BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(MID-SEMESTER EXAMINATION MO/2024)

CLASS: **B.Tech.** **SEMESTER: 7th**
BRANCH: **Chemical Engineering** **SESSION: MO/2024**

SUBJECT: CL427 Microfluidics

TIME: **2 Hours** **FULL MARKS: 25**

INSTRUCTIONS:
1. The question paper contains 5 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

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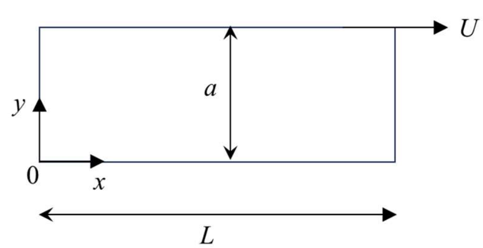
		Marks	CO	BL
Q.1(a)	What do you mean by electrokinetic phenomena? electrons flow through a conductor, can this be termed as an electrokinetic phenomenon?	[2]	427.3	3
Q.1(b)	Electroosmosis and electrophoresis are these two sporadic phenomena, or it has some entangled domain; explain in detail (with proper diagram)	[3]	427.3	3
Q.2(a)	Is zeta potential is a fundamental property, or it can be modulated by some means; tell the difference between compact and diffused electric double layer.	[2]	427.3	3
Q.2(b)	What do you mean by charge rectification; explain how charge rectification can occur due to pressure gradient in a flow field with scattered ions	[3]	427.3	2
Q.3(a)	Make a sketch of how the flow is developed inside a channel in terms of the boundary layer theory. Show the velocity profiles for developing and fully developing flow. What is entrance length?	[2]	427.3	2
Q.3(b)	Consider the steady, laminar, incompressible and fully developed flow of a Newtonian fluid between two parallel plates. The upper plate is moving with a constant velocity *U*. The schematic of the flow is shown in figure 1 which is known as Couette flow. The separation distance between the two plates is '*a*' and the length of each plate is *L*. The governing equations (1-2) based on the rectangular cartesian coordinate system is given below. Simplify the governing momentum equations by using appropriate assumptions and derive the expression for the velocity profile. Also, show the locations of minimum and maximum velocities.	[5]	427.4	3



x-component: $\rho\left(\frac{\partial u}{\partial t}+u\frac{\partial u}{\partial x}+v\frac{\partial u}{\partial y}\right)=-\frac{\partial p}{\partial x}+\mu\left(\frac{\partial^2 u}{\partial x^2}+\frac{\partial^2 u}{\partial y^2}\right)$ (1)

y-component: $\rho\left(\frac{\partial v}{\partial t}+u\frac{\partial v}{\partial x}+v\frac{\partial v}{\partial y}\right)=-\frac{\partial p}{\partial y}+\mu\left(\frac{\partial^2 v}{\partial x^2}+\frac{\partial^2 v}{\partial y^2}\right)$ (2)

		Marks	CO	BL
Q.3(c)	Write down the two important assumptions in the context of microscale flow. What are the three different time scales possible at the microscale?	[2+1]	427.1	1
Q.4(a)	Provide an example in which the angular component of the flow velocity is important. Make a sketch of the same. What is the application of this set up?	[1+1+1]	427.2	1
Q.4(b)	Provide an example of unsteady flow. Briefly describe the physical picture and make a sketch of the same.	[2]	427.2	