

CBCS SCHEME

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15ME33

Third Semester B.E. Degree Examination, Dec.2018/Jan.2019 Basic Thermodynamics

Time: 3 hrs.

Max. Marks: 80

- Note: 1. Answer any FIVE full questions, choosing one full question from each module.
2. Use of Thermodynamic data hand book is permitted.

Module-1

- 1 a. Explain Microscopic and Macroscopic approaches to thermodynamics. (06 Marks)
b. State and explain zeroth law of thermodynamic. (04 Marks)
c. The temperature T on a thermometric scale is defined as $T = a \ln K + b$ where a and b are constants. The values of K are found to be 1.83 and 6.78 at 0°C and 100°C respectively. Calculate the temperature for value of $K = 2.42$. (06 Marks)

OR

- 2 a. Obtain an expression for displacement adiabatic work (work done in an adiabatic process). (06 Marks)
b. Define heat and work with reference to thermodynamic point of view. (04 Marks)
c. A gas expands from an initial state where the pressure is 340KPa and the volume is 0.0425 m^3 to a final pressure of 136KPa. The relationship between the pressure and volume of the gas is $PV^2 = \text{constant}$. Determine the work done for this process. (06 Marks)

Module-2

- 3 a. Derive the steady flow energy equation for an open system. (04 Marks)
b. Show that the Kelvin – Planck and Clausius's statement of the II law of thermodynamic are equivalent. (06 Marks)
c. A gaseous system undergoes three quasistatic processes in sequence. The gas initially at 5 bar 0.01 m^3 is expanded at constant pressure. It is then further expanded according to the relation $PV^{1.4} = C$ to 2 bar, 0.025 m^3 . The gas is then returned to the initial state during which process $PV = \text{constant}$ calculate the work interaction in each of three process and the net work for the system. (06 Marks)

OR

- 4 a. Obtain a relation between COP's of a refrigerator and heat pump. (06 Marks)
b. State and explain the ideal Carnot cycle on P-V diagram. (04 Marks)
c. A series combination of two Carnot engines operates between the temperature of 180°C and 20°C . Calculate the intermediate temperature, if the engine produce equal amounts of work. (06 Marks)

Module-3

- 5 a. Explain the factors that render a process irreversible. (06 Marks)
b. Explain internal and external irreversibility with equation. (04 Marks)
c. A reversible engine operates between a source at 927°C and two sinks at 127°C and 27°C . The energy rejected at both the sinks is the same compute the engine efficiency. (06 Marks)

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg. 42+8 = 50, will be treated as malpractice.

OR

- 6 a. State and prove Clausius inequality and hence define entropy. (06 Marks)
 b. Plot and explain the Carnot cycle with help of temperature entropy diagram. (04 Marks)
 c. A 10kg bar of cast iron initially at 400°C is quenched in a 20 litres water tank initially at 25°C. Assuming no heat transfer with the surroundings and no boiling away of liquid water calculate the net entropy change for the process. $C_{p\text{castiron}} = 0.5$, $C_{p\text{water}} = 4.187$ kJ/kg K. (06 Marks)

Module-4

- 7 a. Obtain an expression for maximum useful work for a system and control volume. (06 Marks)
 b. Define Gibb's and Helmholtz functions and explain its significances. (04 Marks)
 c. Exhaust gases leave an I.C engine at 750°C and 1 atm, after having done 450kJ per kg gas in the engine cylinder. Assume that the enthalpy of the gas is a function of temperature only and that $C_p = 1.1$ kJ/kg K. Assume the temperature of the surrounding to be 27°C. Calculate :
 i) The available and unavailable parts of the energy in every kg gas discharged
 ii) The ratio of available energy to start to the engine work. (06 Marks)

OR

- 8 a. Sketch and explain Throttling Calorimeter. (08 Marks)
 b. Define the following terms : i) Dryness fraction ii) Latent heat
 iii) Total heat of wet steam iv) Superheated steam. (04 Marks)
 c. Find the specific volume, enthalpy and internal energy of wet steam at 18 bar pressure and dryness fraction of 0.85. (04 Marks)

Module-5

- 9 a. Explain Dalton's law of partial pressure and Amagat's law of additive volumes with reference to ideal gas mixture. (06 Marks)
 b. Derive an expression for internal energy and enthalpy of gaseous mixtures. (04 Marks)
 c. A mixture of gases contains 1kg of CO₂ and 1.5kg of N₂. The pressure and temperature of the mixture are 3.5bar and 27°C. Determine for the mixture.
 i) The mass and mole fraction of each constituent gas
 ii) Average molecular weight
 iii) The partial pressures. (06 Marks)

OR

- 10 a. Explain the following :
 i) Generalized compressibility chart
 ii) Law of corresponding states
 iii) Compressibility factor (06 Marks)
 b. Derive Vander Waal's constants in terms of critical properties. (06 Marks)
 c. Determine the pressure exerted by CO₂ in a container of 1.5m³ capacities when it contains 5kg at 27°C.
 i) Using ideal gas equations
 ii) Using Vander Waal's equation. (04 Marks)
