DR. BABASAHEB AMBEDKAR TECHNOLOGICAL UNIVERSITY,
LONERE - RAIGAD - 402 103
Winter Semester Examination - Dec. - 2019

Branch: B. Tech in Mechanical Engineering | Sem.:- III
Subject: Thermodynamics (BTMEC305) | Marks: 60
Date: 19/12/2019 | Time: - 3 Hr.

Instructions to the Students

1. Each question carries 20 marks.
2. Attempt **any five** questions of the following.
3. Illustrate your answers with neat sketches, diagram etc., wherever necessary.
4. If some part or parameter is noticed to be missing, you may appropriately assume it and should mention it clearly.
5. Use of steam tables is allowed.

Q.1. Attempt the following:

(A) Separate the list P (pressure), V (volume), v (specific volume), ρ (density), m (mass), and t (temperature) into intensive properties, and extensive properties. **(03)**

(B) What is the zeroth law of thermodynamics? Consider two closed systems A and B. System A contains 3000 kJ of thermal energy at 20°C, whereas system B contains 200 kJ of thermal energy at 50°C. Now the systems are brought into contact with each other. Whether the direction of heat transfer between the two systems will be from system A to system B or from system B to system A? Why? **(03)**

(C) Determine the total work done by a gas system following an expansion process A-B-C as shown in Figure 1 (C). **(02)**

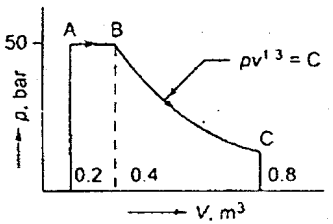

Fig. 1(c). Question 1 (c)

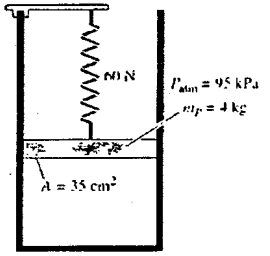

Fig. 1(D), Question 1(D)

115°C. Calculate the dryness fraction of the steam in the main. **(03)**

(C) 0.1 m³ 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 condition from where it started. Calculate:

(i) Pressure at the end of constant volume cooling. **(01)**

(ii) Change in internal energy during constant volume process in kJ. **(02)**

(iii) Net work done and heat transferred during the cycle. **(04)**
Assume C_p = 14.3 kJ/kg K and C_v = 10.2 kJ/kg K.

**********Paper End**********

Q.3. Attempt the following

(A) What is cyclic heat engine? Define thermal efficiency of a heat engine. Can it be 100? Why? **(03)**

(B) What is the difference between a heat pump and a refrigerator? Show that COP of a heat pump is greater than COP of a refrigerator by unity. **(04)**

(C) What is PMM-1 and PMM-2? **(01)**

(D) Using an engine of 30% thermal efficiency to drive a refrigerator having a COP of 5, what is the heat input into the engine for each MJ removed from the cold body by the refrigerator? If this system is used as a heat pump, how many MJ of heat would be available for heating for each MJ of heat input to the engine? **(04)**

Q.4. Attempt the following:

(A) What are the four processes that make up the Carnot cycle? Show the Carnot cycle on P-v and T-s diagrams. What is reversed Carnot cycle? What do you understand by Irreversibility and 'inequality of Clausius'? **(02)**

(B) During the isothermal heat addition process of a Carnot cycle, 900 kJ of heat is added to the working fluid from a source at 400°C. Determine (*a*) the entropy change of the working fluid, (*b*) the entropy change of the source, and (*c*) the total entropy change for the process. **(05)**

Q.5. Attempt the following:

(A) Explain the following terms giving suitable example. **(06)**
(i) Available energy and unavailable energy
(ii) High grade energy and low grade energy
(iii) Dead state

(B) Calculate the decrease in available energy when 25 kg of water, at 95°C mixes with 35 kg of water at 35°C, the pressure being taken as constant and the temperature of the surroundings being 15°C . (Cp of water = 4.2 kJ/kg K). **(06)**

Q.6. Attempt the following:

(A) Steam enters an engine at a pressure 10 bar absolute and 400°C. It is exhausted at 0.2 bar. The steam at exhaust is 0.9 dry. Find : **(02)**
(i) change in enthalpy ;
(ii) Change in entropy.

(B) A throttling calorimeter is used to measure the dryness fraction of the steam in the steam main which has steam flowing at a pressure of 8 bar. The steam after passing through the calorimeter is at 1 bar pressure and

(D) A gas is contained in a vertical, frictionless piston-cylinder device (Fi1. 1(D)). The piston has a mass of 4 kg and a cross-sectional area of 35 cm^2. A compressed spring above the piston exerts a force of 60 N on the piston. If the atmospheric pressure is 95 kPa, determine the pressure inside the cylinder in kPa. **(02)**

(E) Explain the following terms: **(02)**
(i) change of state,
(ii) path,
(iii) process
(iv) Thermodynamic cycle.

Q.2. Attempt the following:

(A) A piston and cylinder machine contains a fluid system which passes through a complete cycle of four processes. During a cycle, the sum of all heat transfers is -170 kJ. The system completes 100 cycles per min. Complete the following table showing the method for each item, and compute the net rate of work output in kW. **(03)**

Process	Q (kJ/min)	W (kJ/min)	ΔE(kJ/min)
a-b	0	2170	---
b-c	21000	0	---
c-d	-2100	---	-36600
d-a	---	---	---

(B) A nozzle is a device for increasing the velocity of a steadily flowing stream. At the inlet to a certain nozzle, the enthalpy of the fluid passing is 3000 kJ/kg and the velocity is 60 m/s. At the discharge end, the enthalpy is 2762 kJ/kg. The nozzle is horizontal and there is negligible heat loss from it.
(a) Find the velocity at exists from the nozzle in m/s. **(02)**
(b) If the inlet area is 0.1 m^2 and the specific volume at inlet is 0.187 m^3/kg, find the mass flow rate in kg/s. **(01)**
(c) If the specific volume at the nozzle exit is 0.498 m^3/kg, find the exit area of the nozzle. **(02)**

(C) What is the difference between 'work transfer' and 'heat transfer'? What is 'point function' and 'path function'? **(04)**