(Time: 3 Hours) **[Total Marks: 80]**

N.B.: (1) Answer any four.
(2) Each question carries equal marks.
(3) Assume **suitable data** if necessary with justification.
(4) Use of steam table, Mollier's chart, enthalpy of formation chart is permitted.

Q1	(a)	What are the availability functions for a) closed system b) steady flow system?	10
	(b)	An insulated pston-cylinder device initially contains 30 L of air at 120 kPa and 27°C. Air is now heated for 5 minutes by a 50 W resistance heater placed inside the cylinder. The pressure of air is maintained constant during this process, and the surroundings are at 27°C and 100 kPa. Determine the irreversibility for this process.	10
Q2	(a)	Air enters a nozzle steadily at 300 kPa and 77°C with a velocity of 50 m/s and exits at 100 kPa and 320 m/s. The heat losses from the nozzle to the surrounding medium at 20°C are estimated to be 3.2 kJ/kg. Determine a) the exit temperature and b) the total entropy change for this process.	12
	(b)	Draw phase equilibrium diagram for pure substance on h-s plot with relevant constant property lines.	8
Q3	(a)	Determine the specific volume of superheated water vapor at 1.6 MPa and 225^0C based on a) ideal gas equation b) generalized compressibility chart and c) steam tables Determine the error involved in the first two cases.	12
	(b)	Describe generalized compressibility chart and state why it is constructed on the basis of reduced properties?	8
Q4	(a)	Methane (CH_4) is burned completely with the stoichiometric amount of air during a steady flow combustion process. If both the reactants and the products are maintained at 25°C and 1 atm and the water in the products exists in the liquid form, determine the heat transfer for this process. What would your answer be if combustion were achieved with 50% excess air?	12
	(b)	What is enthalpy of combustion? What is internal energy of combustion?	8
Q5	(a)	A rigid tank which contains two kg of nitrogen at 25°C and 100 kPa is connected to another rigid tank which contains 3 kg of oxygen at 25°C and 350 kPa. The valve connecting the tanks is opened , and the two gases are\allowed to mix . If the final mixture temperature is 25°C, determine the volume of each tank and the final mixture pressure.	12
	(b)	Derive Clausius-Clapeyron equation. What approximations are involved in the Clausius-Clapeyron equation?	8

Q6 Write short notes 20

i) Bose Einstein statistics
ii) Fermi- Dirac statistics
iii) Gibb's phase rule
iv) Volume expansivity and isothermal compressibility

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