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

CLASS: B. TECH **SEMESTER: III**
BRANCH: PRODUCTION & INDUSTRIAL ENGINEERING (PIE) **SESSION: MO/2025**

SUBJECT: ME24221 THERMAL & FLUID ENGINEERING

TIME: 02 HOURS **FULL MARKS: 25**

INSTRUCTIONS:
1. The question paper contains 5 questions each of 5 marks and total 25 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.

			CO	BL
Q.1(a)	What is meant by thermodynamic equilibrium? How does it differ from thermal equilibrium?	[2]	1	1-2
Q.1(b)	State the thermodynamic definition of work. In what respects are the heat and work interactions (i) Similar and ii) dissimilar? Is there any situation where $W \neq \int Pdv$?	[3]	1	1-2
Q.2	A certain amount of air is heated at constant volume until its temperature is 3 times the original temperature, then it is expanded isothermally till it reaches its original pressure. The air is then cooled at constant pressure till it is restored to the original state. Show the process using a P-V diagram, and determine the net work done by (or upon) per kg of the air if the initial temperature is 350k. Take ideal gas assumption for air, with R_{air} = 287 J/kg K.	[5]	1	1-4
Q.3(a)	Define internal energy and enthalpy of a system, and clearly state the relation between the two. Which of them is used in the First Law analysis of closed systems and open systems respectively, and why?	[3]	2	1-2
Q.3(b)	Air enters a well-insulated compressor operating at steady state at 1 bar and 300K, and exits at 6 bar and 440k. If the flow rate of air through the compressor is 3 kg/s, Calculate the Power Consumption of the Compressor. Take average value of $C_{P,air}$ = 1.0047 KJ/Kg) over the entire temperature range.	[2]	2	1-3
Q.4(a)	State the limitations of the first law of thermodynamics, and establish the importance of the second law. In this light, state the two equivalent theorems of the second law with suitable schematic.	[3]	2	1-2
Q.4(b)	Explain the processes involved in a Carnot cycle with the help of a P-V diagram. Also corroborate the importance of the cycle based on the Carnot Theorem.	[2]	2	1-2
Q.5(a)	Consider a medium in which the heat conduction equation is given in its simplest form as: $\frac{\partial^2 T}{\partial x^2} = \frac{1}{\alpha}\frac{\partial T}{\partial t}$, where all symbols represent usual meanings. Is the heat transfer steady or transient; one-, two-, or three-dimensional; with or without heat generation; and the thermal conductivity of the medium constant or variable?	[2]	3	1-3
Q.5(b)	Consider one-dimensional heat conduction through a large plane wall with no heat generation that is perfectly insulated on one side and is subjected to convection and radiation on the other side. It is claimed that under steady conditions, the temperature in a plane wall must be uniform (the same everywhere). Do you agree with this claim? What if there is heat generation in the wall? Explain your reasoning with the help of the conduction equation.	[3]	3	1-3

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