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**ANNA UNIVERSITY (UNIVERSITY DEPARTMENTS)****B.E. (Full Time) - END SEMESTER EXAMINATIONS, NOV/DEC 2021**

B.E. CIVIL ENGINEERING  
III Semester  
**CE5351 FLUID MECHANICS**

(Regulation 2019)

Time: 3hrs

Max.Marks: 100

CO 1	Demonstrate the difference between solid and fluid, its properties and behaviour in static conditions.
CO 2	Apply the conservation laws applicable to fluids and its application through fluid kinematics and dynamics.
CO 3	Formulate the relationship among the parameters involved in the given fluid phenomenon and to predict the performances of prototype by model studies.
CO 4	Estimate losses in pipelines for both laminar and turbulent conditions and analysis of pipes connected in series and parallel.
CO 5	Explain the concept of boundary layer and its application to find the drag force exerted by the fluid on the flat solid surface.

**BL – Bloom's Taxonomy Levels**

(L1 - Remembering, L2 - Understanding, L3 - Applying, L4 - Analysing, L5 - Evaluating, L6 - Creating)

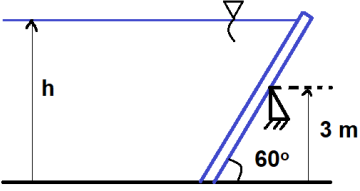
**PART- A (10 x 2 = 20 Marks)**

(Answer all Questions)

Q. No	Questions	Marks	CO	BL
1	With a practical example describe the rheology of a pseudoplastic fluid.	2	1	1
2	The centre of gravity and centre of pressure will coincide for a vertical plane immersed in a static fluid-Justify.	2	1	2
3	Write the type of acceleration associated with the situations given: (i) flow at constant rate passing through a bend (ii) gradually changing flow through a straight pipe (iii) gradually changing flow through a bend and (iv) flow at constant rate passing through a straight uniform diameter pipe.	2	2	1
4	State the reason why stream line, path line, streak line and time line of a steady flow are identical.	2	2	2
5	The time taken by the free falling object depend up on height (h) from the ground level, mass(m) of the object and acceleration due to gravity (g). Show that time ratio $\frac{t_1}{t_2} = 1.5$ , for an object falling from 9 m and 4 m above ground level.	2	3	4
6	State the reasons why only the viscous force is predominating in modeling of pipeline in model studies.	2	3	2
7	Determine the viscosity of an oil (sp.gr. 0.93) having laminar flow in a laboratory set up, where two pressure gauges placed 6 m apart in a 50 mm diameter horizontal pipe showed a pressure difference of 17 kN/m <sup>2</sup> . During the test run of 3 minutes, oil collected in a tank was found to be 5150 N.	2	4	5

8	Write the parameters which determines the friction factor of a turbulent flow in very rough and very smooth pipe.	2	4	1
9	State the effects of positive pressure gradient in the boundary layer.	2	5	2
10	The boundary layer thickness at a distance of 1 m from the leading edge of a flat plate kept at zero angle of incidence to the flow direction is 0.1 cm. If the velocity outside the boundary layer is 25 m/s, calculate the boundary layer thickness at a distance of 4 m from the leading edge.	2	5	3

