Sem-IV / Applied Thermodynamics / PROD

08-06-15

Q.P. Code : 3516

(3 Hours) **[Total Marks : 80**

N.B. : (1) Question **No. 1** is **compulsory.**
(2) Attempt any **Three** out of remaining **Five** questions.
(3) Assume suitable data wherever necessary.

1. (a) Explain briefly First law of thermodynamics and explain its significance. **20**

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

(c) Derive an expression for entropy changes in case ideal constant volume process.

(d) Find the enthalpy and entropy of steam when the pressure is 2MPa and the specific volume is 0.09 m^3/kg.

(e) Draw P-V and T-S diagrams of reversible constant volume and constant pressure processes?

2. (a) Calculate the final temperature, pressure, work done and heat transfer if the fluid is compressed reversibly from volume $6m^3$ to $1m^3$ in a cylinder. Comment on the results when the initial temperature and pressure of fluid as 20^0C and 1 bar. The index of compression may be assumed as 1.3 and 1.4 respectively. Take Cp=1.005 and I Cp=0.718 kj/kg.k. **10**

(b) 0.2 m^3 of air at 4 bar and 130^0 C is contained in a system. A reversible adiabatic expansion takes place till the pressure falls to 1.02 bar. The gas is then heated at constant pressure till enthalpy increases by 72.5 kj. Calculate: i) the work done, ii) the index of expansion, if the above processes are replaced by a single reversible polytropic process giving the same work between the same initial and final states? Take Cp = 1 kj/kg.k and Cv = 0.714 kj/kg.k **10**

3. (a) State and prove Carnot's theorem? **8**

(b) 5 kg of fluid per minute goes through a reversible steady flow process. The properties of fluid at the inlet are : $p_1 = 2$ bar, $\rho_1 = 25kg/m^3$, $C_1 = 100m/s$, and $u_1 = 1900kj/kg$ and at the exit are:: $p_2 = 6$ bar, $\rho_2 = 5.5kg/m^3$, $C_2 = 180m/s$, and $u_2 = 610kj/kg$. During the passage, the fluid rejects 60kj/s and rises through 60 meters. Determine : i) the change in enthalpy ii) work done during the process. **12**

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4. (a) State and prove Claussius's inequality. 8

(b) A Carnot heat engine works between two thermal reservoirs A and B. A is at constant temperature 600°C and B is at 250°C. Half of the power developed by the Carnot's engine is used to drive a generator to produce electricity and the other half is used to drive a heat pump which receives heat from thermal reservoir B and rejects heat to a thermal reservoir C which is at temperature 400°C. Calculate the heat rejected to thermal reservoir C by the heat pump. Also, calculate the heat rejected per hour to hermal reservoir C if 480 kw are generated by generator assuming 100% of generator efficiency. 12

5. (a) Derive an expression for air standard efficiency of Dual cycle? 8

(b) Briefly explain the following properties of steam : dryness fraction, wet steam, dry steam, degree of superheat and super heated steam. 7

(c) Find the dryness fraction, specific volume and internal energy of steam at 7 bar and enthalpy 2550kj/kg. 5

6. (a) In a constant volume Otto cycle, the pressure at the end of compression is 15 times that at the start, the temperature of air at the beginning of compression is 38°C and maximum temperature attained in the cycle is 1950°C.
Determine: i) Compression ratio, ii) Thermal efficiency of the cycle, iii) Work done. Take $\gamma = 1.4$ for air. 10

(b) A simple Rankine cycle works between pressure of 28 bars and 0.06 bar, the initial condition of steam being dry saturated, calculate the cycle efficiency, work ratio and specific steam consumption. 10
