Sem-IV/ PROD/ CBGS/ATD/ NOV-2016/21-12-16

Applied Thermodynamics **Q.P. Code :559803**

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

N.B. : (1) Question No.**1** is **compulsory**.
(2) **Attempt** any **THREE** questions out of remaining FIVE questions.
(3) **All** questions carry **equal** marks.
(4) Assume suitable data wherever necessary.

1. Answer any Four questions: **20**

a) Prove that internal energy is a property of the system.
b) List the steady flow processes. Obtain an expression for work done in case of Isothermal process.
c) State and prove Carnot's theorem.
d) What is entropy? Draw T-s diagram for reversible Constant Volume and Constant Pressure processes and comment.
e) Define: Dryness fraction, Enthalpy of evaporation. Write the expressions for total enthalpy in case of Wet steam, Super heated steam.
f) Compare Otto, Diesel and Dual cycle based on same compression ratio?

2. a) Calculate the non-flow work done for a gas which expands from initial pressure 5 bar and volume $4m^3$ to final volume $20m^3$ under the following reversible processes: $p = c$, $V = c$, $p\,V = c$, $pV^Y = c$, $pV^n = c$. Show the process on p-v diagram. **10**

b) In a piston cylinder arrangement in which the system is air, calculate the quantity of heat added to the cycle, when the cycle is complete by two processes: compression and expansion as follows:- a) During compression process, piston does 20,000 j of work on air while 80Kj of heat is rejected to the surrounding. b) During expansion process, atr does 3,00,000j of work on the piston. **10**

3. a) Explain Joule-Thompson porous plug experiment with a neat diagram and hence the inversion curve. **10**

b) Steam enters a nozzle at a pressure of 7 bar and 20°C with an initial enthalpy of 2850Kj/kg and leaves at a pressure of 1.5bar. The initial velocity of steam at the entrance is 40m/s and the exit velocity from the nozzle is 700m/s. The mass flow rate through the nozzle is 1400kg/h, the heat loss from the nozzle is 11705kj/h. Find the final enthalpy of steam, and the nozzle area if the specific volume is $1.24m^3/kg$. **10**

4. a) What are the limitations of first law of thermodynamics? State Kelvin - Planck and Clausius statements and prove their equivalence. **9**

b) A Camot 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 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 temp. 400°C. Calculate the heat rejected to thermal reservoir C by the heat pump as percentage of heat from thermal reservoir A to the engine. Also calculate heat rejected per hour to the thermal reservoir C if 480 k W are generated assuming 100% generator efficiency. **11**

5. a) Define Clausius inequality and prove it. **8**

b) Define entropy and show that it is a property of the system. **7**

c) A heat engme receives 100k W of heat at constant temperature of 285°C. The heat is rejected at 5°C. The possible heat rejected is 840kW, 492kW and 300kW. Comment on the results. **5**

6. a) Derive an expression for thermal efficiency of Rankine cycle. **10**

b) Compare the changes in efficiency of an Otto cycle when the compression ratio changes from 4 to 5. Take y = 1.4 for air. **5**

c) Calculate the state ofthe steam i.e dry, wet or superheated for the following cases: i. Steam has a pressure of 10 bar and specific volume of $0.12m^3$. ii. Steam has a pressure of 12 bar and temp. 200°C. **5**
