MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
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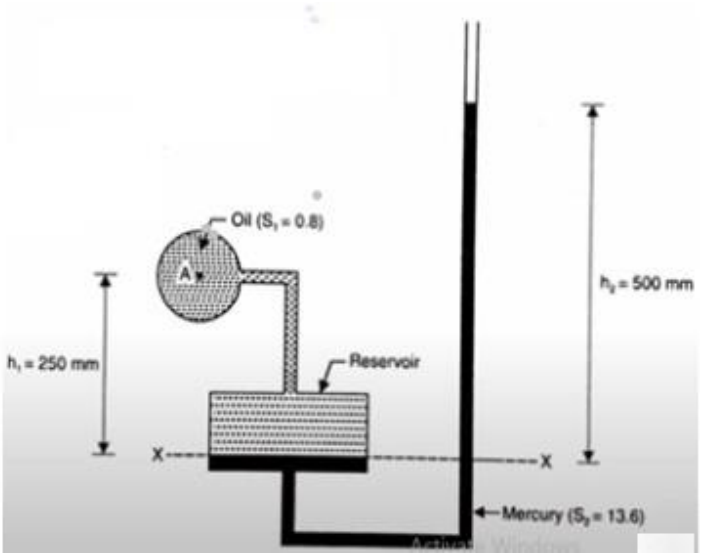
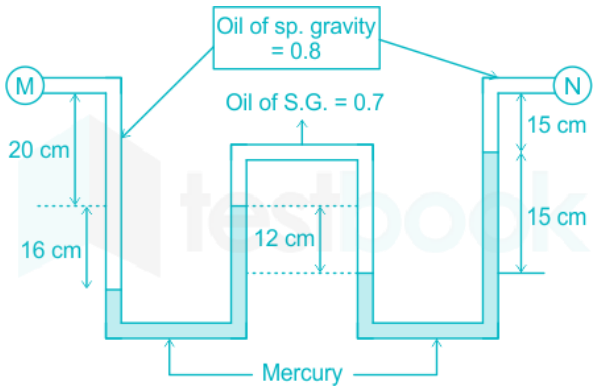
III SEMESTER B.TECH. (BIOTECHNOLOGY)
END-SEMESTER MAKE UP EXAMINATION, 05/01/2024 (09:30 AM-12:30 PM)

SUBJECT: FLUID FLOW OPERATIONS (BIO 2124)

REVISED CREDIT SYSTEM

ANSWER ALL QUESTIONS

TIME: 3 HOURS **MAX. MARKS: 50**

Q. NO	QUESTIONS	M	CO	PO	BTL
1A	The figure shows a single column manometer connected to apipe containing oil of sp.gravity 0.8. The ratio of area of the reservoir to that of the right limb is 100. Find the pressure in the pipe. 	4	1	1-3	4
1B	Determine the pressure difference (P_M - P_N) in N/cm^2 when the manometer indicates as shown in the figure. 	4	1	1-3	4

1C	A flat plate of area 1.5 x 10^6 mm^2 is pulled with the speed of 0.4 m/s relative to another plate located at a distance 0.15 mm apart from it. Find the force and power required to maintain the speed, if the fluid separating them having viscosity of 1 Pa.s.	**2**	**1**	**1-3**	**4**
2A	Water is flowing through a pipe having diameters 300 mm and 200 mm at the bottom end and the upper end respectively. If the pressure at bottom end is 250 kN/m^2 and the upper end is 100 kN/m^2. Determine the difference in datum heads if the rate of flow through pipe is 40 L/s.	**4**	**2**	**1-3**	**3**
2B	A horizontal venturimeter with inlet diameter 20 cm and throat dia 10 cm is used to measure the flow of water. The pressure at inlet is 17.658 N/cm^2 and the vacuum pressure at the throat is 30 cm of mercury. Find the discharge of water through venturimeter. Take C_v = 0.98.	**4**	**2**	**1-3**	**3**
2C	Differentiate between Fanning and Darcy's friction factor.	**2**	**2**	**1-3**	**2**
3A	Soybean oil is being pumped through a uniform diameter pipe at a steady mass flowrate. A pump supplies 209.2 J/kg mass of fluid flowing. The entrance absolute pressure in the inlet pipe to the pump is 103.4 kN/m^2. The exit section of the pipe downstream from the pump is 3.35 m above the entrance and the exit pressure is 172.4 kN/m^2. Exit and entrance pipes are the same diameter. The fluid is in turbulent flow. Calculate the friction loss in the system. Density of oil = 919 kg/m^3.	**4**	**2**	**1-3**	**4**
3B	Water is to be pumped from a tank to the top of a tower 1829 cm above the water level in the tank. It is desired to deliver 0.34 m^3/min of water at a pressure of 2.08 atm. The pipe line consists of 122 m length of straight pipe of 7.62cm ID with EIGHT elbows of 90º and FOUR gate valves. Calculate only the total friction in straight pipe in J/kg. $f = 0.046 / Re^{0.2}$	**3**	**3**	**1-3**	**4**
3C	Water is to flow through 300 m of horizontal pipe at a rate of 0.06 m^3/s. A head of 6 m is available. What must be the pipe diameter? Take fanning friction factor = 0.0056.	**3**	**3**	**1-3**	**5**
4A	Consider a device with one inlet and one outlet. If the volume flow rates at the inlet and the outlet are the same, is the flow through this device necessarily steady? Why?	**2**	**3**	**1-3**	**4**
4B	A cylindrical bioreactor of diameter 3 m has four baffles. A Rushton turbine (refer Curve 1) mounted in the reactor has a diameter one third the tank diameter and is operated at a speed of 90 rpm. The density of the fluid is approximately 1 g/cm^3. The reactor is used to culture an anaerobic organism that doesn't require gas sparging. The broth can be assumed Newtonian. As the cells grow, the viscosity of the broth increases. Calculate the power requirements when the viscosity is aapproximately that of water.	**4**	**4**	**1-3**	**4**

4C	It is desired to agitate a liquid having a viscosity of $1.5x10^{-3}$ Pa.s and a density of 969 kg/m^3 in a tank having a diameter of 0.91 m. The agitator will be a six-blade open turbine having a diameter of 0.305 m operating at 180 rpm. The tank has four vertical baffles each with a width of 0.076 m. Calculate the required power in kW.	**4**	**4**	**1-3**	**5**
5A	Calculate the pressure drop of air flowing at 30 ºC and 1 atm pressure through a bed of 1.25 cm diameter spheres, at a rate of 60 kg/min. The bed is 125 cm diameter and 250 cm height. The porosity of the bed is 0.38. The viscosity of air is 0.0182 cP and the density is 0.001156 gm/cc.	**4**	**4**	**1-3**	**5**
5B	Estimate the minimum fluidization velocity for a bed of particles fluidized by water. Given that D_p = 120 mm; ϕ_s=1; ρ_p = 2500 kg/m^3; e_{mf} = 0.45; ρ =1000 kg/m^3 and μ = 0.9 mPa.s.	**4**	**4**	**1-3**	**4**
5C	Deduce an expression for the sphericity of a solid particle of a cylindrical shape.	**2**	**4**	**1-3**	**5**

CO: Course Outcome; BLOOM TAXONOMY LEVEL: 1-Remember, 2-Understanding, 3-Application, 4-Analyzis, 5-Evaluation, 6-Creation