

Printed Pages – 7

Roll No. :

337355(37)

B. E. (Third Semester) Examination, April-May 2021

(New Scheme)

(Mech., Production & Automobile Engg. Branch)

ENGINEERING THERMODYNAMICS

Time Allowed : Three hours

Maximum Marks : 80

Minimum Pass Marks : 28

Note : Attempt all questions. Part (a) is compulsory in each question. Attempt any two parts from (b), (c) and (d). Use of steam tables and Mollier chart is permitted. Assume suitable data if necessary.

Unit-I

1. (a) Draw the schematic diagrams of a heat engine and a heat pump

2

337355(37)

PTO

[2]

- (b) What are the reasons for the Carnot cycle to be impractical? Derive the expression of thermal efficiency of Carnot cycle as an engine. 7
- (c) What is entropy principle? Show that the entropy of an isolated system increases in all real process and is conserved in reversible process. 7
- (d) Show that when a perfect gas changes from a state p_1, V_1, T_1 to another state p_2, V_2, T_2 the change in entropy per unit mass is given by

$$s_2 - s_1 = C_v \ln \frac{p_2}{p_1} + C_p \ln \frac{v_2}{v_1} \quad 7$$

Unit-II

2. (a) Define :
- (i) Dead state
- (ii) Isothermal compressibility 2
- (b) Derive an expression for availability for a closed system. 7
- (c) Calculate the decrease in available energy when 20 kg of water at 90°C mixes with 30 kg of water

[3]

at 30°C, the pressure being taken as constant and the temperature of the surrounding being 10°C.

Take C_p of water as 4.8 kJ/kg K. 7

- (d) Derive the Maxwell relations. 7

Unit-III

3. (a) Define :
- (i) Reduced co-ordinates
- (ii) Partial pressure and partial volume 2
- (b) Explain the Vander Waal's equation of state and describe its limitations. 7
- (c) A container of 3 m³ capacity contains 10 kg of CO₂ at 27°C. Estimate the pressure exerted by CO₂ by using : (i) Perfect gas equation (ii) Vander Waal's equation. The values of constant 'a' and 'b' in the Vander Waal's equation may be taken as :
- $$a = 363 \times 10^3 \text{ N-m}^4 / (\text{kg mole})^2$$
- $$b = 0.0423 \text{ m}^3 / \text{kg mole} \quad 7$$
- (d) A perfect gas mixture consists of 4 kg of N₂ and 6 kg of CO₂ at a pressure of 4 bar and a temperature of 20°C. Calculate :

[4]

- (i) The mole fraction of each constituent,
 - (ii) The equivalent molecular weight of the mixture,
 - (ii) The equivalent gas constant of the mixture,
 - (iv) The partial pressures and partial volumes,
 - (v) The volume and density of the mixture,
 - (vi) The specific heats C_p and C_v of the mixture.
- Take γ for $\text{CO}_2 = 1.286$ and γ for $\text{N}_2 = 1.4$. 7

Unit-IV

4. (a) Define :
 - (i) Sub-cooled liquid and saturated liquid,
 - (ii) Critical point and triple point. 2
- (b) Explain steam tables and mollier diagrams. 7
- (c) 2 kg of steam at a pressure of 20 bar exists in the following conditions :
 - (i) wet steam with a dryness fraction of 0.9,
 - (ii) dry and saturated steam,
 - (iii) superheated steam with temperature 250°C .

[5]

Calculate :

- (a) enthalpy,
- (b) volume,
- (c) entropy and
- (d) internal energy.

Assume $C_p = 2.023 \text{ kJ/kgK}$ for super heated steam. 7

- (d) In a steam engine cylinder, dry and saturated steam expands from 22 bar to 2 bar isothermally.

Calculate :

- (i) Change in enthalpy,
- (ii) Change in internal energy,
- (iii) Change in entropy,
- (iv) Heat transferred,
- (v) Workdone.

Assume non-flow process in the cylinder. Show the process on $p-v$ and $T-s$ diagrams. 7

Unit-V

5. (a) Define boiler draught. What are the advantages of artificial draught over natural draught? 2

[6]

(b) What are the functions of boiler mountings and accessories? Classify the following fittings and devices as whether they are mountings or accessories. Explain the functions of each of these.

(i) Feed check valve

(ii) Economiser

(iii) Steam trap

(iv) Blow-off cock

7

(c) Explain with neat sketch the construction and working of any one of the following boilers :

(i) Babcock and Wilcox boiler

(ii) Lamont boiler

7

(d) Define boiler efficiency and equivalent evaporation of boiler.

The following data were taken during the test on a boiler for a period of one hour :

Steam generated = 5000 kg,

Coal burnt = 700 kg,

Calorific value of coal = 31402 kJ/kg,

Quality of steam = 0.92

337355(37)

[7]

If the boiler pressure is 1.2 MPa and the feed water temperature is 45°C, find the boiler equivalent evaporation and the efficiency of boiler.

7

100]

337355(37)