



B.TECH. DEGREE EXAMINATIONS: APRIL / MAY 2023

(Regulation 2018)

Fourth Semester

BIOTECHNOLOGY

U18BTT4001: Fluid and Particle Mechanics in Bioprocess

COURSE OUTCOMES

- CO1:** Conceptualize fluids properties and its behaviour under static conditions.
CO2: Identify and analyse 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

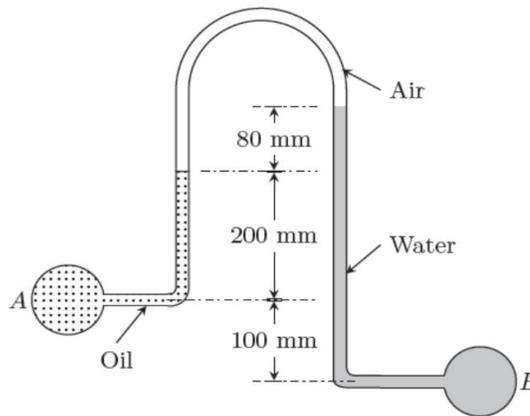
PART A (10 x 2 = 20 Marks)
(Answer not more than 40 words)

1. Calculate the magnitude of the force (in N) required to hold a body of volume 0.05 m^3 and mass 40 kg in water (density 1000 kg/m^3) at a depth of 0.1 m is ($g = 9.81 \text{ m/s}^2$). CO1 [K₃]
2. Use the definition, $\tau = \mu \frac{du}{dy}$ to determine the dimensions of viscosity. CO1 [K₁]
3. When 2500 liters of water flows per minute through a 0.3 m diameter pipe which later reduces to a 0.15 diameter pipe, calculate the velocities of flow in the two pipes. CO2 [K₃]
4. A pipe 50 mm diameter is 2 m long and the velocity of flow of water in the pipe is 2.4 m/s . What loss of head? Take $f = 0.04$. CO2 [K₃]
5. List out the advantages of Anemometer and its applications. CO3 [K₁]
6. Define cavitation and priming. CO3 [K₁]
7. Name four principle of size reduction involved in comminution. CO4 [K_L]
8. Why is granulation technique preferred for size enlargement? CO4 [K_L]
9. Distinguish between radial flow impellers and axial flow impellers. CO5 [K₂]
10. What is meant by filter aids? CO6 [K₁]

Answer any FIVE Questions
PART B (5 x 16 = 80 Marks)
(Answer not more than 400 words)

11. a) The tip deflection, δ , of a cantilever beam is a function of tip load, W , beam length, l , second moment of area, I , and Young's modulus, E . Perform a dimensional analysis of this problem. 8 CO1 [K4]

- b) An inverted U tube manometer is used to measure the pressure difference between two pipes A and B, as shown in the figure. Pipe A is carrying oil (specific gravity = 0.8) and pipe B is carrying water. The densities of air and water are 1.16 kg/m^3 , respectively. The pressure difference between pipes A and B is kPa. Acceleration due to gravity $g = 10 \text{ m/s}^2$.



8 CO1 [K3]

12. a) A 0.3 m pipe carries water at a velocity of 24.4 m/s. At points A and B measurements of pressure and elevation were respectively 361 k N/m^2 and 288 k N/m^2 and 30.5 m and 33.5 m. For steady flow, find the loss of head between A and B. 8 CO2 [K3]

- b) A straight stretch of horizontal pipe having a diameter of 5 cm is used in the laboratory. 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. Oil is allowed to discharge at $0.0033 \text{ m}^3/\text{sec}$. Determine the viscosity of the oil. 8 CO2 [K3]

13. a) Water flows at the rate of $0.147 \text{ m}^3/\text{s}$ through a 150 mm diameter orifice inserted in a 300 mm diameter pipe. If pressure gauges fitted at the upstream and the downstream of the orifice plate give readings of 176.58 kN/m^2 and 88.29 kN/m^2 respectively, find the coefficient of discharge of the orifice meter. Density of water = 1000 kg/m^3 . 8 CO3 [K3]

- b) Explain with neat sketch the working of a centrifugal pump. 8 CO3 [K2]

14. a) Elaborate on trommel screening equipment construction and working with diagram. 8 CO4 [K2]

b) A material is crushed in a Blake jaw crusher such that the average size of particle is reduced from 50 mm to 10 mm with the consumption of energy of 13.0 kW/(kg/s). What would be the consumption of energy needed to crush the same material of average size 75 mm to an average size of 25 mm. By using Rittinger's law. 8 CO4[K3]

15. a) For producing an oil-water emulsion, two portable three-bladed propeller mixer are available. 0.5 m diameter impeller rotating at 1 Hz and 0.35 m impeller rotating at 2 Hz. Assuming turbulent condition prevail, which unit have the lower power consumption? 8 CO5[K3]

b) Discuss with neat diagram of agitation equipment used in industries. 8 CO5[K2]

16. a) A suspension of *Bacillus subtilis* cells is filtered under constant pressure for recovery of protease. A pilot-scale filter is used to measure the filtration properties. The filter area is 0.25m², the pressure drop is 360 mmHg, and the filtrate viscosity is 4.0 cP. The cell suspension deposits 22 g of cake per litre of filtrate. The following data are measured. Determine the specific cake resistance and filter medium resistance. 8 CO6[K4]

Time (min)	2	3	6	10	15	20
Filtrate volume (l)	9.8	12.1	18.0	23.8	29.9	37.5

b) Summarize the working principle of Spitzkasten gravity settling chamber with diagram. 8 CO6[K2]
