B.E. (Aeronautical Engineering) Semester Third (C.B.S.)

Aero - Thermodynamics Paper - II

P. Pages : 4 **KNT/KW/16/7259**

Time : Three Hours Max. Marks : 80

* 0 9 3 8 *

Notes :
1. All questions carry marks as indicated.
2. Solve Question 1 OR Questions No. 2.
3. Solve Question 3 OR Questions No. 4.
4. Solve Question 5 OR Questions No. 6.
5. Solve Question 7 OR Questions No. 8.
6. Solve Question 9 OR Questions No. 10.
7. Solve Question 11 OR Questions No. 12.
8. Due credit will be given to neatness and adequate dimensions.
9. Assume suitable data whenever necessary.
10. Diagrams and chemical equations should be given whenever necessary.
11. Illustrate your answers whenever necessary with the help of neat sketches.
12. Use of non programmable calculator is permitted.
13. Use of steam tables and Mollier chart is permitted.

1. a) Define extensive and intensive properties. Explain whether the following can be used as properties. **6**

i) $\int pdv$

ii) $\int vdp$

iii) $\int (pdv + vdp)$

b) Explain thermodynamic equilibrium of a system. **3**

c) A certain fluid at 10 bar is contained in a cylinder behind a piston, the initial volume being 0.05 m^3. Calculate work done by the fluid when it expands reversibly. **5**

a) At constant pressure to final volume of 0.2 m^3.

b) According to linear law to final volume of 0.2 m^3 and a final pressure of 2 bar.

c) According to law PV = constant to final volume of 0.1 m^3. Sketch all process on P-V diagrams.

OR

2. a) What is the difference between a closed system, an open system and an Isolated system? Illustrate by giving example. **5**

b) What are exact and inexact differential? Show that heat transfer is an inexact differential. **4**

c) A gas in a piston-cylinder assembly undergoes an expansion process for which the relationship between pressure volume is given by PV^n = constant. The initial pressure is 0.3 MPa, the initial volume is 0.1 m^3 and Final volume is 0.2 m^3. Determine the work for the process in kJ if **5**

a) n = 1.5

b) n = 1.0 and

c) n = 0.

3. a) State the first. Law of Thermodynamics and prove that for a non-flow process, it leads to the energy equation $Q = \Delta u + W$. **3**

b) Define internal energy & prove that it is a property of system. **4**

c) When a system is taken from state 'a' to 'b', in fig. 3.1 along path 'acb', 84 kJ of heat flow into the system, and the system does 32 kJ of work. **6**

a) How much will the heat that flows into the system along path 'adb' be, if the work done is 10.5 kJ?

b) When system is returned from 'b' to 'a' along the curved path, the work done on the system is 21kJ. Does the system absorb or liberate heat, and how much of the heat is absorbed or liberated?

c) If $U_a = 0$ & $U_d = 42\,kJ$, find the heat absorbed in the processes 'ad' and 'db'.

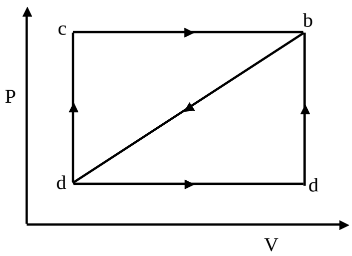


Fig 3.1

OR

4. a) Using steady flow energy equation, show that enthalpy of fluid before throttling is equal to enthalpy after throttling. **5**

b) Air flows steadily at the rate of 0.5 kg/s through an air compressor, entering at 7 m/s velocity, 100 kPa pressure, and 0.95 m^3/kg volume, and leaving at 5 m/s, 700 kPa and 0.19 m^3/kg. The internal energy of leaving are is 90 kJ/kg greater than that of air entering. Cooling water in the compressor jackets absorbs heat from air at the rate of 58 kW. **8**

a) Compute the rate of shaft work input to the air in kW.

b) Find the ratio of inlet pipe diameter to outlet pipe diameter.

5. a) State the limitation of First law of Thermodynamics. **2**

b) Give the following statement of 2^{nd} Law. **4**

i) Kelvin – Planck statement.

ii) Clausius statement.

c) A heat pump working on the Carnot cycle takes in heat from reservoir at 5ºC and delivers heat to reservoir at 60ºC. The Heat pump is driven by a reversible Heat engine which takes in heat from a reservoir at 840º C & rejects heat to the reservoir at 60ºC. The reversible heat engine also drives a machine that absorbs 30 kw. If the heat pump extracts 17 kJ/S from the 5ºC reservoir, determine. **7**

a) The rate of heat supply from 840ºC source.

