Time : 3 Hours **Total Marks:80**

N.B. : (1) Question No 1 is Compulsory.
(2) Attempt any three questions out of the remaining five.
(3) All questions carry equal marks.
(4) Assume suitable data, if required and state it clearly.
(5) Use of steam table and Mollier Diagram is permitted.

1 Solve **Any Four** **20**

a State Perpetual Motion Machine (PMM) - I & II.

b State the similarities and dissimilarities between heat and work transfer.

c Define the following term,
(i) Saturation temperature (ii) Sensible heat
(iii) Critical point (iv) Triple point

d Draw P-V and T-S diagram of Otto cycle and Brayton cycle.

e Discuss the Mach number corresponding to
(i) Subsonic flow
(ii) Sonic Flow
(iii) Supersonic flow

2 a In a gas turbine, the gases flow at the rate of 5 kg/s. The gases enter the turbine at a pressure 7 bar with a velocity 120 m/s. The turbine is insulated. The exit pressure and velocity are 2 bar and 250 m/s. If the enthalpy of the gas at the inlet is 900 kJ/kg and at the outlet is 600 kJ/kg, determine the capacity of the turbine. **10**

b Discuss generation of steam from ice at – 5°C at 1 atm with the help of T–S and P–V diagrams. **10**

3 a A heat pump working on a Carnot cycle takes in heat from a reservoir at 5 °C and delivers heat to a reservoir at 60 °C. The heat pump is driven by a reversible heat engine which takes in heat from a reservoir 840 °C and reject heat to a reservoir at 60 °C. The reversible heat engine also drives a machine that absorbs 30 kW. If the pump extracts 17 KJ/s from the 5 °C reservoir, Determine **10**

(i) the rate of heat supply from 840 °C source and
(ii) the rate of heat rejection to the 60 °C sink.

	b	Explain the concept of available and unavailable energy. When does the system become dead state?	05
	c	Describe reheat cycle and compare it with simple Rankine cycle.	05
4	a	Derive the Clausius theorem.	**10**
	b	Write the equations of Maxwell's Relations.	05
	c	During a thermodynamic cycle of processes (A-B-C-D-A), the heat transferred during each process are: 120 kJ, −16 kJ, −48 kJ and 12 kJ respectively. Estimate network transferred during the thermodynamic cycle, direction of work transfer, change in internal energy using the first law of Thermodynamics.	05
5	a	Derive the expression of efficiency of Diesel cycle and state the assumptions.	**10**
	b	Steam turbine working on Rankine cycle is supplied with dry saturated steam at 20 bar and the exhaust takes place at 0.3 bar. For a steam flow rate of 10 kg/s. Determine the quality of steam at end of expansion and Rankine efficiency,	10
6	a	An aeroplane is flying at 1000 km/h through still air having a pressure of 78.5 kN/m^2 (abs.) and temperature – 8°C. Calculate on the stagnation point on the nose of the plane : (i) Stagnation pressure, (ii) Stagnation temperature, (Take for air : R = 287 J/kg K and $\gamma = 1.4$)	**10**
	b	In an air standard diesel cycle, the compression ratio is 15 and the properties at the beginning of compression are 100 kPa and 300 K. For a peak temperature of 1600 K, Calculate the percentage of stroke at which cut- off occurs and the cycle efficiency	10

****