**PART- B (5 x 13 = 65 Marks)**

Q. No	Questions	Marks	CO	BL
11 (a) (i)	A vertical gap 23.5 mm wide of infinite extent contains oil of specific gravity 0.95 and viscosity 2.45 Ns/m <sup>2</sup> . A metal plate 1.5 m x 1.5 m x 1.5 mm weighing 49 N is to be lifted through the gap at a constant speed of 0.1 m/s. (i) Estimate the force required. Also, (ii) determine the viscosity of the oil if the total force required to lift the plate at same speed is 188 N.	13	1	4
<b>OR</b>				
11 (b) (i)	A gate supporting water as shown in Figure-1. Find the height of water so that the gate tips about the hinge. Take width of gate as unity.   <p align="center">Figure-1</p>	13	1	4
12 (a)	If the velocity components of a possible flow are $v = 4ay(3x^2 - y^2)$ , $u = -4ax(x^2 - 3y^2)$ , determine whether or not the motion is possible and obtain both velocity potential and stream function.	13	2	3
<b>OR</b>				
12 (b)	A 300 mm diameter pipe carries water at a head of 20 m with velocity 3.5 m/s. If the axis of the turns through 45° in the vertical plane, find the magnitude and direction of the resultant force on the bend with neat sketches.	13	2	3
13 (a)	Find the form of the equation for discharge Q through a sharp-edged triangular notch assuming Q depends on the central angle $\alpha$ of the notch, head H, gravitational acceleration g, the density $\rho$ , viscosity $\mu$ and surface tension $\sigma$ of the fluid.	13	3	3
<b>OR</b>				
13 (b)(i)	Water with kinematic viscosity of 0.01 cm <sup>2</sup> /s flows in a 20 cm pipe with absolute roughness 0.004 cm with a mean velocity of 1 m/s and observed head loss is 60 cm in a 100 m length of pipe. If a glycerine-water mixture of kinetic viscosity of 0.02 cm <sup>2</sup> /s flow in a 10 cm pipe of roughness 0.002 cm with a velocity of 4 m/s, how much head loss per 100 m of the pipe should be expected?	6	3	3

13 (b)(ii)	A model of rectangular pier 1.5 m wide and 4.5 m long in a river is built to a scale of 1/25. The average depth of water in the river is 3 m. The model was tested in a laboratory, where the velocity of the flow was maintained constant at 0.65 m/s. It was observed that the force acting on the model was 3.92 N and the height of the standing wave was 3.5 cm. Determine for the prototype (i) corresponding speed, (ii) the force acting and (iii) the height of the standing wave at nose.	7	3	3
14 (a)	A horizontal pipe of 5 cm conveys oil of specific gravity 0.9 and dynamic viscosity 0.8 kg/ms. Measurements indicate a pressure drop of 20 kN/m <sup>2</sup> per meter of pipe length. Calculate, (i) flow rate of oil and centerline velocity, (ii) wall shear stress and the frictional drag over 100 m length of pipe, (iii) power of pump required assuming an overall efficiency of 60% and (iv) velocity and shear stress at 1 cm from the pipe surface.	13	4	4
<b>OR</b>				
14 (b)	Two pipes of diameter 40 cm and 20 cm are each 300 m long. When the pipes are connected in series and discharge through pipeline is 0.1 m <sup>3</sup> /s, find the loss of head incurred. What could be the loss of head in the system to pass the same total discharge when the pipes are connected in parallel? Take friction factor $f = 0.0075$ for each pipe.	13	4	4
15 (a)	For velocity profile of laminar boundary layer flow given as $\frac{u}{U} = 2\left(\frac{y}{\delta}\right) - \left(\frac{y}{\delta}\right)^2$ , find boundary layer thickness $\delta$ , wall shear stress $\tau_o$ and drag force on one side of the flat plate $F_D$ in terms of Reynolds number.	13	5	2
<b>OR</b>				
15 (b)	The velocity distribution in the boundary layer over a high spillway face was found to have the following form $\frac{u}{U} = \left(\frac{y}{\delta}\right)^{0.22}$ . Prove that the displacement thickness, momentum thickness and energy thickness in terms of $\delta$ (boundary layer thickness) can be expressed as $\frac{\delta^*}{\delta} = 0.18$ ; $\frac{\theta}{\delta} = 0.125$ and $\frac{\delta^{**}}{\delta} = 0.217$ .	13	5	2

**PART- C (1 x 15 = 15 Marks)**

(Q.No.16 is compulsory)

Q. No	Questions	Marks	CO	BL
16. (i)	A piece of alloy containing gold and silver weighs 20.5 N in air and 18.8 N in water. Find the percentage of gold and silver in the alloy. Take specific gravity of gold $S_g = 19.5$ and specific gravity of silver $S_s = 10.5$ . Instead of silver if copper is used, what could be the weight of ornament in water if the weight in air remains constant? Take specific gravity of copper $S_c = 8.9$ .	15	1	6