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

CLASS: BTECH | **SEMESTER : III**
BRANCH: PIE | **SESSION : MO/2024**

SUBJECT: ME289 THERMAL & 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.

			CO	BL
Q.1(a)	Write short note: (i) Moving boundary work (ii) Van der Waals Equation of State (iii) Triple point in solid-liquid-gas phase diagram.	[6]	1	2
Q.1(b)	The piston/cylinder contains carbon dioxide at 300 kPa, 100°C with a volume of 0.2 m^3. Mass is added at such a rate that the gas compresses according to the relation $PV^{1.2}$ = constant to a final temperature of 200°C. Determine the work done during the process.	[4]	2	4
Q.2(a)	Explain with p-v plot why for the same compression ratio the $\eta_{Otto\ cycle} > \eta_{Disel\ cycle}$	[2]	2	3
Q.2(b)	A Carnot heat engine operates between a source at 1000 K and a sink at 300 K. If the heat engine is supplied with heat at a rate of 800 kJ/min. Determine (i) the thermal efficiency (ii) the power output of the heat engine.	[4]	2	4
Q.2(c)	A turbine operates under steady flow conditions. The rate of steam flow through the turbine is 1.1 kg/s. At the entry, the steam velocity and enthalpy are 60 m/s and 2700 kJ/kg respectively. At the turbine exists, the steam leaves at 110 m/s with an enthalpy of 1800 kJ/kg. Determine the power output of the turbine. Neglect the change in potential energy.	[4]	2	5
Q.3(a)	Write the mathematical formulation of one-dimensional, steady-state heat conduction for a hollow sphere with constant thermal conductivity in the region $a \le r \le b$, when heat is supplied to the sphere at a rate of q_o W/m^2 from the boundary surface at $r = a$ and dissipated by convection from the boundary surface at $r = b$ into a medium at zero temperature with heat transfer coefficient h.	[4]	3	4
Q.3(b)	Consider a plane composite wall that is composed of two materials A and B of thermal conductivities k_A = 0.1 W/m.K and k_B = 0.04 W/m.K and and thicknesses L_A = 10 mm and L_B = 20 mm. The contact resistance at the interface between the two materials is 0.30 m^2.K/W. A fluid flowing contact with material A at 200°C for which h = 10 W/m^2. K and another fluid flowing contact with material B at 40°C for which h = 20 W/m^2. K. (i) What is the rate of heat transfer through a wall that is 2 m high by 2.5 m wide? (ii) What is the surface temperature of material A adjoining to fluid? (iii) What is the surface temperature at the interface?	[6]	3	5
Q.4(a)	What are the different equilibrium conditions of the floating and submerged bodies?	[6]	4	2
Q.4(b)	Consider a flow field represented by the stream function $\psi = -\frac{A}{2\pi\left(x^2+y^2\right)}$, where A = constant. Justify your answer (i) Is this a possible two-dimensional incompressible flow? (ii) Is the flow irrotational?	[4]	5	5
Q.5(a)	Write the functional relationship of frictional torque T of a disc of diameter D rotating at speed N in a fluid of viscosity μ and density ρ in a flow by using Buckingham π theorem.	[6]	4	3
Q.5(b)	Water flows with dynamic viscosity 0.001 N.s/m^2 between two large parallel plates at a distance of 1.6 mm apart. The average velocity of flow is 0.2 m/s. Determine (i) the maximum velocity (ii) the pressure drop per unit length (iii) the shear stress at the walls.	[4]	5	4

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