BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)

CLASS: BTECH | **SEMESTER: III**
BRANCH: PIE | **SESSION: MO/2023**

SUBJECT: ME289 THERMAL AND FLUID ENGINEERING

TIME: 3 Hours | **FULL MARKS: 50**

INSTRUCTIONS:
1. The question paper contains 5 questions each of 10 marks and total 50 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
4. Before attempting the question paper, be sure that you have got the correct question paper.
5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

Q. No.	Question	Marks	CO	BL
Q.1(a)	A cylinder fitted with a piston contains 1 kg of air at a pressure of 20 bar and having a volume of 0.05 m^3. Air is allowed to expand according to the law PV = constant until the volume is doubled. The air is then cooled at constant pressure until the piston regains its initial volume. Air is then heated with the piston firmly locked in this position until pressure rises to the initial value of 20 bar. Calculate the network done during the cycle. Sketch the cycle on a P-V diagram.	[5]	1	L
Q.1(b)	A vessel of volume 0.04 m^3 contains a mixture of saturated water and saturated steam at a temperature of 250^0C. The mass of the liquid present is 9 kg. Find the mass, specific volume, and the specific enthalpy. (Properties of wet steam at 250^{0}C are: $v_f = 0.001251\ m^3/kg$, $v_g = 0.05013\ m^3/kg$, $h_f = 1085.36\ kJ/kg$, $h_g = 2801.5\ kJ/kg$).	[5]	1	M
Q.2(a)	State and prove Carnot theorem.	[5]	2	L
Q.2(b)	Two reversible heat engines are placed in series. The first one receives 6400 KJ of heat per minute from a high temperature reservoir at 1300 ^oC and rejects heat to a low temperature reservoir at T Kelvin. The second one in turn receives the heat rejected by the first reversible engine and rejects heat to another low-temperature reservoir at 400 K. Determine the heat rejected per minute by the first and second engines when equal work is delivered by each of them.	[5]	2	M
Q.3(a)	Derive an expression for the temperature distribution in a plane wall having uniformly distributed heat sources and one face is maintained at a temperature T_1 while the other face is maintained at a temperature T_2. The thickness of the wall may be taken as 2L.	[5]	3	L
Q.3(b)	A hot steam pipe having an inside surface temperature of 250^{0}C has an inside diameter of 8 cm and a wall thickness of 5.5 mm. It is covered with a 9 cm layer of insulation having $k = 0.5\ W/m°C$, followed by a 4 cm layer of insulation having $k = 0.25\ W/m°C$. The outside temperature of the insulation is 20^{0}C. Calculate the heat lost per meter of length. Assume $k = 47\ W/m°C$ for the pipe.	[5]	3	M
Q.4(a)	The velocity components in a two-dimensional flow are as follows: $u = \frac{y^3}{3} + 2x - x^2y$, $v = -\frac{x^3}{3} + 2y - xy^2$. Show that these components represent a possible case of irrotational flow.	[5]	4	M
Q.4(b)	A heavy car plunges into a lake during an accident and lands at the bottom of the lake on its wheels. The door is 1.2 m high and 1 m wide, and the top edge of the door is 8 m below the free surface of the water. Determine the hydrostatic force on the door and the location of the pressure center.	[5]	4	M
Q.5(a)	A pressurized tank of water has a 10-cm-diameter orifice at the bottom, where water discharges to the atmosphere. The water level is 2.5 m above the outlet. The tank air pressure above the water level is 250 kPa (absolute) while the atmospheric pressure is 100 kPa. Neglecting frictional effects, determine the initial discharge rate of water from the tank.	[5]	5	M
Q.5(b)	Derive an expression for head loss due to sudden enlargement in a pipe.	[5]	5	L

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