Question Paper

Exam Date & Time: 11-May-2018 (09:30 AM - 12:30 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

INTERNATIONAL CENTRE FOR APPLIED SCIENCES
END SEMESTER THEORY EXAMINATION - APRIL 2018
III SEMESTER B. S. (ENGG)
Date: 11.05.2018
Time: 9.30 A. M. TO 12.30 P.M.
PRINCIPLES OF THERMODYNAMICS [ME 231]

Marks: 100 **Duration: 180 mins.**

Answer 5 out of 8 questions.

Use of thermodynamic data handbook is permitted.

1) A) Differentiate between (8)
i) Microscopic and macroscopic approach
ii) State and path
iii) Work transfer and heat transfer
iv) Intensive and extensive property

B) Explain zeroth law of thermodynamics. How it is helpful in the measurement of temperature? (6)

C) The temperature t on a thermometric scale is defined in terms of a property K by the relation t=A1nK+B where A and B are constants. The values of K are found to be 1.83 and 6.78 at the ice point and the steam point, the temperatures of which are assigned the numbers 0 and 100 respectively. Determine the temperature corresponding to a reading of K equal to 2.42 on the thermometer. (6)

2) A) Explain quasistatic process. Derive the expression for pdv work for a polytropic process. (7)

B) Differentiate between paddle wheel work and free expansion. (6)

C) A fluid, contained in a horizontal cylinder fitted with a frictionless leak proof piston, is continuously agitated by means of a stirrer passing through the cylinder cover. The cylinder diameter is 0.40 m. During the stirring process lasting 10 minutes, the piston slowly moves out a distance of 0.485 m against the atmosphere. The net work done by (7)

the fluid during the process is 2 kJ. The speed of the electric motor driving the stirrer is 840 rpm. Determine the torque in the shaft and the power output of the motor.

3) Explain Joules experiment applicable for a cycle. (6)

A)

B) Prove that energy is a property of the system. (6)

C) A gas with a mass of 1.5kg undergoes a quasi-static process p = a + bV, where a and b are constants. The initial and final pressures are 1000kPa and 200kPa respectively and corresponding volumes are 0.2m^3 and 1.2 m^3. The specific internal energy of the gas is given by the relation u = 1.5pv - 68 kJ/kg where p is in kPa and v is in m^3/kg. Calculate the net heat transfer. (8)

4) Derive Steady Flow Energy Equation. Mention the assumptions made. (8)

A)

B) Determine the exit velocity of nozzle by using SFEE. (4)

C) A turbine operating under steady flow conditions receives steam at the following state: pressure=13.8bar, specific volume=0.143m^3/kg, specific internal energy=2590kJ/kg, velocity = 30m/s. The state of the system leaving the turbine is as follows: pressure=0.35bar, specific volume= 4.37m^3/kg, specific internal energy=2360kJ/kg, velocity=90m/s. Heat is rejected to the surroundings at the rate of 0.25kW and the rate of steam flow through the turbine is 0.38kg/sec. Calculate the power developed by the turbine. (8)

5) Explain with neat sketch the working of throttling calorimeter. (8)

A)

B) Draw P V T Surface for water. (4)

C) A vessel of volume 0.04m^3 contains a mixture of saturated water and saturated steam at a temperature of 250$\hat{A}^{\circ}$C. The mass of the liquid present is 9kg. Find the pressure, mass, specific volume, enthalpy of vapor. (8)

6) Prove that two statements of II law of thermodynamics are equivalent to each other. (10)

A)

B) Two reversible engines operate in series between a high temperature T_1 and low temperature T_2 reservoirs. Engine A rejects heat to Engine B, which in-turn rejects heat to the low temperature reservoir. The high temperature reservoir (10)

supplied heat to engine A. Let T_1=1000K and T_2= 400K and the engine thermal efficiencies are equal. The heat received by engine A is 500kJ. Determine (i) Temperature of heat rejection by engine A, (ii) work output of engine A and B, (iii) heat rejected by engine B. Also sketch the arrangement.

7) State and prove clausius theorem. (8)

A)

B) Obtain an expression for the maximum work obtainable from a heat engine working between two finite bodies. (8)

C) A block of iron weighing 100 kg and having a temperature of 100Â°C is immersed in 50 kg of water at a temperature of 20Â°C. What will be the change of entropy of the combined system of iron and water? Specific heats of iron and water are 0.45 and 4.18 kJ/kg K respectively. (4)

8) Derive the equation of state for ideal gases. (8)

A)

B) Write short notes on: (6)

i) Carnot Cycle

ii) Thermocouple

C) A mass of 0.25kg of an ideal gas has a pressure of 300kPa, a temperature of 80Â°C, and a volume of 0.07m^3. The gas undergoes an irreversible adiabatic process to a final pressure of 300kPa and final volume of 0.1m^3, during which the work done on the gas is 25kJ. Evaluate Cp and Cv of the gas and the increase in entropy of the gas. (6)

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