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10ME/AU33

Third Semester B.E. Degree Examination, June/July 2019

Basic Thermodynamics

Time: 3 hrs. Max. Marks:100

Note: 1. ***Answer any FIVE full questions, selecting at least TWO questions from each part.***
2. ***Use of thermodynamic data hand book permitted.***

PART – A

1 a. Define the following terms with reference to thermodynamics : system, state, process, property, cycle, universe. **(06 Marks)**

b. Differentiate between:
(i) System boundary and control surface.
(ii) Microscopic and macroscopic approach.
(iii) Path and Point functions.
(iv) Reversible and irreversible process. **(08 Marks)**

c. A new scale N of temperature is divided in such a way that the freezing point of ice is 100°N and the boiling point is 400°N. What is the temperature reading on this new scale when the temperature is 150°C? At what temperature both the Celsius and the new temperature scale reading would be the same? **(06 Marks)**

2 a. Define work and heat. Write the similarities between them. **(06 Marks)**

b. Derive an expression for work done during quasi-static process. **(06 Marks)**

c. The change of properties of a closed system follows the law PV = 2.8, where P is the pressure in bar and 'V' is volume in m^3. Determine the work done in kJ, when the pressure increases from 1.4 bar to 7 bar. **(08 Marks)**

3 a. Write the statement of first law of thermodynamics for a system under going,
(i) a cycle (ii) a process. **(04 Marks)**

b. Show that for a reversible adiabatic process, pressure and volume are related by the expression PV^{γ} = constant. **(06 Marks)**

c. One kg of fluid enters the steady flow apparatus at a pressure of 6 bar velocity 16 m/s and specific volume 0.4 m^3/kg. The inlet is 30 m above the ground level. The fluid leaves the apparatus at a pressure of 1 bar, velocity 275 m/s and specific volume 0.6 m^3/kg. The outlet is at the ground level. The total heat loss between the inlet and outlet is 10 kJ/kg. If 140 KJ/kg of work is done by the system, find the change in specific internal energy and indicate whether this is an increase or decrease. **(10 Marks)**

4 a. Show that two statements of second law of thermodynamics are equivalent. **(06 Marks)**

b. Define reversible and irreversible processes and explain the factors which makes the process irreversible. **(05 Marks)**

c. 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 drives power for its operation from a reversible engine operating within the lower and higher temperatures of 77°C and 1077°C. For 100 kJ/kg of energy supplied to reservoir at 77°C, estimate the energy taken from the reservoir at 1077°C. **(09 Marks)**

PART – B

5 a. Show that entropy is a property of a system. **(05 Marks)**

b. Define available and unavailable energy. Derive an expression for availability for a non-flow, steady flow process with usual notations. **(07 Marks)**

c. In a cross flow heat exchanger, 50 kg of water per minute is heated from 20°C to 60°C by passing the hot gases from boiler at 200°C. The gas flow rate is 100 kg/min. Determine the net change of entropy of the system, considering the heat exchanger as an isolated system. Take $C_{P_g} = 1$ KJ/kg.K and $C_{P_w} = 4.18$ KJ/kg.K **(08 Marks)**

6 a. Draw the phase equilibrium diagrarm for a pure substance on P. T coordinates and explain triple point for water. **(06 Marks)**

b. Define dryness fraction and explain the method of determining dryness function of steam using throttling calorimeter with a neat sketch. **(08 Marks)**

c. A steam engine obtains steam from a boiler at a pressure of 15 bar and 0.98 dry. It was observed that the steam losses 21 kJ of heat per kg as it flows through the pipe line, pressure remaining constant. Calculate dryness fraction of steam at the engine end of the pipeline. **(06 Marks)**

7 a. Define universal gas constant and specific gas constant of a perfect gas. **(04 Marks)**

b. Derive an expression for change in entropy of an ideal gas for the reversible process in general. **(06 Marks)**

c. One kg of air occupies 0.084 m^3 at 12.5 bar and 537°C. It is expanded at a constant temperature to a final volume of 0.336 m^3.
Calculate (i) the final pressure (ii) work done during expansion (iii) heat absorbed by the air (iv) change in entropy of air. **(10 Marks)**

8 a. Explain why the real gas deviates from the ideal gas behavior. **(06 Marks)**

b. Define compressibility factor and explain generalized compressibility chart. **(06 Marks)**

c. A container of 3 m^3 capacity contains 10 kg of CO_2 at 27°C. Estimate the pressure exerted by CO_2 using, (i) Perfect gas equation (ii) Vander Waal's equation. **(08 Marks)**

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