Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent unit of MAHE, Manipal)

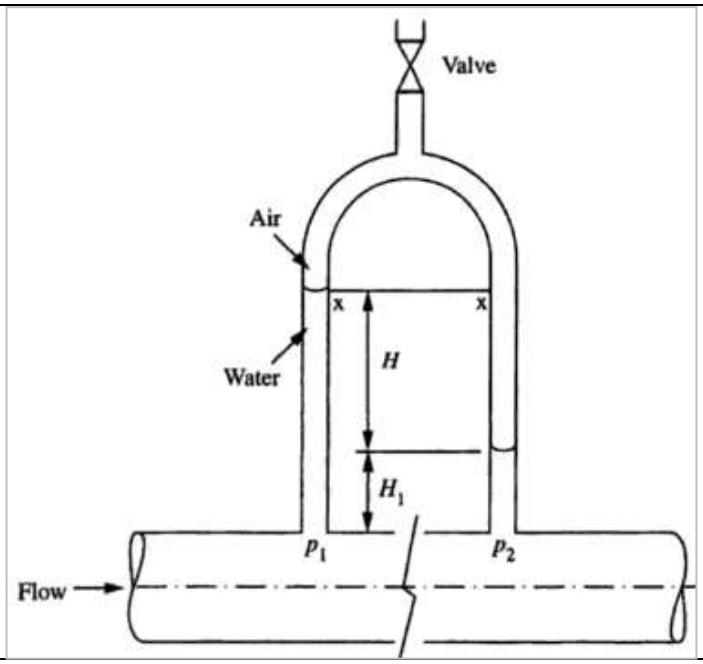
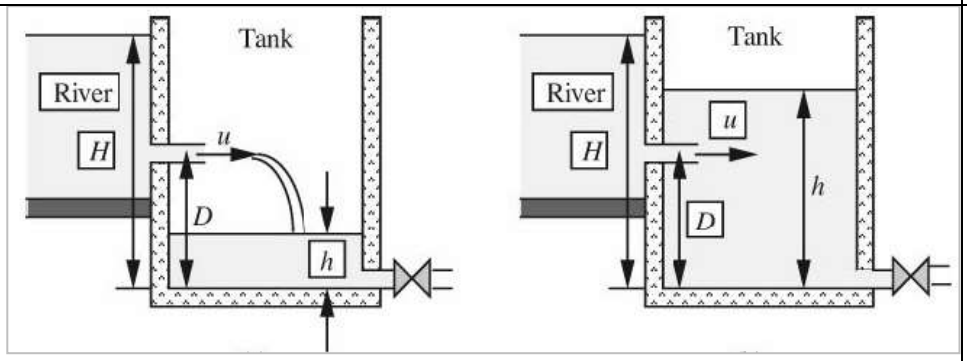
III SEMESTER B.TECH. END SEMESTER EXAMINATIONS NOV 2018

SUBJECT: MOMENTUM TRANSFER [CHE 2102] (20/11/2018)

Time: 3 Hours **REVISED CREDIT SYSTEM** MAX. MARKS: 50

Instructions to Candidates:

☑ Answer **ALL** the questions. ☑ Assume any missing data suitably.

1A.	Derive an expression for pressure drop in a pipe when connected to an inverted manometer (refer the figure), and determine the pressure drop in the pipe carrying water if a differential head of 40 cm is recorded. 	**3**
1B.	A thin-walled pipe, of diameter 4 in., is held stationary in a river flowing at 6 ft/s parallel to its axis. The pipe contains a sharp-edged orifice, of diameter 3 in., with a contraction coefficient of 0.62 based on the area. Neglecting entry losses and shear forces on the pipe, and assuming that the orifice is distant from either end of the pipe, calculate the pressure drop across the pipe and the flow rate through it.	**4**
1C.	Explain the rheological characteristics of non-Newtonian fluids.	**3**
2A.	Fig. shows a concrete tank that is to be filled with water from an adjacent river. The level of the river is H = 10 ft above the base of the tank, and the short connecting pipe, which offers negligible resistance, discharges water at a height D = 4 ft above the base of the tank. The inside cross-sectional area of the pipe is a = 0.1 ft^2, and that of the tank is A = 1,000 ft^2. Derive an algebraic 	

	expression for the time t taken to fill the tank, and then evaluate it for the stated conditions.	6
2B.	Derive steady-state energy balance equation with the help of a neat schematic diagram. Clearly mention all the assumptions considered.	4
3A.	A pump delivers a power P kW to transfer Q m^3/s of crude oil of density ρ kg/m^3 through a long-distance horizontal pipeline of length L m, with a friction factor f_F. The installed cost of the pipeline is $\$c_1 D_m L$ (where m = 1.4) and that of the pumping station is $\$(c_2 + c_3 P)$; both these costs are amortized over n years. Electricity costs $\$c_4$ per kWh and the pump has an efficiency η. The values of c_1, c_2, c_3, and c_4 are known. The pump inlet and pipeline exit pressure are the same. If there are N hours in a year, prove that the optimum pipe diameter giving the lowest total annual cost is: $D_{opt} = \left(\frac{5\alpha}{\beta m}\right)^{1/(m+5)}$; *where* $\alpha = \left(\frac{32 f_F \rho Q^3 L}{\pi^2}\right)\left(\frac{N c_4}{1000\eta} + \frac{c_3}{n}\right); \beta = \frac{c_1 L}{n}$ If c_1 = 2280, c_2 = 95000, c_3 = 175, c_4 = 0.11, ρ = 850, L = 50000, η = 0.75, and f_F = 0.0065, all in units consistent with the above, evaluate D_{opt} for Q = 0.2 m^3/s, and n = 10 years.	5
3B.	Water is flowing turbulently at a mean velocity of u_m = 10 ft/s in a 1.0-in. I.D. horizontal pipe, and the Fanning friction factor is f_F= 0.0060. What error in the pressure drop would ensue if (erroneously) the assumption were made that the flow was laminar, abandoning the previous value of the friction factor? Derive the pressure drop expression used here with the help of a neat schematic diagram. Clearly mention all the assumptions considered.	5
4A.	For a liquid flowing through a packed bed, derive an expression for the pressure drop per unit length of the bed with the help of a neat schematic diagram. Clearly mention all the assumptions considered.	5
Data for Q.No. 4B. & 4C.: (Note: Refer the expression derived in Q.No. 4A to solve.) $D_p = 1*10^{-3} m; \rho_f = 1000 kg/m^3; \mu_f = 1*10^{-3} kg/m.s; \rho_s = 2500 kg/m^3$		
4B.	When u_0 is 0.005 m/s and ε = 0.5, calculate the ratio of the viscous loss to the kinetic energy loss.	3
4C.	On further increasing u_0, minimum fluidization is achieved. Assuming that the porosity of the bed remains unaltered, determine the pressure drop per unit length (in Pa/m) under minimum fluidization condition.	2
5A.	Describe a centrifugal pump characteristic curve with the help of a neat schematic.	3
5B.	List out the differences between centrifugal and positive-displacement reciprocating pumps.	3
5C.	Write the advantages and disadvantages of packed bed and fluidized bed columns.	4

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