Reg. No.										

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

DEPARTMENT OF MECHATRONICS

VI SEMESTER B.TECH. (MECHATRONICS)

END SEMESTER EXAMINATION, APRIL/MAY 2024

SUBJECT: ENERGY AND HEAT TRANSFER [MTE 3252]

(02.05.2024)

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 furnace wall is composed of 220 mm of five brick, 150 mm of common brick, 50 mm of 85% magnesia and 3 mm of steel plate on the outside. If the inside surface temperature is 1500°C and outside surface temperature is 90°C. Estimate the temperature between layers and calculate the heat loss in kJ/h-m^2. Assume, k (for fire brick) = 4 kJ/m−h°C, k (for common brick) = 2.8 kJ/m−h°C, k for 85% magnesia) = 2.4 kJ/m−h°C, k (for steel) = 240 kJ/m−h°C.	**5**	**2**	**1, 2, 3**	**1, 3**	**4**
1B.	Derive an expression for pressure drop of the fluid along the length of the pipe.	**3**	**5**	**1, 2, 3**	**1**	**3**
1C.	Distinguish the relationship between Coefficient of Performance (COP) of Heat pump and Refrigerator.	**2**	**1**	**1, 2, 12**	**1, 3**	**3**
2A.	Prove that the ratio of maximum velocity and average velocity in laminar flow through conduit is equal to 2.	**4**	**6**	**1, 2, 3**	**1, 3**	**4**
2B.	Two Carnot engines A and B are connected in a series between two thermal reservoirs at 1000 K and 100 K respectively. Engine A receives 1680 kJ of heat from the high-temperature reservoir and rejects heat to the Carnot engine B. Engine B takes in heat rejected by engine A and rejects heat to a low-temperature reservoir. I) If engines A and B have equal thermal efficiencies, determine: a) Heat rejected by engine B. b) Temperature at which heat is rejected by engine A. c) Work done during the processes by engines A and B respectively. II) If engines A and B deliver equal work, determine a) Amount of heat taken by engine B. b) Efficiencies of engine A and B	**4**	**1**	**1, 2, 12**	**1, 3**	**4**
2C.	Explain the concept of thermal contact resistance involved in composite walls, and mention strategies exist to mitigate or avoid it.	**2**	**2**	**1, 2, 3**	**1, 3**	**3**
3A	An oil of viscosity 0.1Ns/m^2 and relative density 0.9 is flowing through a circular pipe of diameter 50 mm and of length 300 m. The rate of flow of fluid through the pipe is 3.5litres/s. Determine the pressure drop in a length of 300 m and the shear stress at the pipe wall.	**4**	**5**	**1, 2, 3**	**1, 3**	**3**
3B	Three pipes of diameters 300 mm, 200 mm and 400 mm and lengths 450m, 255m and 315m respectively are connected in series. The difference in water surface	**3**	**6**	**1, 2, 3**	**1, 3**	**4**

	levels in two tanks is 18m. Determine the rate of flow of water if coefficients of friction are 0.0075, 0.0078 and 0.0072 respectively. (i) Considering Minor losses and (ii) Neglecting minor losses.					
3C	Diagrammatically represent the velocity and shear stress distribution profiles for a laminar flow through conduits. Mention all the notations and flow directions suitably.	**3**	**5**	**1, 2, 3**	**1**	**2**
4A	Formulate an expression for overall heat transfer coefficient for a cylindrical pipe with two flowing fluids separated by thin surface.	**5**	**3**	**1, 2**	**1, 2, 3**	**3**
4B	Determine the amount of heat transferred through an iron fin of length 50 mm, width 100 mm and thickness 5 mm. Assume k = 210 kJ/mh°C and h = 42 kJ/m^2h°C for the material of the fin and the temperature at the base of the fin as 80°C. Also calculate the temperature at tip of the fin, if the atmosphere temperature is 20°C.	**3**	**3**	**1, 2**	**1, 2, 3**	**4**
4C	Distinguish on the effect of temperature on viscosity of the fluid.	**2**	**5**	**1, 2, 3**	**1**	**3**
5A	Explain the concept of conservation of energy in a streamline flow using Bernoulli's equation considering all types of head losses.	**5**	**6**	**1, 2, 3**	**1, 3**	**3**
5B	A turbine operates under steady flow conditions, receiving steam at the following state: pressure 1.2 MPa, temperature 188°C, enthalpy 2785 kJ/kg, velocity 33.3 m/s and elevation 3m. The steam leaves the turbine at the following state: pressure 20 kPa, enthalpy 2512 kJ/kg, velocity 100 m/s and elevation 0 m. Heat is lost to the surroundings at the rate of 0. 29 kJ/s. If the rate of steam flow through the turbine is 0.42 kg/s, Estimate the power output of the turbine in kW.	**3**	**1**	**1, 2, 12**	**1, 3**	**5**
5C	The flow rates of hot and cold water streams running through a parallel flow heat exchanger are 0.2 kg/s and 0.5 kg/s respectively. The inlet temperatures on the hot and cold sides are 75°C and 20°C respectively. The exit temperature of hot water is 45°C. If the individual heat transfer coefficients on both sides are 650 W/m^{2°C, Calculate the area of the heat exchanger.	**2**	**3**	**1, 2**	**1, 2, 3**	**3**