Mech - sem-III - old - Thermodynamics 27/11/2015

QP Code : 1097

(OLD COURCE)
(3 Hours)

[Total Marks: 100]

N.B. (1) Question No. 1 is **compulsory.**
(2) Attempts any **four** questions from remaining **six** questions.
(3) Draw **neat sketches** wherever necessary.
(4) Use of steam table, gas table and Mollier chart are **permitted**.
(5) **Assume** suitable data if necessary.

1 Answer any **five:** 20

(a) What are the limitations of First Law of Thermodynamics and essence of Second Law of Thermodynamics?

(b) A car operating at high elevation looses power. Do you agree with this statement? Give reasoning about your answer.

(c) What is the difference between flow and non-flow work?

(d) Define a pure substance. Is water a pure substance?

(e) Give reasons why the Carnot cycle cannot be considered as the theoretical cycle for steam power plant even though its efficiency is maximum.

(f) What is compressible fluid? What is Mach Number?

2 (a) Steam enters a nozzle at a pressure of 7 bar and 20°C (i.e. initial enthalpy 2850 kJ/kg) and leaves at a pressure of 1.5 bar. The initial velocity of steam at the entrance is 40 m/s and the exit velocity from the nozzle is 700 m/s. The mass flow rate through the nozzle is 1400 kg/h. The heat lost from the nozzle is 11705 kJ/h. Determine the final enthalpy of steam and the nozzle area if the specific volume is 2.4 m^3/kg. 14

(b) What do you mean by available and unavailable energy? What do you mean by dead state? 6

3 (a) For the same compression ratio and heat supplied compare Otto, Diesel and Dual cycle with the help of P-v and T-s diagram. 8

(b) A Rankine cycle operates between the pressure 15 bar and 0.01 bar. The initial degree of superheat is 100°C. Assuming isentropic efficiency of expansion 85 %, calculate: 12
(i) Pump work
(ii) Actual turbine work
(iii) Thermal efficiency.

4 (a) Derive an expression for a one dimensional steady isentropic flow through a C-D nozzle. 10

(b) Write short notes on throttling process. 5

(c) State and prove Carnot theorem. 5

5 (a) A cylinder contains 0.115 m^3 of gas at 1 bar and 90°C. This is compressed to volume 0.0288m3, the final pressure being 5.67 bar. Calculate (i) the mass of the gas, (ii) energy of the 10

gas and (iii) heat transfer during compression.
If, after the above compression, the gas is cooled at constant pressure to its original temperature, find the further work of compression required. Assume $\gamma = 1.4$, $R = 0.3$ kJ/kg K.

(b) 3 kg of steam at 10 bar and 250°C undergoes a constant pressure process. The resulting steam is wet having dryness fraction 0.6. Calculate the (i) work done, (ii) change in enthalpy and (iii) heat transferred assuming the non-flow process. 10

6 (a) An air-standard Otto Cycle has a compression ratio of 8.At the start of the compression process, the temperature is 26°C and the pressure is 1 bar. If the maximum temperature of the cycle is 1080°C, calculate (i) the heat supplied per kg of air, (ii) the net work done per kg of air and (iii) the thermal efficiency of cycle. 10

(b) A C-D nozzle has a throat area 500 mm^2 and an exit area of 1000 mm^2. Air enters the nozzle with a stagnation temperature of 360 K a stagnation pressure of1 MPa. Determine the maximum flow rate of air that the nozzle can pass, and the static pressure, static temperature, Mach number, and velocity at the exit from the nozzle, if (i) the divergent section acts as a nozzle, and (b) the divergent section acts as a diffuser. 10

7 Write short notes on: 20
(a) Heat pump and Heat engine.
(b) Rankine cycle.
(c) Application of First Law to a closed System.
(d) Rayleigh and Fanno line.
