MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
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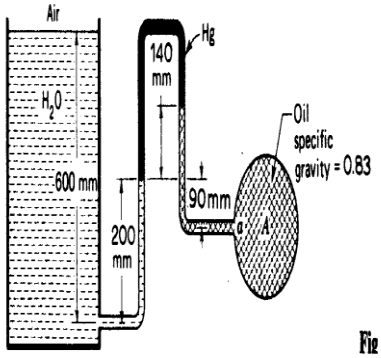
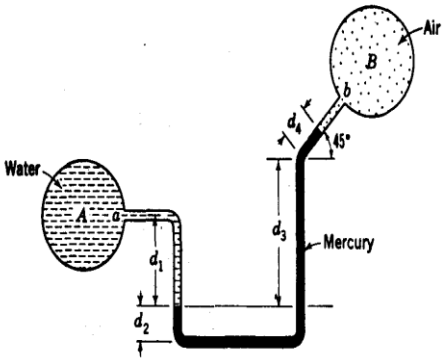
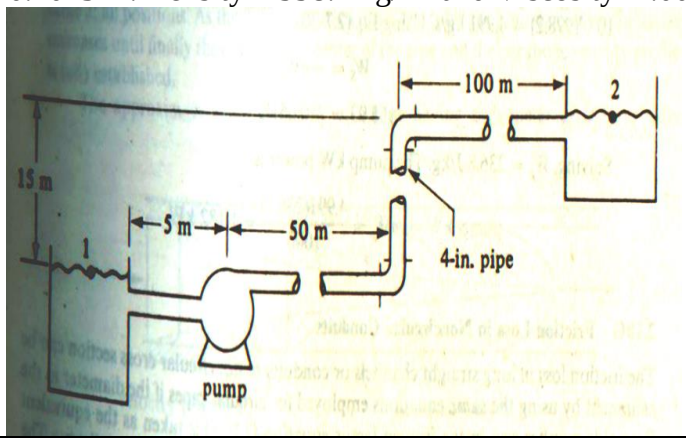
III SEMESTER B.TECH. (BIOTECHNOLOGY)
END-SEMESTER EXAMINATION, 30/11/2023 (9:30-12:30)
SUBJECT: FLUID FLOW OPERATIONS (BIO 2124)
REVISED CREDIT SYSTEM
ANSWER ALL QUESTIONS

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

Q. NO	QUESTIONS	M	CO	PO	BTL
1A	For the setup shown in Figure, calculate the absolute pressure at '**a**'. Assume standard atmospheric pressure, 101.3 kPa.  Fig	**4**	**1**	**1-3**	**4**
1B	Find the difference in pressure between tanks A and B in Figure, if d_1 = 330mm, d_2 = 160 mm, d_3 =480 mm, and d_4 = 230mm. 	**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	A Pitot tube is installed along the axis of a horizontal pipe of 76 mm inner diameter. Air at 40 ^oC and 105 kPa flows through the pipe. Calculate the rate of flow of air, if the reading of the water differential manometer connected	**4**	**2**	**1-3**	**3**

	across the tube is 12 mm. Viscosity of air at 40 ^oC is 0.019 mPa.s. Take v_{avg}/v_{max}=0.81 for N_{Remax} between 60000 to 70000.				
2B	A rotameter calibrated for metering has a scale ranging from 0.014 m^3/min to 0.14 m^3/min. It is intended to use this meter for metering a gas of density 1.3 kg/m^3 with in a flow range of 0.028 m^3/min to 0.28 m^3/min. What should be the density of the new float if the original one has a density of 1900 kg/m^3? Both the floats can be assumed to have the same volume and shape.	**4**	**2**	**1-3**	**3**
2C	Compare the flow measuring devices orifice and venturi meters.	**2**	**2**	**1-3**	**2**
3A	A centrifugal pump is being tested for performance. and during the test the pressure reading in the 0.305 mdiameter suction line just adjacent to the pump casing is 20.7 kPa (vacuum below atmospheric pressure). In the discharge line with a diameter of 0.254 m at a point 2.53 m above the suction line, the pressure is 289.6 kPa gage. The flow of water from the pump is measured as 0.1133 m^3/s. The density can be assumed as 1000 kg/m^3. Calculate the kW input of the pump.	**5**	**2**	**1-3**	**4**
3B	Water at 20 ^oC is being pumped from a tank at the rate of $5x10^{-3}$ m^3/s. All of the piping is 4" schedule 40 pipe. The pump has an efficiency of 65 %. Calculate only the total friction in straight pipe in J/kg. Given for 4" Schedule 40 pipe, D=0.1023 m. Density = 998.2 kg/m^3 and Viscosity=1.005 cP. 	**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.	**2**	**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?	**3**	**3**	**1-3**	**4**
4B	A fermentation broth with viscosity 10^{-2} Pa.s and density 1000 kg/m^3 is agitated in a 50 m^3 baffled tank using a marine propeller (refer curve 5) 1.3 m in diameter. Calculate the power required for a stirred speed of 4 rps.	**3**	**4**	**1-3**	**4**
4C	A flat blade turbine agitator with disk having six blades is installed in a tank. The tank diameter is 1.83 m, the turbine diameter is 0.61 m. The tank contains four baffles. The turbine operated at 90 rpm and the liquid in the tank has a viscosity of 10 cP and a density of 929 kg/m^3. Calculate the required kW of	**4**	**4**	**1-3**	**5**

	the mixer. Given Data: Width of blade = 0.122 m; and Width of jacket = 0.15 m.				
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 are 0.001156 g/cc.	**4**	**4**	**1-3**	**5**
5B	Particles having a size of 0.1 mm, a shape factor of 0.86, and a density of 1200 kg/m^3 are to be fluidized using air at 25 ºC and 202.65 kPa abs pressure. The void fraction at min fluidizing conditions is 0.43. The bed diameter is 0.6 m and the bed contain 350 kg of solids. i. Calculate the minimum height of the fluidized bed. ii. Calculate the pressure drop at minimum fluidizing conditions.	**4**	**4**	**1-3**	**4**
5C	Calculate the sphericity of a solid particle of a cubical shape.	**2**	**4**	**1-3**	**5**
	CO: Course Outcome; BLOOM TAXONOMY LEVEL: 1-Remember, 2-Understanding, 3-Application, 4-Analyzis, 5-Evaluation, 6-Creation				