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

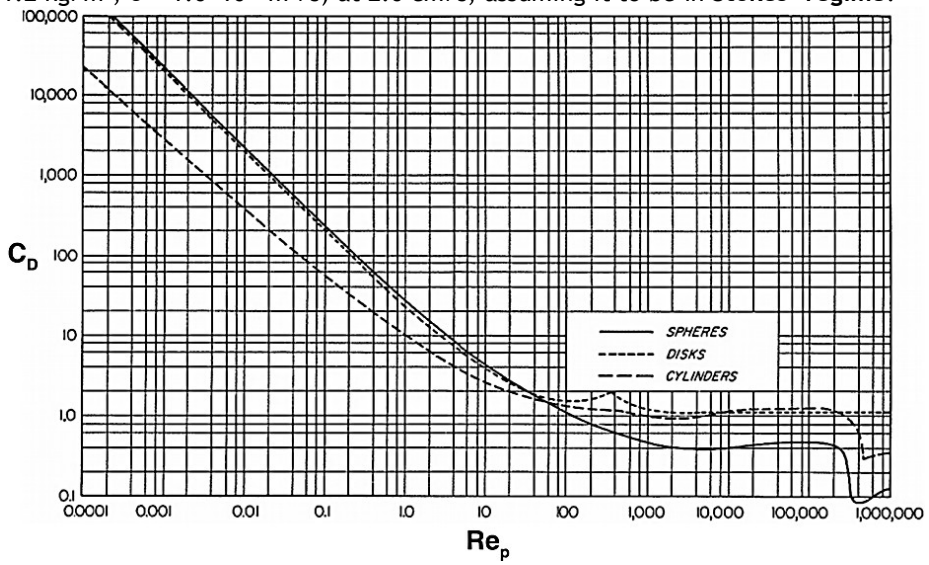
CLASS: BTECH **SEMESTER : V/ADD**
BRANCH: CHEMICAL **SESSION : MO/2025**

SUBJECT: CL343 FLUID-SOLID OPERATIONS

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.
***4*. Tables/Data handbook/Graph paper etc., if applicable, will be supplied to the candidates**

			CO	BL
Q.1	Answer the following questions for a randomly packed bed.		3	4
	a. Derive the equation for pressure drop in the laminar flow regime.	[2]		
	b. Derive the equation for pressure drop in the turbulent flow regime.	[1]		
	c. Obtain an expression for the **total** fractional pressure drop valid for **any** flow regime.	[2]		
Q.2	Answer the following questions for a randomly packed bed.		3	4
	a. Sketch the pressure drop – flow rate relationship in the laminar regime when flow rate is gradually increased to the end of regime and then decreased to zero.	[1]		
	b. Derive an alternative equation for pressure drop at the **end** of laminar regime.	[2]		
	c. Derive an equation for the critical velocity at the **end** of laminar regime.	[2]		
Q.3	Answer the following using your answers of q. # 1 and 2.		3	4
	a. What will be the pressure drop if the bed is in use for a **long time**? Justify.	[1]		
	b. What will be the pressure drop if the bed is **repacked**? Justify.	[1]		
	c. Provide a physical interpretation of the term $2\times1.75\times(1-\varepsilon)\times(L/\varepsilon D_p)$	[3]		
Q.4	Answer the following questions on free settling with the help of C_D – Re_p relationship.		1,2	4
	a. Obtain an expression for the terminal velocity (u_t) of a **spherical** particle beginning from an expression valid for a particle of arbitrary shape.	[1]		
	b. Set up an algorithm to estimate u_t if the Reynolds number is given by $Re_p = (\rho u_t D_p)/\mu$.	[3]		
	c. Estimate C_D for a spherical particle of catalyst (D_p = 62 μm) freely settling in air (ρ = 1.2 kg/m^3, υ = 1.6×10^{-5} m^2/s) at 2.6 cm/s, assuming it to be in **Stokes' regime**.			



Q.5	Local void fraction (ε) varies from location–to–location in packed beds. The radial distribution of void fraction is given by $\varepsilon(r)=\bar{\varepsilon}+(1-\bar{\varepsilon})J_0(ar/D_p)exp(-br/D_p)$ .Using the approximate relations $a=2.932/(A-9.864)$, $b=0.304-(0.724/A)$, $A=D_b/D_p$, and $\bar{\varepsilon}=0.379+(0.078/(A-1.8))$ for a packed bed of perfectly spherical particles, estimate ε variation for an industrial–scale packed bed for which A = 25, until $\varepsilon\rightarrow\bar{\varepsilon}$. Use r/D_p = 0, 1, 2, 3, 4, 5. Also sketch the resulting distribution.	[5]	3	4

:::::23/09/2025 :::::M