Total number of printed pages – 8

B. Tech

BENG 1103

First Semester Examination – 2007

THERMODYNAMICS

Full Marks – 70

Time – 3 Hours

*Answer Question No. **1** which is compulsory and any **five** from the rest.*

The figures in the right-hand margin indicate marks.

1. Answer the following questions : 2×10

   (a) Define specific heat at constant volume in terms of the ratio of partial differentials of two properties. What is its value for air at standard atmospheric conditions ?

(b) "Heat transfer is always associated with change in temperature". Is it true or false? Justify your answer with example.

(c) The pressure in a condenser is measured as 30 mm of water column. What will be its absolute value in kPa ?

(d) Represent a constant pressure heating process that changes the state of a pure substance other than water from saturated liquid to super heated vapour on a Temperature – Entropy diagram.

(e) During temperature conversion one claims that 40 °C is equal to 450 Rankine in absolute scale. Check its validity.

(f) A system initially at 37 °C and 1 atmospheric pressure has compressed to 127 °C and 8.105 bar pressure. Write the general expression of the process.

(g) Write the causes for internal and external irreversibility (two from each).

(h) Using energy equation for a control volume proves that throttling process is an isoenthalpy process.

(i) Define quality of vapour. What is its value when the system is at saturated liquid and saturated vapour state ?

(j) State and explain PMM-2.

2. (a) Explain the salient features of triple point and critical point for a pure substance with water as an example. Draw a P-T diagram representing these points. 4

(b) A rigid enclosure, 50 cm on each side, contains a wet mixture of water vapour at 90 °C and 20 percent quality. Heat is added until the pressure is raised to 500 kPa. Determine the final state and the quantity of heat added. 6

3. (a) Prove the equivalence of Kelvin-Plank and Clausius statements of second law of thermodynamics. 4

(b) A dwelling requires 527.5 MJ per day to maintain its temperature at 23 °C when the outside temperature is 10 °C. If a heat pump cycle is used to supply this energy, determine the theoretical work input for one day of operation in kJ. 6

4. (a) State and explain increase-of-entropy principle. 4

(b) A power cycle operating between two reservoirs receives energy Q_H by heat transfer from a hot reservoir at 2000 K and rejects energy Qc by heat transfer to a closed reservoir at 400 K. For each of

the following case determine, whether the cycle operates reversibly, irreversibly or is impossible. 6

5. (a) Briefly explain work transfer and heat transfer from thermodynamic view point. How these can be calculated for a reversible process ? 4

(b) A system consists of a block of mass "m" and an inclined plain. Initially the block is at rest on the inclined plain. A process occurs in which the block slides down the plain, eventually coming to rest again at the lowest elevation. There is no significant heat transfer between the system and its surroundings during the process. Use Kelvin Planks statement of

the second law, demonstrate that this process involving friction is irreversible. 6

6. (a) Explain briefly control volume approach of energy analysis. State the assumptions made during the control volume analysis. 4

(b) Air enters a compressor operating at steady state at a pressure of 1 bar, a temperature of 290 K and a velocity of 6 m/s through an inlet with area 0.1 m^2. At the exit, the pressure is 7 bar, the temperature is 450 K and the velocity is 2 m/s. Heat transfer from the compressor to its surroundings occurs at a rate of 180 kJ/min. Employing the ideal gas model, calculate the power input to the compressor. 6

7. (a) State first law of thermodynamics for a fixed mass system that executes any process. Prove that internal energy of an ideal gas is only a function of Temperature. 4

(b) A mass of 0.25 kg of an ideal gas has a pressure of 300 kPa, a temperature of 80 °C and a volume of 0.07 m^3. The gas undergoes an irreversible adiabatic process to a final pressure of 325 kPa and final volume of 0.12 m^3, during which the work done on the gas is 26 kJ. Evaluate C_P and C_V of the gas and the increase in entropy of the gas. 6

8. (a) Explain different methods for temperature calibration with their limitations. 4

(b) Liquid water at 1 MPa and 20 °C is mixed with steam at 1 MPa and 100 percent quality to produce hot water to produce hot water at 120 °C. The mixing occurs in a steady flow process inside an insulating box. If the inlet water flow at 20 °C is 7.2 kg, calculate the quantity of steam required. 6

14/1/8

80 - 1:5