Reg. No. | | | | | | | | | |

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

DEPARTMENT OF MECHATRONICS

VI SEMESTER B.TECH. (MECHATRONICS)

END SEMESTER MAKEUP EXAMINATION, JUNE 2024

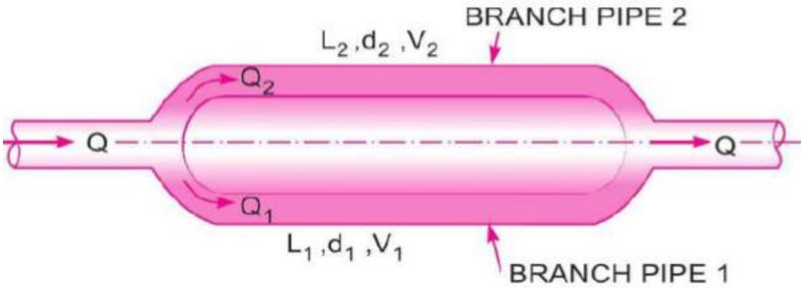
SUBJECT: ENERGY AND HEAT TRANSFER [MTE 3252]

(18.06.2024)

Time: 180 MINUTES **MAX. MARKS: 50**

Instructions to Candidates:
- Answer **ALL** the questions.
- Missing data if any can be suitably assumed.

Q. No	QUESTIONS	M	CO	PO	LO	BL
1A.	A gas of 4 kg is contained within a piston-cylinder machine. The gas undergoes a process for which $pV^{1.5}$ = constant. The initial pressure is 3 bar, and the initial volume is 0.1 m^3 and the final volume is 0.2 m^3. The specific internal energy of the gas decreases by 4.6 kJ/kg. There are no significant changes in KE and PE. Determine the net heat transfer for the process.	5	2	1, 2, 3	1, 3	4
1B.	Derive an expression for Darcy-Weisbach equation, explain the loss component in it.	3	5	1, 2, 3	1	3
1C.	Differentiate between open, closed and isolated systems.	2	1	1, 2, 12	1, 3	3
2A.	Formulate an expression for flow through pipes connected in series and parallel.	4	6	1, 2, 3	1, 3	4
2B.	A heat pump is to be used to heat a house in winter and then reversed to cool the house in summer. The interior temperature is to be maintained at 20°C. Heat transfer through the walls and roof is estimated to be 0.525 kJ/s per degree temperature difference between the inside and outside. (a) If the outside temperature in winter is 5°C, what is the minimum power required to drive the heat pump? (b) If the power output is the same as in part (a), what is the maximum outer temperature for which the inside can be maintained at 20°C?	4	1	1, 2, 12	1, 3	4
2C.	Write an expression for heat transfer in a composite wall with the help of suitable representations in the diagram.	2	2	1, 2, 3	1, 3	3
3A	A fluid of viscosity 0 7 Ns/m^2 and specific gravity 1.3 is flowing through a circular pipe of diameter 100 mm The maximum shear stress at the pipe wall is given as 196.2 N/m^2. Find a) The pressure gradient, b) The average velocity, and c) Reynolds number of the flow	4	5	1, 2, 3	1, 3	3
3B	A main pipe divides into two parallel pipes which again forms one pipe as shown in Figure 3B. The length and diameter for the first parallel pipe are 2000 m and 1.0 m respectively, while the length and diameter of 2nd parallel pipe are 2000 m and 0.8 m Find the rate of flow in each parallel pipe, if total flow in the main is 3.0 m^3/s The	3	6	1, 2, 3	1, 3	4

	coefficient of friction for each parallel pipe is same and equal to 0.005.  Fig. 3B. Piping Arrangement					
3C	Derive a continuity equation for the incompressible fluid. Mention all the notations and flow directions suitably in the relevant diagram.	**3**	**5**	**1, 2, 3**	**1**	**2**
4A	Derive an expression or critical thickness of insulation.	**5**	**3**	**1, 2**	**1, 2, 3**	**3**
4B	A carbon steel (k = 54 W/m°C) rod with a cross-section of an equilateral triangle (each side 5 mm) is 80 mm long. It is attached to a plane wall which is maintained at a temperature of 400°C. The surrounding environment is at 50°C and unit surface conductance is 90 W/m2°C. Compute the heat dissipated by the rod.	**3**	**3**	**1, 2**	**1, 2, 3**	**4**
4C	Distinguish between different types of fluid flows.	**2**	**5**	**1, 2, 3**	**1**	**3**
5A	Derive an expression for shear stress and velocity of laminar flowing fluid through a circular conduit.	**5**	**6**	**1, 2, 3**	**1, 3**	**3**
5B	A counterflow heat exchanger of heat transfer area A = 12.5 m2 is to cool oil [cph = 2000 J/(kg.s)] with water [cpc = 4170 J/(kg.s)]. The oil enters at 100°C and mh = 2 kg/s, while the water enters at 20°C and mc = 0.48 kg/s. The overall heat transfer coefficient is U = 400 W/(m2°C). Calculate the exit temperature of water and the total heat transfer rate Q.	**3**	**1**	**1, 2, 12**	**1, 3**	**5**
5C	A heat engine is used to drive a heat pump. The heat transfers from the heat engine and from the heat pump are used to heat the water circulating through the radiators of a building. The efficiency of the heat engine is 27% and the COP of the heat pump is 4. Evaluate the ratio of the heat transfer to the circulating water to the heat transfer to the heat engine.	**2**	**3**	**1, 2**	**1, 2, 3**	**3**