Exam Date & Time: 23-Jan-2023 (09:30 AM - 12:30 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

III SEMESTER B.TECH END SEMESTER EXAMINATIONS, JAN 2023

THERMODYNAMICS -I [MME 2155]

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

A

Answer all the questions.

Instructions to Candidates: Answer ALL questions Missing data may be suitably assumed

1) What do you mean by path and point function? Give examples. (2)

A)

B) State Zeroth Law of Thermodynamics and explain how it is useful in measurement of temperature. (3)

C) A cylinder contains one kg of certain fluid at an initial pressure of 20 bar. The fluid is allowed to expand reversibly behind a piston according the law $PV^2=C$ until the volume is doubled. The fluid is then cooled reversibly at constant pressure until the piston regains its original position; heat is then supplied reversibly with the piston firmly held in this position until the pressure rises to 20bar. Calculate the net work done by the fluid for an initial volume of $0.5m^3$. (5)

2) Write the two statements of second law of Thermodynamics (2)

A)

B) State and explain Clausius Theorem. (3)

C) Air at a temperature of 15°C passes through a heat exchanger at a velocity of 30m/s where its temperature is raised to 800°C.It then enters a turbine with the same velocity of 30m/s and expands until the temperature falls to 650°C. On leaving the turbine the air is taken at a velocity of 60m/s to a nozzle where it expands until the temperature has fallen to 500°C.If the air flow rate is 2 kg/s,calculate (a) the rate of heat transfer to the air in the heat exchanger(b) the power output from the turbine assuming no heat loss and (c) the velocity at exit from the nozzle, assuming no heat loss.Take the enthalpy of air as $h = C_pT$ where $C_p$is the specific heat equal to 1.005kJ/kgK and T is the temperature. (5)

3) Draw the P-v and T-s plot for the Carnot cycle and write the processes involved. (2)

A)

B) List and explain the causes of irreversibilities. (3)

C) (5)

A heat pump working on a reversed Carnot cycle takes in energy from a reservoir maintained at 5°C and delivers it to another reservoir where temperature is 77°C. The heat pump derives power for its operation from a reversible engine operating within the higher and lower temperatures of 1077°C and 77°C. For 100 kJ/kg of energy supplied to reservoir at 77°C, estimate the energy taken from the reservoir at 1077°C.Draw the necessary heat flow diagram.

4) Describe how the properties of the pure substance tabulated. (2)

A)

B) Prove logically 'Violation of Kelvin Planck statement leads to violation of Clausius statement' (3)

C) Two streams of steam, one at 2MPa, 300°C and the other at 2 MPa, 400°C, mix in a steady flow adiabatic process. The rates of flow of the two streams are 3 kg/min and 2 kg/min respectively. Evaluate the final temperature of the emerging stream, if there is no pressure drop due to the mixing process. What would be the rate of increase in the entropy of the universe? This stream with a negligible velocity now expands adiabatically in a nozzle to a pressure of 1kPa. Determine the exit velocity of the stream and the exit area of the nozzle. (5)

5) Define gas constant and universal gas constant. How they are different? (2)

A)

B) Write the SFEE with usual notations clearly specifying the units and meaning of each term in the equation. Reduce the SFEE under ideal conditions for the following cases (i) Turbine (ii) Adiabatic nozzle. (3)

C) A mixture of ideal gases consists of 3 kg of nitrogen and 5 kg of carbon dioxide at a pressure of 300kPa and a temperature of 20°C. Find (a) the mole fraction of each constituent (b) the equivalent molecular weight of the mixture (c) the equivalent gas constant of the mixture (d) the partial pressures. (5)

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