Exam Date & Time: 26-Nov-2019 (09:00 AM - 12:00 PM)

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent unit of MAHE, Manipal)

DEPARTMEMENT OF MECHANICAL & MANUFACTURING ENGINEERING
THIRD SEMESTER B.TECH (MECHANICAL)
END SEMESTER EXAMINATIONS, NOV 2019

THERMODYNAMICS -I [MME 2155]

Marks: 50 **Duration: 180 mins.**

A

Answer all the questions.

Instructions to Candidates:
1. Answer ALL questions.
2. Missing data if ann may be suitably assumed.
3. Thermodynamic data hand book is permitted.

1) What are the limitations of first law of thermodynamics? (2)

A)

B) Derive the expression for the work done for the following cases along with necessary P-V diagram: (i) Isobaric Process (ii) Isochoric Process (iii) Isothermal process (iv) Adiabatic Process. (3)

C) In a steady flow apparatus 135kJ of work is done by each kg of fluid. The specific volume, pressure and velocity at the inlet are: 0.37m^3/kg, 600kPa and 16m/s. The inlet is 32 m above the floor and the discharge pipe is at floor level. The discharge conditions are: 0.62 m^3/kg, 100kPa and 270m/s. The total heat loss between the inlet and discharge is 9 kJ/kg of fluid. For the flow through this apparatus does the specific internal energy increases or decreases and by how much? (5)

2) Write the two statements of second law of thermodynamics. (2)

A)

B) Define an irreversible processes. List the causes of irreversibility and explain them. (3)

C) A house hold refrigerator is maintained at a temperature of 2^0C. Every time the door is opened, warm material is placed inside introducing an average of 420kJ of heat but making a small change in temperature of the refrigerator. The door is opened 20 times a day and refrigerator operates at 15% of ideal COP. The cost of the work is Rs. 1.32 per kWh. What is the monthly bill for this refrigerator? The surrounding temperature is 30^0C. If the surrounding temperature increases by 10^0C, what will be percentage change in monthly bill? (5)

3) Draw the phase equilibrium diagram (P-T diagram) for the pure substance and locate all the phases and phase boundaries (2)

A)

B) With a neat sketch explain the working of throttling calorimeter. (3)

C) A spherical rigid vessel of 0.9m^3 capacity contains steam at 8bar and 0.9dry. Steam is blown off until the pressure drops to 4 bar. The valve is closed and the steam is allowed to cool until the pressure falls to 3bar. Assuming that enthalpy of steam in the vessel remains constant during blowing off periods, determine: (i) The mass of steam blown off (ii) Heat lost during the cooling process (5)

4) Obtain an expression for entropy change of an ideal gas in terms of specific heat at constant volume, temperature ratio and gas constant. (3)

A)

B) Half kg of ice block at -10^{0}C is brought in contact with five kg copper block at 80^{0}C in an insulated container. Determine the change in entropy of (i) Ice (ii) Copper block (iii) Universe. Given specific heat of ice= 2.1kJ/kg K, Specific heat of water= 4.2kJ/kg K, heat of fusion of ice =335kJ/kg, Heat of vaporization of water at 100^{0}C=2257kJ/kg, Specific heat of steam = 2.1kJ/kg K, specific heat of copper =150J/kg K. (3)

C) A well-insulated rigid vessel contains 0.3kg of a perfect gas of Molecular weight 20 and specific heat at constant pressure of 1.8kJ/kg K at a pressure of 100kPa and a temperature of 20^{0}C. A coiled tube within the vessel is connected to a reservoir containing dry and saturated steam at a pressure of 100kPa. The steam condenses in the coil and collects therein as saturated water at the same pressure of 100kPa. (i) Calculate the maximum pressure reached by the gas (ii) Quantity of steam condensed in the coil to achieve this maximum pressure condition. (4)

5) Define: (i) Gas constant (ii) Universal gas constant (iii) Mole fraction (iv) Mass fraction (v) Partial pressure (vi) Compressibility factor. (3)

A)

B) State the Dalton's law of partial pressure.

Show that mixture of ideal gases behaves like an ideal gas (3)

C) A mass of 1.5 kg-mole of an ideal gas of molecular mass 25 is contained in a rigid vessel of volume 4 m^3 at a temperature of 100^o C. Evaluate the mass, the pressure, the specific volume and the gas constant of the gas. If the value of adiabatic index = 1.38. (i) Evaluate the corresponding values of C_P, C_V. (ii) Subsequently the gas cooled to atmospheric temperature 15^o C. Evaluate the final pressure of the gas. (iii) Assuming the gas to be perfect, evaluate the increase in internal energy, the increase in enthalpy, change in entropy and the magnitude and sign of the heat transfer (4)

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