B.E. Fourth Semester (Mechanical Engineering / Power Engineering) (C.B.S.)

Engineering Thermodynamics Paper - II

P. Pages : 4 **KNT/KW/16/7284/7308**

Time : Three Hours Max. Marks : 80

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. Assume suitable data whenever necessary.
9. Illustrate your answers whenever necessary with the help of neat sketches.
10. Use of non programmable calculator is permitted.
11. Use of steam table and Mollier chart is permitted.
12. The solutions must be supported with appropriate P-v/ T-s / h-s diagrams.

1. a) What is an isolated system. Prove that energy of on isolated system is always constant. **4**

b) A thermocouple with test junction at T°C on gas thermometer scale and reference junction at ice point gives the **5**

e. m. f. as

$e = 0.20T - 5x10^{-4} T^2$ mV

The millivolt meter is calibrated at ice point and steam point. What will be the reading on this thermometer where the gas thermometer reads 70°C?

c) Differentiate between point function and path function giving suitable examples. **4**

OR

2. a) 0.1 m^3 of an ideal gas at 300 K and 1 bar is compressed adiabatically to 8 bar. It is then cooled at constant volume and further expanded isothermally so as to reach the initial conditions. **9**

Calculate

i) Pressure at the end of constant volume cooling.

ii) Change in internal energy during constant volume process.

iii) Net work done and heat transferred during the cycle.

Assume $C_P = 14.3 \frac{kJ}{kg\,k}$ and $C_V = 10.2 \frac{kJ}{kg\,k}$ plot the cycle on P-V coordinates.

b) Explain the following. **4**

i) Boyle's law.

ii) Charle's law

3. a) Prove that in a constant pressure non flow process, the enthalpy change is equal to heat transfer. **5**

b) A cylinder fitted with a spring - loaded frictionless piston contains fluid whose pressure and volume are related by the equation P = a + b V, where a and b are constants. **8**
The internal energy, pressure and volume of the fluid are related by the equation
$U = 34 + 3.15\ PV$
Where U is in KJ, P is in kPa and V in m^3. If the fluid changes from an initial state of 170 kPa, 0.03 m^3 to a final state of 400 kPa, 0.06 m^3 with no work other than that done on the piston, find the direction and magnitude of the work and heat transfer.

OR

4. a) Write the general steady flow energy equation and deduce its simplified from for. **5**

i) Gas Turbine.

ii) Steam nozzle.

b) A centrifugal pump operating under steady flow conditions delivers 3000 kg of water per minute at 20ºC. The suction pressure is 0.8 bar and delivery pressure is 3 bar. The suction pipe diameter is 15 cm and discharge pipe diameter is 10 cm. Find the capacity of the drive motor. **8**
Neglect the change in internal energy and assume that the suction and discharge are at same level.

5. a) State kelvin - Planck and Clausius statement of second law of thermodynamics. **4**

b) Explain perpetual motion machine of first and second kind. **4**

c) A cold storage plant requires 40 tons of refrigeration. The freezing temperature is - 35ºC while the ambient temperature is 30ºC. If the performance of the plant is 20% of the theoretical reversed Carnot cycle working within the same temperature limits, calculate the power required. **6**

OR

6. a) Give the expressions for entropy changes for a closed system in the following cases. **4**

i) Heating a gas at constant volume.

ii) Heating a gas at constant pressure.

iii) Isothermal process.

iv) Polytrophic process.

b) Prove that Entropy is a property of the system. **4**

c) An iron cube at a temperature of 400°C is dropped into an insulated both containing 10 kg water at 25°C. The water finally reaches a temperature of 50°C at steady state. Find the entropy change for the iron cube and water. **6**
specific heat of water = 4186 J/kgk
specific heat of iron = 0.5 kJ/kg°k

7. a) What are the different instruments used to measure the dryness fraction of steam? Explain construction and working of separating calorimeter with a neat sketch. **6**

b) The following observations were recorded using a combined separating and throating calorimeter. **7**
Water separated = 2 kg.
Steam discharged from throttling calorimeter = 20.5 kg.
Temperature of steam after throttling = 110°C.
Initial pressure = 12 bar.
Barometer reading = 760 mm of Hg.
Final gauge pressure = 5 mm of Hg.
Estimate the quality of steam supplied.

8. a) Explain the following terms relating to steam formation. **5**

i) Sensible heat of water.

ii) Latent heat of steam.

iii) Dryness fraction of steam.

iv) Superheated steam.

v) Degree of sub - cooling.

b) Steam enters an engine at a pressure of 10 bar absolute and 400°C. It is exhausted at 0.2 bar. The steam at exhaust is 0.9 dry. Find **8**

i) Drop in enthalpy

ii) Change in entropy.

9. a) Describe the different operations of rankine cycle and represent them on P-v and T-s diagrams. Also derive an expression for efficiency of Rankine cycle. **5**

b) Steam at 20 bar and 360°C is expanded isentropically in a steam turbine upto 0.08 bar. It is then condensed in a condenser to saturated liquid water. The pump feeds back the water into the boiler. **8**
Assuming ideal processes, find

i) The net work/kg of steam.

ii) The cycle efficiency.

10. a) Explain the effect of following operating conditions on Rankine cycle efficiency. **6**

i) Boiler pressure.

ii) Condenser pressure.

iii) Superheating of steam.

b) Explain a Reheat and Regeneration cycle with a neat diagram. Also state its advantages. **7**

11. a) Plot otto cycle on P-v & T-s diagrams prove that efficiency of an otto cycle is a function of compression ratio. **5**

b) An air standard Diesel cycle has a compression ratio of 18 and the heat transferred to the working fluid per cycle is 1800 kJ/kg. At the beginning of the compression stroke the pressure is 1 bar and the temperature is 300K. **9**

Calculate.

i) Thermal efficiency.

ii) Mean effective pressure.

12. An air standard Dual cycle has a compression ratio of 16 and compression begins at 1 bar and 50ºC. The maximum pressure is 70 bar. The heat transferred to air at constant pressure is equal to that at constant volume. **14**
Draw the cycle on P-v and T-s diagrams.

Determine

i) Temperature and pressure at all the salient points.

ii) Heat transferred.

iii) Work Done.

iv) Thermal efficiency.

v) Mean effective pressure.

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