SE Mech. III CBSGS 18.5.17 (75)

Thermodynamics

Q.P. Code : 554901

(3 Hours) **[Total Marks : 100**

N.B. : (1) Question **No.1** is **Compulsory.**
(2) Answer **any three** from remaining **five** questions.
(3) Assume suitable data wherever required.
(4) Assumptions made should be stated clearly.

1. Solve the following **(Any Four)** **20**
   (a) Explain zeroth law of thermodynamics with neat sketch. State its significance.
   (b) Write both the statements of second law of thermodynamics.
   (c) Define: enthalpy of combustion, enthalpy of formation and standard reference state.
   (d) Define : available energy, dead state and irreversibility.
   (e) Define : compression ratio, clearance ratio and mean effective pressure.
   (f) Explain process of phase change of ice into steam with the help of T-S diagram.

2. (a) A system containing 0.2 m^3 of air at a pressure of 4 bar and 160°C expands isentropically to a pressure of 1.06 bar and after this 65 kJ of heat is supplied at constant pressure. Calculate combined work done of both processes. Now assuming that these processes are replaced by a single reversible polytropic process producing the same amount of work between initial and fmal state. Find the index of expansion for polytropic process. **12**

   (b) Prove that entropy is property of the system. **8**

3. (a) Steam enters a nozzle at a pressure of 7 bar and 20°C with an initial enthalpy of 2850 kJ /kg and leaves at a pressure of 1.5 bar. Initial velocity of steam at the entrance is 40 m/ s and exit velocity from nozzle is 700 m/s. The mass flow rate of steam is 1400 kg/hr. The heat loss from the nozzle is 11705 kJ/hr. Determine the final enthalpy of steam and the nozzle area if the sp volume is 1.24 m^3 /kg. **8**

   (b) Explain heat pump and refrigerator with neat sketch. **6**

TURN OVER

SE Mech. III CBSGS 18.5.17 (75)

Thermodynamics Q.P. Code : 554901

(c) Explain Carnot theorem with neat sketch. 6

4. (a) Compare Exergy (Availability) and energy based upon their characteristics. 6

(b) Write four Maxwell relations. 4

(c) A heat pump is run by a reversible heat engine operating between reservoirs at 800°C and 50°C. The heat pump working on Carnot cycle picks up 15 kW heat from reservoir at 10°C and delivers it to a reservoir at 50°C. The reversible engine also runs a machine that needs 25 kW. Determine the heat received from highest temperature reservoir and heat rejected to reservoir at 50°C. 10

5. (a) Define Joule-Thomson coefficient. 2

(b) A steam power plant working on Rankine cycle uses steam at 50 bar (dry and saturated) and the steam is condensed at 0.05 bar in condenser. Determine thermal efficiency of the cycle and plot the cycle on T-S chart. 10

(c) Determine the enthalpy of combustion of liquid octane C_8H_{18} at 25°C and 1 atm using following data :- 8

Enthalpy of formation for CO_2 at 25°C & 1 atm = -393520 kJ/kmol.

Enthalpy of formation for $H_2O(l)$ = -285830 kJ/kmol.

Enthalpy of formation for C_8H_{18} (l) = -249950 kJ/kmol

Calculate in kJ /kg of C_8H_{18}. Take molar mass of C_8H_{18} = 114.23 kg/kmol.

6. (a) Derive an expression for air standard efficiency of Otto cycle. State assumption also. 8

(b) Calculate specific enthalpy and specific entropy of steam at a pressure of 10 bar and having dryness fraction of 0.85 4

(c) An engine working on air standard Diesel cycle compresses the air from 1 bar and 26°C. Max temperature in the cycle is 1370°C. If the clearance volume is 12.5% of stroke volume, find (i) Compression ratio & cutoff ratio (ii) thermal efficiency of the cycle. 8
