CBCS SCHEME

USN | | | | | | | | | | |

18MR33

Third Semester B.E. Degree Examination, July/August 2021
Basic Thermodynamics

Time: 3 hrs. Max. Marks:100

Note: *1. Answer any FIVE full questions.*
2. Use of thermodynamic data hand book is permitted.

1 a. Distinguish between :
i) Microscopic and Macroscopic point of view
ii) Intensive and extensive property
iii) Open, closed and isolated system. **(10 Marks)**

b. Define a Quasi – Static process. A platinum wire is used as a resistance thermometer. The wire resistance was found to be 10Ω and 16Ω at ice point and steam point respectively, and 30Ω at sulphur boiling point of 444.6°C. Find the resistance of the wire at 750°C, if the resistance varies with temperature by the relation $R = R_0(1 + \alpha t + \beta t^2)$. **(10 Marks)**

2 a. Obtain an expression for displacement work done in an adiabatic process. **(06 Marks)**

b. Define heat and work with reference to thermodynamic point of view. **(04 Marks)**

c. Nitrogen at a pressure of 80 bar and a temperature of 2000K expands polytropically in a cylinder from a volume of $0.03m^3$ to a volume of $0.36m^3$. The pressure after expansion is 2.47bar. The nitrogen is then cooled at constant volume until the temperature is 300K. Calculate : i) index n ii) work done. **(10 Marks)**

3 a. Write the first law of T.D statements for a system undergoing. i) a cyclic ii) non cyclic iii) open system. **(08 Marks)**

b. Air flows steadily through a rotary compressor. At entry the air is 20°C and 0.1MPa. At exit the same air is at 200°C and 0.6MPa. Assuming the flow to be adiabatic :
i) Evaluate the work done per kg of air if the velocities at inlet and exit are negligible.
ii) What would be the increase in work input if the velocities at inlet and exit are 50m/s and 110m/s. **(08 Marks)**

c. State the limitation of 1st law of thermodynamics. **(04 Marks)**

4 a. State and explain Kelvin–Planck and Clausius statements of 2nd law of thermodynamics with sketches. **(10 Marks)**

b. A reversible heat engine operates between two reservoirs at temperature of 600°C and 40°C. The engine drives a reversible refrigerator, which operates between reservoirs at temperature of 40°C and –20°C. The heat transfer to the heat engine is 2000KJ and the net work output of the combined engine refrigerator plant is 360KJ. (i) evaluate the heat transfer to the reservoir at 40°C (ii) reconsider (i), given that the efficiency of the heat engine and the COP of the refrigerator are each 40% of their maximum possible values. **(10 Marks)**

5 a. State and prove Clausius inequality. **(06 Marks)**

b. Show that entropy is a property of the system. **(06 Marks)**

c. A volume of $0.05m^3$ of a perfect gas for which R = 0.297KJ/kg K is compressed reversibly in cylinder according to the law $PV^n = C$ and then cooled at constant pressure. The initial temperature is 27°C and the final pressure is 8.5times. The initial pressure, the final volume is $0.007m^3$. Determine the following : i) the final temperature after compression ii) the final temperature iii) The net heat transfer per kg iv) The net change in specific entropy. **(08 Marks)**

6 a. With a net sketch explain the measurement of dryness fraction by using throttling calorimeter. **(10 Marks)**

b. Steam at 1MPa and 250°C enters a nozzle with a velocity of 60m/s and leaves the nozzle at 10KPa. Assuming the flow process to be isentropic and the mass flow rate to be 1kg/s determine. i) the exit velocity ii) the exit diameter. **(10 Marks)**

7 a. Derive the Tds relations for a reversible problems. **(06 Marks)**

b. Write Maxwell relation. **(06 Marks)**

c. $0.2m^3$ of mixture of fuel and air at 1.2bar and 60°C is compressed until its pressure becomes 12 bar and temperature becomes 270°C. Then it is ignited suddenly at constant volume and its pressure becomes twice the pressure at the end of compression. Find the maximum temperature reached and change in internal energy. Take $\gamma = 1.4$, $R = 0.2943KJ/kg\ K$, $C_p = 1.072KJ/kg\ K$. **(08 Marks)**

8 a. Explain the concept of specific heats for constant volume and constant pressure. **(10 Marks)**

b. A quantity of air at a pressure of 100KPa, 27°C occupying a volume of $0.5m^3$ is compressed to a pressure of 500KPa and volume of $0.12m^3$ according to the law $Pv^n = C$. Find :
i) The value of index 'n' ii) the mass of air iii) work transfer iv) heat transferred during the process v) Change in entropy. **(10 Marks)**

9 a. Explain and write Dalton's law of partial pressure. **(06 Marks)**

b. Write a note on Amagats law of additive volumes. **(06 Marks)**

c. 0.5 kg of air is compressed reversibly and adiabatically from 80KPa, 60°C to 0.4MPa and is then expanded at constant pressure to the original volume. Sketch these processes on the P –V and T – S planes. Compute the heat transfer and work transfer for the whole path. **(08 Marks)**

10 a. Write a note on :
i) Compressibility chart and Compressibility factor
ii) Van-der Waal's equation of state
iii) Beattie – Bridgeman equation. **(12 Marks)**

b. Compute from the Van – der– Walls equation the pressure exerted by 1kg of CO_2 at 100°C if the specific volume is $1m^3/kg$. Also compute the results obtained if CO_2 is treated as an ideal gas. Take $a = 362.85 \times 10^3$ $R = 8314.3$ and $b = 0.0423$. **(08 Marks)**

* * * * *