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

CLASS: BTECH **SEMESTER : VI**
BRANCH: CHEMICAL ENGG. **SESSION : SP/2025**

SUBJECT: CL329 TRANSPORT PHENOMENA

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

INSTRUCTIONS:
1. The question paper contains 4 questions of total 25 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
***4*. Tables/Data handbook/Graph paper etc., if applicable, will be supplied to the candidates**

			CO	BL
Q.1(a)	The equation of motion is given by $\rho\left[\frac{\partial\vec{v}}{\partial t}+\vec{v}.\nabla\vec{v}\right]=-\nabla p+\mu\nabla^2\vec{v}+\rho\vec{g}$ i) What kind of fluid and flow is this form of equation of motion valid? ii) Express the equation for any one of the x y or z components of the cartesian frame of reference. iii) Express the equation for Static fluid, Steady high velocity (inertial regime), and Creeping flow regime.	[3]	1,2	2
Q.1(b)	Prove that $\nabla.[\nabla\times\vec{v}]=0$	[2]	1	3
Q.2	A Newtonian fluid flows down an inclined plane with an angle of inclination of *β* with vertical and a film thickness of *δ*.			
Q. 2(a)	Sketch the physical description of the problem. List all the possible assumptions for the determination of the velocity profile analytically.	[3]	1,2	2
Q. 2(b)	Simplify the governing equations (continuity and motion) of fluid flow and develop the differential equation for the determination of velocity.	[3]	3	3
Q. 2(c)	Specify suitable boundary conditions to solve the differential equation derived in (b).	[1]	1	2
Q. 2(d)	Solve the differential equation derived in (b) with the help of boundary conditions specified in (c) to determine the equation for velocity profile.	[3]	3	3
Q.3	Consider a Newtonian fluid (constant ρ and μ) in incompressible, laminar flow in a long and vertical circular tube of radius R and length L. The fluid flows downwards under the influence of a pressure difference and gravity.			
Q. 3(a)	Derive the equation for the steady-state velocity distribution using shell momentum balance with proper boundary conditions.	1,3		3
Q. 3(b)	Derive the Hagen-Poiseuille equation for the average volumetric flow in the tube.	1,3		3
Q.4(a)	Define substantial or material derivative with an example.	[2]	1	2
Q.4(b)	Explain the operation mechanism of the Couette viscometer with a sketch.	[3]	1,2	2

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