B.E. Mechanical Engineering (Model Curriculum) Sem-III

PCC-ME201 : Thermodynamics

P. Pages : 2 **GUG/W/22/14058**

Time : Three Hours * 3 2 8 7 * Max. Marks : 80

Notes :
1. All questions carry equal marks.
2. Due credit will be given to neatness and adequate dimensions.
3. Assume suitable data wherever necessary.
4. Illustrate your answers wherever necessary with the help of neat sketches.
5. Use of slide rule, Logarithmic tables, Steam tables, Mollier's chart, Drawing instruments, Thermodynamic tables for moist air, Psychrometric charts and Refrigeration charts is permitted.
6. Solve. Q. 1 or Q. 2, Q. 3 or Q. 4, Q. 5 or Q. 6, Q. 7 or Q. 8, Q. 9 or Q. 10.

1. a) Define thermodynamic systems? Classify and discuss them? **6**

b) State and differentiate between extensive, intensive and specific properties with example? **5**

c) Differentiate between state function and path function starting their examples? **5**

OR

2. a) Show that for an ideal gas, $c_p - c_v = R$ **6**

b) A system of 1kg of gas expands from an initial state at pressure of P_1 bar and a volume of $v_1\ m^3/kg$ to a volume of $v_2\ m^3/kg$. Calculate the work done by gas when expansion is **10**
i) Isobaric, ii) Isothermal, iii) Polytropic?

3. a) Prove that the energy is a property of the system? **6**

b) A system undergoes cyclic process composed of four processes 1 – 2, 2 – 3, 3 – 4, 4 – 1. The energy transfer is tabulated below. **10**

Process	Q kJ/min	W, kJ/min	U, kJ / min
1 – 2	400	150	-----
2 – 3	200	------	300
3 – 4	-200	------	-----
4 – 1	0	75	-----

OR

4. a) What is PMM – 1? **4**

b) A perfect gas undergoes a cycle comprises of three processes. It is first compressed isothermally from 1 bar and 27 ºC to 1/8th of its initial volume. Energy is then added at constant pressure. Increasing the temperature of gas and the cycle is completed by isentropic expansion to original conditions. Take . $Cp = 1.25\,kJ/kg.K$ and $R = 0.5\,kJ/kg.K$. **12**
Calculate the maximum cycle temperature and pressure. Also find net work transfer per kg.

5. a) Write a steady flow energy equation (SFEE)? Apply SFEE to **6**
i) Throttling device and ii) Turbine

b) A nozzle is a device used for increasing the velocity of steadily flowing stream. At the inlet to certain nozzle, enthalpy of fluid passing is 3000 kJ/ kg and velocity is 60 m/s. At the discharge end, enthalpy is 2762 kJ/kg. The nozzle is horizontal and there is negligible heat loss from it. Find: i) Exit velocity from the nozzle, ii) Mass flow rate, if inlet area is $0.1 m^2$ and specific volume at inlet is $0.187 m^3/kg$, iii) Exit area of nozzle if specific volume at the nozzle exit is $0.498 m^3/kg$. **10**

OR

6. Air at a temperature of 15ºC passes through a heat exchanger at a velocity of 30 m/s where its temperature is raised to 800ºC. It then enters turbine with same velocity of 30 m/s and expands until temperature falls to 650ºC. On leaving the turbine air is taken at a velocity of 60 m/s to a nozzle where it expands until temperature has fallen to 500ºC. If air flow rate is 2kg/s, calculate i) Rate of heat transfer to air in heat exchanger, ii) Power output from the turbine assuming no heat loss, iii) Velocity at the exit from nozzle, assuming no heat loss. **16**

Take enthalpy of air as $h = C_p.T$, Where C_p is specific heat and equal to 1.005 kJ/ kg.K and T = temperature.

7. a) With block diagram explain the operation of heat engine, refrigerator and heat pump? Also define their performance parameters? **6**

b) Two Carnot engines are working in series between a source and a sink. First engine receives heat from a reservoir at a temperature of 1000 K and rejects the waste heat to another reservoir at the temperature T_2. The second heat engine receives a heat energy rejected by the first engine. It converts some of energy into useful work and rejects the rest to a reservoir at temperature of 300 K. if both engines deliver equal power, determine the efficiency of each engine? **10**

OR

8. a) Define entropy and prove that entropy is a property? **6**

b) 4 kg of air is compressed from 40ºC and 125 kPa to 250ºC and 875 kPa. It is then throttled to 257 kPa. Finally it is cooled to a pressure of 125 kPa and 180ºC. Calculate the overall change in entropy? **10**

Take $C_p = 1.005 kJ/kg.K$ and $C_v = 0.717 kJ/kg.K$

9. a) Define: i) Dryness fraction, ii) Degree of superheat, iii) Latent heat of vaporization. **6**

b) A vessel of volume $0.04 m^3$, contains a mixture of saturated water and saturated steam at a temperature of 250ºC. The mass of liquid present is 9 kg. Find the pressure, the mass, specific volume, enthalpy and entropy and internal energy? **10**

OR

10. a) With neat sketch and T-s diagram, explain the procedure of measuring dryness fraction of the steam using throttling calorimeter? **6**

b) Following data were obtained with separating and throttling calorimeter: **10**
Pressure in pipeline : 1.5 MPa.
Condition after throttling: 0.1 MPa, 110ºC
During 5 min moisture collected in the separator: 0.150 litre at 70ºC
Steam condensed after throttling during 5 min: 3.25 kg
Find the quality of steam in pipeline?

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