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

Engineering Thermodynamics

P. Pages : 3 **NRT/KS/19/3369/3393**

Time : Three Hours * 0 6 5 3 * 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 thermodynamics steam table and Mollier chart are permitted.

1. a) Explain what you understand by thermodynamic equilibrium? Also explain in brief quasi-static process? **6**

b) 680 kg of fish at 5ºC are to be frozen and stored at –12ºC. The specific heat of fish above freezing point is 3.182, and below freezing point is 1.717 kJ/kg K. The freezing point is –2ºC, and the latent heat of fusion is 234.5 kJ/kg. How much heat must be removed to the cool the fish, and what percent of this is latent heat? **5**

c) State zeroth law of thermodynamics and give its significance. **3**

OR

2. a) Prove that for ideal gas Cp – Cv = R **4**
where Cp – specific heat at constant pressure
Cv – specific heat at constant volume
R – gas constant.

b) A mass of 8 kg gas expands within a flexible container so that the p-v relationship is of the form $PV^{1.2}$ = constant The initial pressure 10 bar and volume is 1 m^3. The final pressure is 5 kPa - If the specific internal energy of the gas Descartes by 40 kJ|kg, find the heat transfer in magnitude and direction. **6**

c) Prove that work done in polytropic process is given by **4**

$$W_{1-2} = \frac{mR(T_2 - T_1)}{n-1}$$

3. a) Prove that system energy is a property. **5**

b) A gas undergoes a thermodynamic cycle consisting of three process beginning at an initial state where $P_1 = 1 \text{ bar}, V_1 = 1.5 \text{ m}^3$ and $U_1 = 512 \text{ kJ}$. The process are as follows :- **8**

i) Process 1-2 : compression with pV = constant to $P_2 = 2 \text{ bar}$, $U_2 = 690 \text{ kJ}$

ii) Process 2-3 : $W_{23} = -150 \text{ kJ}$ and

iii) Process 3-1 ; $W_{31} = +\ 50 \text{ kJ}$. Neglecting change in K. E. & P. E. energies.

Draw the cycle on P - V and T - S diagram

Determine i) φ_{1-2} ii) φ_{3-1} iii) W_{net}

OR

4. a) Give the differential form of steady flow energy equation and explain terms involved Apply S. F. E. E. to the following devices **5**

i) Throttling device like partially opened value.

ii) Steam generating device like boiler.

b) Air flow steadily at the rate of 0.4 kg/s through an air compressor entering at 6 m/s with a pressure of 1 bar and a specific volume of 0.85 m^3/kg and leaving at 4.5 m/s with a pressure of 6.9 bar and a specific volume of 0.16 m^3/kg. The internal energy of the air leaving is 88 kJ|kg greater than that of the air entering. Cooling water in a jacket surrounding the cylinder absorbs heat from the air at rate of 59 W. Calculate the power required to drive the compressor and the inlet and outlet cross - sectional areas. **8**

5. a) State statement of second law of thermodynamics and prove that both statements are equivalence to each other. **5**

b) A heat pump is to be used to heat a house in winter and then reversed to cool the house in summer. The interior temperature is to be maintained at 20ºC. Heat transfer through the wall and roof is estimated to be 0.525 kJ|5 per degree temperature difference between the inside and outside **8**

i) If the outside temperature in winter is 5ºC, what is the minimum power required to drive the heat pump?

ii) If the power output is the same as in part (i), what is the maximum outer temperature for which the inside can be maintained at 20ºC?

OR

6. a) Prove that the efficiency of cannot cycle depends only minimum and maximum temperature in the cycle? **6**

b) What do you understand by entropy principle? State and prove Clausius theorem? **7**

7. a) Explain the following terms. **6**

i) Wet steam.

ii) Dryness fraction.

iii) Superheated steam.

iv) Enthalpy of steam

v) Critical point

vi) Triple point.

b) Find enthalpy, work of evaporation of 2 kg of steam at a pressure of 15 bar, when the condition of steam is **7**

i) Wet with dryness fraction 0.9

ii) Superheated with degree of superheat 50ºC.

iii) Dry steam

Take $(Cp)_{sup} = 2.25 \text{ kJ} | \text{kgK}$

OR

8. a) Explain the method to measure dryness fraction of steam using throttling Calorimeter. Also derive the necessary equation for dryness fraction. Give its limitation also. **6**

b) Two boilers are with superheater and other without superheat are delivering equal quantities of steam into a common main. The pressure in the boilers and in the main is 22 bar. The temperature of steam from a boiler with superheats is 300ºC and the temperature of steam in the main 225ºC. Determine the quality of steam supplied by the other boiler Take $(Cp)_{sup} = 2.25\ kJ/kgK$. **7**

9. a) Explain component of steam power plant. Also derive expression for Rankine efficiency. **6**

b) A steam power plant operates on the ideal Rankine cycle receives steam at 20 bar and 350ºC at rate of 2 kg/s and it is expanded to 0.1 bar **7**
Determine i) Net work done
ii) Rankine efficiency

OR

10. a) Explain the reheating and regeneration in steam power cycle. **6**

b) List out method to increase thermal efficiency of power plant. Explain regenerative Rankine cycle with opened and closed feed water heater. **7**

11. a) Derive an expression for thermal efficiency of Brayton cycle. **5**

b) A diesel cycle with a compression ratio of 18 is having lowest pressure and temperature in the cycle as 1 bar & 27ºC respectively. The heat added per kg of fuel is 2500 kJ|kg. Determine **9**

i) Thermal efficiency.

ii) Mean effective pressure.

iii) Max. temp and pressure in the cycle.

OR

12. a) Explain Otto cycle and Stirling cycle with the help of P -V and T - S diagram. **6**

b) Compare Otto, diesel and dual cycle for the following condition. **8**

i) Save heat supplied

ii) Save peak temp and pressure.

iii) save compression ratio & heat rejection.

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