BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(MID SEMESTER EXAMINATION SP/2025)

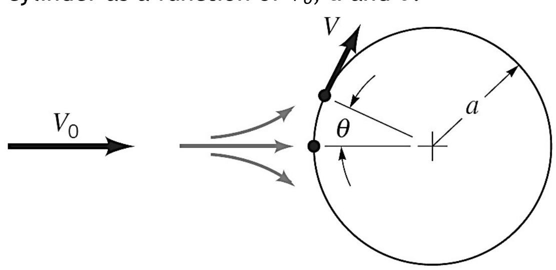
CLASS: BTECH | **SEMESTER: IV**
BRANCH: MECHANICAL | **SESSION: SP/2025**

SUBJECT: ME213 THERMO-FLUID ENGINEERING

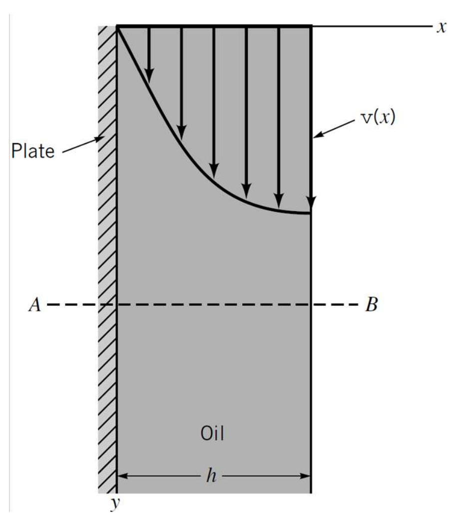
TIME: 02 Hours | **FULL MARKS: 25**

INSTRUCTIONS:
1. The question paper contains 5 questions each of 5 marks and total 25 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.

			CO	BL
Q.1	Define streamlines and pathlines in fluid flow. Also comment on the validity (or invalidity) of the following statements, with suitable justification: (i) Streamlines and pathlines can never coincide. (ii) Two streamlines can never intersect. (iii) Streamlines through a point at successive intervals of time can be different.	[5]	1	1-4
Q.2(a)	A fluid flows past a circular cylinder of radius *a* with an upstream speed of V_o as shown in the figure below. The velocity of the fluid along the surface of the cylinder is given by V = $2V_o \sin\theta$. Determine the streamline and normal components of acceleration on the surface of the cylinder as a function of V_o, *a* and θ.	[2]	1-2	1-3

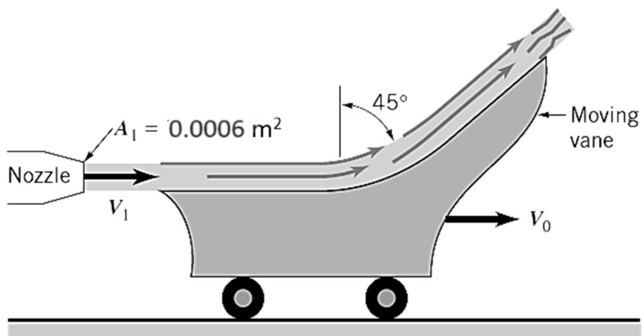


Q.2(b)	A layer of oil flows down a vertical plate as shown in the figure with a velocity of $\vec{V} = \frac{V_0}{h^2}(2hx - x^2)\,\hat{j}$, where V_0 and *h* are constants. (a) Show that the fluid sticks to the plate (x = 0) and that the shear stress at the edge of the layer (x = *h*) is zero. (b) Determine the volumetric flowrate across surface *AB*. Assume the width of the plate is *b*.	[3]	1-3	1-3



Q.3 Derive the equation defining conservation of angular momentum in integral analysis of fluid motion, starting from Newton's 2nd law and using RTT. Briefly describe how this equation can be used to find the torque on the shaft of a rotating lawn sprinkler, clearly showing the control volume and the control surfaces considered for the analysis. [5] 1-3 1-2

Q.4 A vane on wheels moves with constant velocity of V_o = 6 m/s when a stream of water having a nozzle exit velocity of V_1 = 30 m/s is turned 45° by the vane as indicated in the figure. The cross-sectional area of the stream of water over the vane is 0.0006 m^2, and the length of the water stream is equal to 0.3 m. Determine the magnitude of force in the horizontal and vertical directions, F_x and F_y, exerted by the stream of water on the vane surface. [5] 1-3 1-4



Q.5 Derive the equation of conservation of mass in differential form for fluid flow in the 3D rectangular cartesian coordinate. Also state the following forms of the mass conservation equation: [5] 1-2 1-2

(i) generalized coordinate independent vectorial form
(ii) reduced form for steady compressible flow
(iii) reduced form for incompressible flow.

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