3 | [K ₂] |
| 6. | Explain the principle of dimensional homogeneity with an example. | CO3 | [K ₂] |
| 7. | Define the term boundary layer. | CO4 | [K ₂] |
| 8. | Determine the momentum thickness in terms of boundary layer thickness δ in the case of the linear velocity profile. | CO4 | [K ₂] |
| 9. | Obtain the expression for the force exerted by a jet of water on a plate kept perpendicular to the axis of the jet. | CO5 | [K ₃] |
| 10. | Draw a vector diagram for a jet of water striking the curved plate at one end tangentially when the plate is symmetrical. | CO5 | [K ₂] |

Answer any FIVE Questions:-

PART B (5 x 16 = 80 Marks)

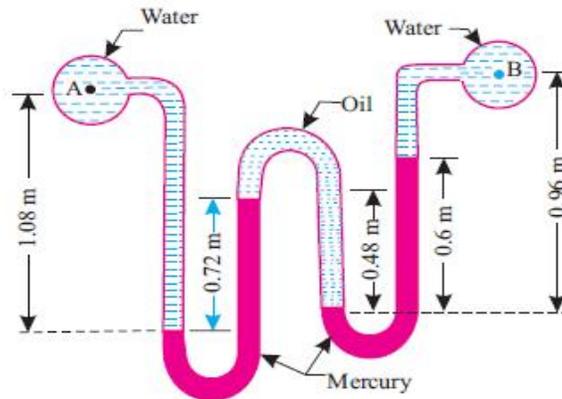
(Answer not more than 400 words)

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| 11. | a) | Two large fixed parallel planes are 12 mm apart. The space between the surfaces is filled with oil of viscosity $0.972 \text{ Ns} / \text{m}^2$. A flat thin plate 0.25 m^2 area moves through the oil at a velocity of 0.3 m/s . Calculate the drag force, when the plate is equidistant from both planes. State the assumptions made. | 8 | CO1 | [K ₃] |
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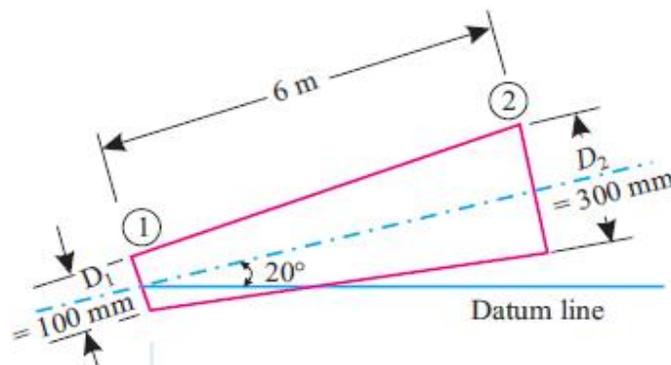


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| b) | With a neat sketch and description derive the three-dimensional continuity equation in differential form. State the assumptions made in deriving the equation. | 8 | CO2 | [K ₃] |
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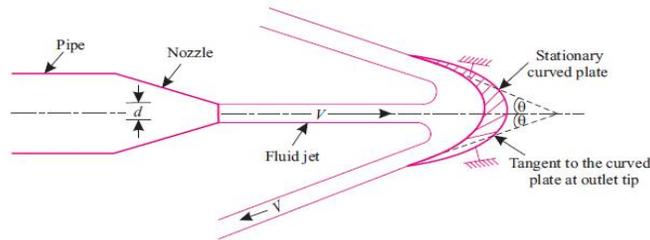
12. a) Calculate pressure difference between the points A and B of the compound meter shown in fig. Take specific weights as $W_w = 10 \text{ kN/m}^3$ for water, $W_m = 136 \text{ kN/m}^3$ for mercury, $W_o = 8.5 \text{ kN/m}^3$ for oil. 8 CO1 [K3]



- b) Determine the displacement thickness and momentum thickness of a boundary layer region with a velocity profile $\frac{u}{U} = \frac{3}{2}(y/\delta) - \frac{1}{2}(y/\delta)^2$ 8 CO4 [K3]
13. a) The velocity components for a two-dimensional flow are given by $u = -4ax(x^2 - 3y^2)$ and $v = 4ay(3x^2 - y^2)$ 8 CO2 [K3]
Examine whether these velocity components represent a physically possible two-dimensional flow, if so whether the flow is rotational or irrotational?
- b) Explain the terms Geometric Similarity, Kinematic Similarity and Dynamic Similarity. 8 CO3 [K2]
14. a) A 6m long uniformly tapered pipe is inclined at an angle 20° with the horizontal. The smaller section which is at lower level is of 100 mm diameter and the larger section of the pipe is of 300 mm diameter as shown in the figure, If the velocity of the water at the smaller section is 1.8 m/s, determine the difference of pressures between the two sections. 8 CO2 [K4]



- b) Consider a jet of water with uniform velocity striking the stationary curved plate at the center as shown in figure. Obtain the expressions for forces acting on the curved plate along the direction of the jet and in the perpendicular direction. 8 CO5 [K4]



15. a) Describe Buckingham's method of Π -theorem to formulate a dimensionally homogeneous equation between various physical quantities affecting certain phenomena. 8 CO3 [K3]
- b) With the help of neat sketch, describe the boundary layer formation and its characteristics for a flow over a flat plate. 8 CO4 [K3]
16. a) Explain separation of boundary layer with the help of the velocity profiles . 8 CO4 [K3]
- b) A 75 mm diameter jet having a velocity of 30 m/s strikes a flat plate, the normal of which is inclined at 45° to the axis of the jet. Find the normal force on the plate (i) When the plate is stationary and (ii) When the plate is moving with a velocity of 15 m/s in the direction away from of jet . 8 CO5 [K3]