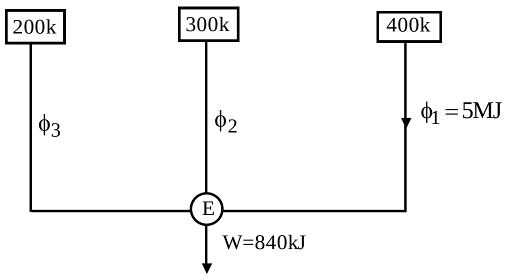
b) The rate of heat rejection to the 60ºC Sink.

OR

6. a) Prove that entropy is the property of a system. **4**

b) Explain the concept of Available and unavailable energy. When does the system becomes dead? **3**

c) A reversible engine, shown in fig. 6.1 during a cycle of operation draws 5 MJ from 400K reservoir & does 840 kJ of work. Find the amount and direction of heat interaction with other reservoir. **6**



(Fig. 6.1.)

7. a) Draw phase equilibrium diagram for pure substance on P-V, T-S and h-s plot with relevant content property Lines. **6**

b) A vessel of volume $0.04m^3$ contains a mixture of saturated water and saturated steam at a temperature of 250ºC. The mass of the liquid present is 9 kg. Find. **7**

i) The pressure
ii) The mass
iii) The specific volume
iv) The enthalpy
v) The entropy
vi) The internal energy

OR

8. a) Draw neat sketch of throttling colorimeter and explain how dryness fraction of steam is determined? Clearly explain its limitation. **6**

b) Steam initially at 0.3 MPa, 250ºC is cooled at constant volume. **7**
a) At what temperature will the steam become saturated Vapour?
b) What is the quality at 80ºC?
c) What is the heat transfer per Kg of steam in cooling from 250ºC to 80ºC?

9. a) Derive an expression for an air standard efficiency of an Otto cycle. **6**

b) In an air standard Diesel cycle, the compression ratio is 16, & at the beginning isentropic compression, the temperature is 15ºC & the pressure 0.1 MPa. Heat is added untill the temperature at the end of constant pressure process is 1480ºC. Calculate. **8**

i) The cut-off ratio.
ii) The heat supplied per Kg of air.
iii) The cycle efficiency.
iv) The m.e.p.

OR

10. a) State and explain the methods of increasing the thermal efficiency of Rankine cycle. **5**

b) Show that pressure ratio of Brayton cycle for maximum work is given by **5**

$r_p = \left(\frac{T_3}{T_1}\right)^{\left[\frac{r}{2(r-1)}\right]}$ where specific heat ratio. - $\left(r = \frac{C_p}{C_v}\right)$

T_3 - maximum temperature of cycle.

T_1 - minimum temperature of cycle.

c) The mean effective pressure of a Diesel cycle is 7.5 bar & compression ratio is 12.5. Find the parentage cut-off of the cycle if its initial pressure is 1 bar. **4**

11. a) State the application of the following devices and obtained the expression for work done. **6**
i) Turbine
ii) Compressor

b) In a gas turbine unit, the gases flow through the turbine is 15 kg/s & the power developed by the turbine is 12000 kW. The enthalpies of gases at the inlet and outlet are 1260 kJ/Kg & 400 kJ/kg respectively, & the velocity of gas at inlet & outlet are 50 m/s & 110 m/s respectively. Determine. **7**

i) The rate at which heat is rejected to turbine &.

ii) The area of inlet pipe given that the specific volume of the gases at inlet is 0.45 m^3/kg.

OR

12. a) Explain clearly the difference between a non-flow process and a steady flow process. **6**

b) An air turbine froms part of an aircraft refrigerating plant. Air at a pressure of 295 kPa and a temperature of 58ºC flow steadily into the turbine with a velocity of 45 m/s. The air leaves the turbine at a pressure of 115 kPa, a temperature of 2ºC, & a velocity of 150 m/s. The shaft work delivered by turbine is 54 kJ/kg of air. Neglecting changes in elevation, determine the magnitude & sign of heat transfer per unit mass of air flowing. **7**
For air $C_p = 1.005\,kJ/kg\,k$ and Enthalpy $h = C_p T$.

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