Register Number:……..

KUMARAGURU
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B.TECH. DEGREE EXAMINATIONS: NOV / DEC 2024

(Regulation 2018)

Fourth Semester

BIOTECHNOLOGY

U18BTT4001 : Fluid and Particle Mechanics in Bioprocess

COURSE OUTCOMES

CO1: Conceptualize fluids properties and its behavior under static conditions.
CO2: Identify and analyze the significance of pressure drops and boundary layers concepts.
CO3: Elucidate the flow measurements and transportation of fluids.
CO4: Apply the principles of size reduction and equipment.
CO5: Solve importance of mixing and agitation and scale up.
CO6: Elaborate the principles of filtration, centrifugal and sedimentation.

Time: Three Hours **Maximum Marks: 100**

Answer all the Questions
PART A (10 x 2 = 20 Marks)
(Answer not more than 40 words)

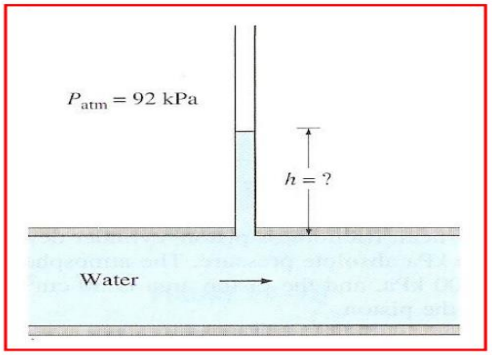
1.	The wall shear stress, τ_w = 0.981 N/m^2 and average shear rate in circular pipe, γ = 981 (s)$^{-1}$ is obtained for the fluid flow. Calculate the viscosity of the fluid.	CO1	[K_2]
2.	What is the pressure difference over a manometer in N/m^2? If density of the manometric fluid is mercury = 13600 kg/m^3 and flowing fluid through piping is carbon tetrachloride density is 1600 kg/m^3 and the manometer reads 200 mm.	CO1	[K_2]
3.	Recall the assumptions made for solving the Bernoulli's equation.	CO2	[K_1]
4.	Name the various factors depends on magnitude of drag force.	CO2	[K_1]
5.	What are the classification of control valves? Give examples for each.	CO3	[K_1]
6.	List out the pressure ranges involved for fans, blowers, and compressors.	CO3	[K_1]
7.	Interpret the separation techniques and particle-size range of various solid-solid operations.	CO4	[K_2]
8.	What is the objectives of size enlargement?	CO4	[K_2]
9.	Outline the purpose of agitation and mixing in bioreactor	CO5	[K_1]
10.	Distinguish between free settling and hindered settling.	CO6	[K_2]

Answer any FIVE Questions
PART B (5 x 4 = 20 Marks)
(Answer not more than 80 words)

11.	Water flows through a 25 mm diameter pipeline at a rate of 0.8 *l*/s. If the temperature of water is 303 K, determine the type of flow. At 303 K the density of water is 996 kg/m^3 and the viscosity of water is 0.8 mPa. s.		CO1	[K_3]
12.	In an air pipeline, the flow has the following conditions at station 1: Density of air = 2.1 kg/m^3, Velocity = 15 m/s and Pipe inside the diameter = 50 mm. The conditions at station 2 are: Pipe inside the diameter = 75 mm and Density of air = 1.517 kg/m^3. Estimate the mass flow rate of air and the velocity at station 2.		CO2	[K_3]
13.	Summarize about the constant head meter and variable head meter.		CO3	[K_2]
14.	What is the power required to crush 100 tons /hr of limestone if 80 per cent of the feed passes a 2-inch screen and 80% of the product a 1/8-inch screen? Given index for limestone is 12.74.		CO4	[K_3]
15.	Demonstrate the different flow patterns involved in fermenter and its factors to be considered.		CO5	[K_2]
16.	Label the ideal flow patterns in a membrane filtration with diagram.		CO6	[K_2]

Answer any FIVE Questions
PART C (5 x 12 = 60 Marks)
(Answer not more than 300 words)

17.	a)	The power required P for an agitator depends upon the propeller diameter D, the rotational speed N of the agitator, the liquid density ρ, the viscosity μ and the gravitational acceleration g. Find by Rayleigh's method, the correct representation for the power requirement in terms of dimensionless groups.	6	CO1	[K_4]

	b)	 A glass tube is attached to a water pipe, as shown in Figure. If the water pressure at the bottom of the tube is 115 kPa and the local atmospheric pressure is 92 kPa, determine how high the water will rise in the tube, in m. Assume g = 9.8 m/s^2 at that location and take the density of water to be 1000 kg/m^3.	6	CO1	[K$_4$]
18.	a)	A straight stretch of horizontal pipe having a diameter of 5 cm is used in the laboratory to measure the viscosity of crude oil. During a test run a pressure difference of 1.75 t/m^2 is obtained from two pressure gages, which are located 6 m apart on the pipe. Determine the viscosity of the oil if the discharge is 0.0033m^3/s.	6	CO2	[K$_4$]
	b)	Acetic acid is to be pumped at a rate of 0.02 m^3 /s through a 75 mm inner dia. pipeline. What does the pressure drop in the pipeline over a length of 70 m? Date: Fanning friction factor f = 0.001 Density of acetic acid = 1060 kg/m^3 Viscosity of acetic acid = 0.0025 (N s)/m^2	6	CO2	[K$_4$]
19.	a)	Orifice meter is installed in a pipeline for measurement of flow rate of water. The pressure drop across the orifice meter is 10 cm of mercury. Estimate the volumetric flow rate in m^3/s. Data: Diameter of orifice = 25 mm Diameter of pipe = 50 mm Coefficient of orifice = 0.62 Density of water = 1000 kg/m^3 Density of mercury = 13,600 kg/m^3	6	CO3	[K$_3$]
	b)	Explain the working of negative displacement pump with neat diagram and its significance.	6	CO3	[K$_3$]
20.	a)	If the total percentage of particles larger than the screen opening in the feed, product and undersize is 25%, 90%, and 5% respectively, calculate the effectiveness of the screen.	6	CO4	[K$_3$]
	b)	Illustrate about the working principle, construction, and application of roll crusher with neat diagram.	6	CO4	[K$_2$]

21.	a)	Enumerate the three main types of impellers involved in agitation.	6	CO5	[K_2]
	b)	A six-blade turbine agitator of diameter 60 cm is installed centrally in tank with flat bottom of diameter 180 cm, at a height of 60 cm from the bottom. The tank is filled with a solution of viscosity 10 Cp and of 1.45 g/ml density. The speed of agitation is 90 rpm. The tank is baffled. Calculate the power required. Data: Power number Np = 1.05 for $N_{Re} > 4000$ & $N_p = 0.042$ for $N_{Re} < 4000$	6	CO5	[K_4]
22.	a)	The following data belongs to lab tests undertaken on a calcium carbonate slurry. The filter area equals 0.045 m^2 and the solid concentration in the slurry is 24 kgm^{-3}. Evaluate the mean specific cake resistance and the filter medium resistance at a fixed pressure of 50 kPa.	6	CO6	[K_3]

V (L)	0.5	1.0	1.5	2.0	2.5	3
t (s)	17.3	42.3	72.0	108.3	152	202.7

	b)	Discuss the working and construction of Dorr thickener with neat diagram.	6	CO6	[K_2]

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