Paper / Subject Code: 50002 / THERMODYNAMICS

Date-18/11/19

S.E. (Mechanical) (Sem-III) (CBSGS)

Duration: 3 hours **Total Marks** 80

- **Question No 1 is COMPULSORY.**
- **Attempt any THREE questions out of remaining questions.**
- **Assume suitable data wherever required.**
- **Illustrate answers with sketches wherever required.**
- **Use of steam table, Gas table and Mollier chart is permitted.**

Q1 Solve the following **(any FIVE)** **20**

1. Explain zeroth law of thermodynamics with neat sketch.
2. Define coefficient of performance. Show that $(COP)_{HP}=(COP)_{REF}+1$
3. Define: Useful work, Availability, Dead state and Irreversibility.
4. Define: Triple point, Critical point, Dryness fraction and Degree of superheat
5. Explain mean temperature of heat addition in case of Rankine cycle.
6. Write the applications of the compressed air.

Q2 (i) Explain statements of the second law of thermodynamics with sketch. **6**

(ii) Differentiate between (i) Point and Path Function (ii) Heat & Work **4**

(iii) 0.4 kg of air 6 bar receives an amount of heat at constant volume so that its temperature rises from 383 K to 923 K. It is then expanded polytropically according to $pV^{1.32}=C$ to initial temperature and finally it is compressed isothermally to its original volume. Calculate (i) Pr at end state (ii) work transfer and heat transfer during each process. Take C_v=0.718 kJ/kgK & R=0.287 kJ/kgK. **10**

Q3 (i) What are Maxwell relations and why they are important in thermodynamics? **4**

(ii) A heat engine is supplied with 1130 kW of heat at a constant temperature of 292°C and it rejects heat at 5°C. The following results were recorded: **6**

(i) 834 kW heat is rejected (ii) 556 kW heat is rejected (iii) 278 kW heat is rejected. Determine whether the results report a reversible cycle, irreversible cycle or impossible cycle.

(ii)

(iii) Air flows steadily through an air compressor. Air enters at a temperature of 16°C at a pressure of 100kPa and an enthalpy of 391.2 kJ/kg. The air leaves the compressor at a temperature of 245°C, a pressure of 0.6 MPa and an enthalpy of 534.5 kJ/kg. If the flow through the compressor is adiabatic Calculate (i) work input to the compressor per kg of air assuming no change in kinetic energy of gas (ii) work input to the compressor per kg of air, if its inlet velocity is 80 m/s and exit velocity is 160 m/s. **10**

Q4 (i) A reversible heat engine receives heat from two thermal reservoirs maintained at constant temperatures of 750 K and 500 K. The engine develops 100 kW of power and rejects 3600 kJ/min of heat to a heat sink at 250 K. Determine the thermal efficiency of the engine and heat supplied by each thermal reservoir. **10**

	(ii)	Explain reheat Rankine cycle with the help of schematic, T-s & h-s chart.	**5**
	(iii)	Prove that entropy is property of the system.	**5**
Q5	**(i)**	(a) Compare the reciprocating and rotary compressor based on the following aspects: Pressure ratio, air supply, speed, size of the compressor.	**4**
		(b) Represent the following cycles on PV and TS chart. (i) Otto Cycle (ii) Diesel Cycle (iii) Brayton Cycle	**6**
	(ii)	An engine working on Otto cycle has a clearance volume of 17% of stroke volume and initial pressure of 0.95 bar and a temperature of 30 °C. If the pressure at the end of constant volume heat addition is 28 bar find (i) Air standard efficiency (ii) Maximum temperature in the cycle. (iii) Ideal mean effective pressure. Assume working fluid to be air.	**10**
Q6	**(i)**	A steam power plant operates on ideal Rankine cycle. The steam enters the turbine at 3 MPa, 350°C and is condensed in the condenser at a pressure of 75 kPa. Determine (i) Thermal efficiency (ii) Back work ratio (iii) Work ratio of this cycle.	**10**
	(ii)	A single stage single acting reciprocating air compressor has bore of 20 cm and a stroke of 30 cm. The compressor runs at 600 rpm. The clearance volume is 4% of the swept volume and index of expansion and compression is 1.3. The suction conditions are at 0.97 bar and 27°C and delivery pressure is 5.6 bar. The atmospheric conditions are at 1.01 bar and 17°C. Determine (i) Free air delivered in m^3/min (ii) Volumetric efficiency referred to free air conditions. (iii) The indicated power.	**10**
