Code - 5012

G. S. Mandal's

Maharashtra Institute of Technology, Aurangabad

(An Autonomous Institute)

END SEMESTER EXAMINATION

First Year M.Tech(ME) -April/May 2022

Course Code : MTM104 **Course Name : Adv. Thermodynamics**

Duration : 2 Hrs **Max. Marks : 50** **Date : 11/04/2022**

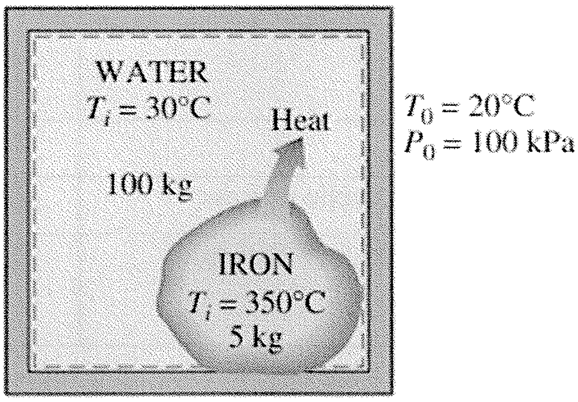
Instructions :

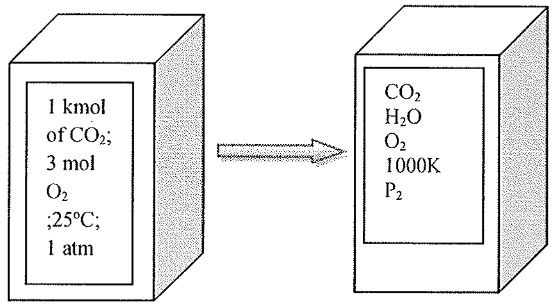
i) **All questions are compulsory**

ii) **Assume suitable data wherever necessary and clearly state it**

iii) **Figures to the right indicate full marks**

Q. 1	**Solve/Answer any five (Marks:10)**			
	Questions	Marks	CO	BL
a)	Briefly explain the need to study 'Statistical Thermodynamics.	2	1	2
b)	State 'Dalton's law'.	2	1	2
c)	Somebody claims that the mass and mole fractions for a mixture of CO_2 and N_2O gases are identical. Is this true? Why?	2	1	2
d)	State Nernst heat theorem.	2	1	2
e)	State first law of thermodynamics for a cyclic process.	2	1	2
f)	Define 'Standard enthalpy of combustion and 'Standard enthalpy of formation'.	2	1	2
Q. 2	Derive the equation of state for ideal and real gas.	8	2	3
Q. 3	Prove that for any fluid, $i)(\frac{\partial h}{\partial v})_T = v(\frac{\partial p}{\partial v})_T + T(\frac{\partial p}{\partial T})_v$ $ii)(\frac{\partial h}{\partial p})_T = v - T(\frac{\partial v}{\partial T})_p$ Show that for a liquid obeying van der Waal's equation $p = \frac{RT}{(v-b)} - \frac{a}{v^2}$ where R,a and b are constants, $h\ (enthalpy) = p = \frac{RTb}{(v-b)} - \frac{2a}{v} + f(T)$ where f(T) is arbitrary.	8	3	5

Q. 4	Justify the statement that 'among the four quantities, that claims to be called energy quantity, only the internal energy deserves this name. The other functions, i.e., enthalpy H, Helmholtz energy A, and Gibbs energy G are the parts of a mathematical apparatus for calculating various quantities, such as useful work, equilibrium constants, etc.'	8	6	5
Q. 5	A 5-kg block initially at 350°C is quenched in an insulated tank that contains 100 kg of water at 30°C as shown in the figure. Assuming the water that vaporizes during the process condenses back in the tank and the surroundings are at 20°C and 100 kPa, determine (a) the final equilibrium temperature, (b) the exergy of the combined system at the initial and the final states, and (c) the wasted work potential during this process. (Use Specific heat for iron and water at room temperature is 0.45 kJ/kg. °C and 4.18 kJ/kg. °C respectively)  **(OR)**	8	4	4
Q. 5	Examine exergy interactions associated with a fixed mass or closed system in the forms of heat transfer and work.	8	4	4
Q. 6	Explain 'Adiabatic Flame Temperature'. **(OR)**	8	5	5
Q. 6	The constant volume tank as shown in the figure contains 1 kmol of Methane (CH_4) gas and 3 kmol of O_2 at 25 °C and 1 atm. The contents of the tank are ignited, and the methane gas burnt completely. If the final temperature is 1000 K, determine (a)The final pressure in the tank and b) The heat transfer during the process.	8	5	5



Before Reaction   After Reaction

Use the data mentioned in the table below: -

Substance	$\bar{h}_f^o$ kJ/kmol	$\bar{h}_{298\,K}$ kJ/kmol	$\bar{h}_{1000\,K}$ kJ/kmol
CH_4	-74,850	--	--
O_2	0	8682	31,389
CO_2	-393,520	9364	42,769
$H_2O_{(g)}$	-241,820	9904	35,882