CBCS Scheme

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

15MR33

Third Semester B.E. Degree Examination, June/July 2017

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 is permitted.

Module-1

1 a. Define the following : i) Closed system ii) Open system iii) Isolated system iv) Equilibrium v) Property. **(05 Marks)**

b. Classify the following properties as intensive or extensive. i) Refractive index of a glass slab ii) Velocity of a bullet iii) Energy required to left a bucket of water iv) Specific heat of a substance v) Size of a platoon of cadets. **(05 Marks)**

c. The readings t_A and t_B of two Celsius thermometers A and B agree at the ice point (0°C) and the steam point (100°C) and are related by the equation $t_A = \ell + mt_B + t_B^2$. Where ℓ, m, n are constants, when both thermometers are immersed in a well stirred oil bath, A resisters 55°C while B registers 50°C. Determine the reading on B when A reads 25°C. **(06 Marks)**

OR

2 a. Derive the expression of work done for the following non flow process.

i) $P = \frac{C}{V}$ ii) $P = \frac{C}{V^2}$ where P is pressure, V is volume and C is constant. **(06 Marks)**

b. Classify the following as heat and work interaction. The system to be considered is shown underlined. i) A honybee sucking rector from a flower ii) Baking of Bread in an oven iii) A person drawing money from his ATM cash counter.
iv) Rising of mercury column is a thermometer placed in the month of a patient. **(04 Marks)**

c. A spherical ballon of one meter diameter contains a gas at 1.5bar. Due to heating, the pressure reaches 4.5 bars. During this process the pressure is propositional to the diameter cubed of balloon. Determine the work done. **(06 Marks)**

Module-2

3 a. Show that the heat transferred during a polytropic process is $\left(\frac{\gamma - n}{\gamma - 1}\right)$ times the work transfer. **(06 Marks)**

b. Clearly write the steady flow energy equation for an open system and explain the terms involved. Given a chance how would you modify the same to suit i) Steam turbine ii) steam nozzle. **(04 Marks)**

c. Air flows steadily through a rotary compressor. At entry the air is 20°C and 101KPa. At exit the same air is at 200°C and 600KPa. Assuming the flow to be adiabatic.
i) Evaluate the work done per unit mass 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. **(06 Marks)**

OR

4 a. State the Kelvin – Planck and Clausius statements of the second law of thermodynamics and Show that the violation of the former results in the violation of the latter. **(08 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 refrigerant and the net 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. **(08 Marks)**

Module-3

5 a. Apply the Clausius in equality for a system under going on irreversible cyclic change and Show that the entropy change of the system is given by $ds \geq \frac{\delta Q}{T}$ **(06 Marks)**

b. A volume of $0.05m^3$ of a perfect gas for which R = 0.297kJ/kg K and C_p = 1.04kJ/kg K is compressed reversibly in a cylinder according to the law $PV^{1.33} = C$ and then cooled at constant pressure. The initial temperature is 27°C and the final pressure is 8.5 times the initial pressure. The final volume is $0.007m^3$. Sketch the process on P-V and T-S diagram. Determine : i) The temperature after compression ii) Final temperature
iii) The net heat transfer per kg iv) the net change in specific entropy. **(10 Marks)**

OR

6 a. Define : i) Pure substance ii) Critical point
iii) Triple point iv) Dryness fraction or quality of seam. **(08 Marks)**

b. With a neat sketch brief the working of a throttling Colorimeter to determine the quality of steam. **(08 Marks)**

Module-4

7 a. Explain the terms Gibbs free energy and Helmholtz free energy. **(04 Marks)**

b. Write a note on Maxwell's equation. **(02 Marks)**

c. $0.2m^3$ of mixture of fuel and air at 1.2 bar and 60°C is compressed until its pressure belong 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 temperature reached and change in internal energy. Also find the heat transferred during compression process. Take γ = 1.4, R = 0.2943lK/kg K C_p = 1.072 kJ/kg K. **(10 Marks)**

OR

8 a. Define Ideal gas, specific heat of a gas and Clausius Clay person's equation. **(06 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 and v) Change in entropy. **(10 Marks)**

Module-5

9 a. Write a note on : i) Equation of states ii) Boyles law
iii) Charles law iv) Vander Waals equation of states. **(08 Marks)**

b. Compute form the Vander Walls equation the pressure exited by 1kg of CO_2 at 100°C is the specific volume is $1m^3$/kg. Also compute the results obtained if CO_2 is heated as an ideal gas, Take a = 362 − 85 × 10^3, R = 8314.3 J/kg mol K b = 0.0423 and molecular weight of CO_2 = 44. **(08 Marks)**

OR

10 a. Write a brief note on compressibility chart and compressibility factor. **(08 Marks)**

b. State: i) Dalton's law of partial pressure ii) Amagath law of additive volume. **(08 Marks)**