SE/Sem III/CBCGS/AUTO/MJ2019/14-05-2019

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

N. B. : (1) Question No. **1** is **compulsory**.
(2) Solve any **three** out of the remaining **five** questions.
(3) Assume suitable data if required and state it clearly.
(4) Use of Steam Table and Mollier diagram is permitted

1 Attempt any **four** out of the following 20

(a) What is the difference between a closed and an open system

(b) Define Mech. Efficiency in case of reciprocating air compressor and state the methods used to improve isothermal efficiency?

(c) Define: available energy, dead state and irreversibility

(d) Draw a simple schematic diagram of a thermal power plant with one reheater. Also represent this on T-S diagram

(e) Write four Maxwell relations.

2 (a) A fluid system contained in a piston cylinder machine, passes through a complete cycle of four processes. The sum of all heat transfer during the cycle is -170 KJ. The system completes 100 cycles/min. Complete the following table showing the method for each process and compute the net rate of work output in KW. 12

Process	Q(KJ/min)	W(KJ/min)	ΔE(KJ/min)
1-2	0	2170	----
2-3	21000	0	----
3-4	-2100	----	-36600
4-1	----	----	----

(b) Derive and show that the efficiency of Brayton cycle depends on the pressure ratio. 8

3 (a) Air enters a compressor operating at steady state at a pressure of 1 bar, a temperature of 290 K and a velocity of 6 m/s through an inlet with an area of 0.1 m^2. At exit the pressure is 7 bar, the temperature is 450 K and the velocity is 2 m/s. Heat transfer from the compressor to the surroundings occur at the rate of 180 kJ/min. Employing the ideal gas model , calculate the power input to the compressor. 10

(b) Calculate the decrease in exergy when 25 kg of water at 95°C mix with 35 kg of water at 35°C, the pressure being taken as constant and the temperature of surroundings being 15°C. 10

4 (a) Explain the Carnot heat engine cycle executed by a) a stationary system and b) a steady flow system. 8

(b) Two reversible heat engines A and B are arranged in series, A rejecting heat directly to B. Engine A receives 200 kJ at a temperature of 421°C from a hot source, while engine B is in communication with a cold sink at a temperature of 4.4°C. If the work output of A is twice that of B, find a) intermediate temperature between A and B b) efficiency of each engine and c) the heat rejected to the cold sink. 12

5 (a) In an I.C. engine operating on the dual cycle, the temperature of the working fluid (air) at the beginning of the compression is 27°C. The ratio of the maximum and minimum pressures of the cycle is 70 and compression ratio is 15. The amounts of heat added at constant volume and constant pressure are equal. Compute the air standard thermal efficiency of the cycle. 10

(b) Air initially occupying 1 m^3 at 1.5 bar, 20°C undergoes an internally reversible compression for which PV^n = constant to a final state where the pressure is 6 bar and temperature is 120°C. Determine i) the value of n ii) the work and heat transfer iii) change in entropy 10

6 (a) In a Rankine cycle the stream at the inlet to the turbine is at 100 bar and 500°C. If the exhaust pressure is 0.5 bar, determine the pump work, turbine work, condenser heat flow and Rankine efficiency. 10

(b) What is meant by complete and perfect intercooling in case of multistage air compressor? What is the effect of multi staging over the volumetric efficiency of reciprocating air compressor? 10