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

10ME/AU/TL33

Third Semester B.E. Degree Examination, June/July 2014
Basic Thermodynamics

Time: 3 hrs. Max. Marks:100

Note: ***1. Answer FIVE full questions, selecting at least TWO questions from each part.***
2. Use of thermodynamic data handbook and steam tables is permitted.

PART – A

1 a. Define the following :
(i) Open system (ii) Closed system and (iii) Isolated system , and classify the following into open closed and isolated system and explain giving reasons:
(i) Radiator of a car (ii) Thermos flask (iii) Water pump & (iv) Pressure cooker. **(07 Marks)**

b. What are international fixed reference points? Name few of them. What is their importance? **(05 Marks)**

c. Define a new temperature scale 'N' in which freezing point and boiling point of water are 100 °N and 300 °N respectively. Correlate this temperature scale with centigrade scale for which freezing and boiling points are 0°C and 100°C respectively. **(08 Marks)**

2 a. Starting from a convenient common state point, on P-V diagram, show the four expansion processes for n = 0, n = 1, n = γ (where γ is specific heat ratio) and n = ∞, what are each processes called? Indicate their names adjacent to the processes on the diagram. **(06 Marks)**

b. Show that work and heat are path functions. **(04 Marks)**

c. To a closed system 150 kJ of work is done on it. If the initial volume is 0.6 m^3 and pressure of system varies as follows:

$$P = (8 - 4V),$$

where 'P' is pressure in bar and 'V' is volume in m^3. Determine the final volume and pressure of the system. **(10 Marks)**

3 a. Write the steady flow energy equation for an open system and explain the terms involved in it, and simplify SFEE for the following systems:
(i) Steam turbine and (ii) Nozzle. **(06 Marks)**

b. The properties of a certain fluid are related as follows:

$$u = 0.718t + 196$$
$$Pv = 0.287(t + 273),$$

where 'u' is specific internal energy (kJ/kg), 't' is temp in °C, 'P' is pressure in (kN/m^2) and 'v' is specific volume in (m^3/kg). For this fluid find c_p and c_v (ie., specific heat at constant pressure and specific heat at constant volume). If a system composed of 2 kg of this fluid expands in a frictionless piston and cylinder machine from an initial state of 1 MPa, 100°C to a final temperature of 30°C. If there is no heat transfer, find the net work for the process. **(08 Marks)**

c. A blower handles 1 kg/s of air at temperature of 20°C and consumes a power of 15 kW. The inlet and outlet velocities of air are 100 m/sec and 150 m/sec respectively. Find the exit temperature of air, assuming adiabatic conditions. Take c_p = 1.005 kJ/kg K. **(06 Marks)**

4 a. State and prove Carnot's theorem. **(10 Marks)**

b. A heat engine is used to drive a heat pump. The heat transfer from the engine and heat pump are used to heat water circulating through the radiators of a building. The efficiency of the heat engine is 27 percent and coefficient of performance of heat pump is 4. Evaluate the ratio of the heat transfer to the radiator circulating water to the heat transfer to the engine. **(10 Marks)**

PART – B

5 a. State and prove Clausius inequality? What is the significance of Clausius inequality? **(10 Marks)**

b. An adiabatic vessel contains 85 kg of oil at a temperature of 27°C. A spherical ball made of steel of 10 kg at 727°C is immersed in oil. Determine change in entropy for the universe. Take specific heat of oil = 3.5 kJ/kg K ; Specific heat of steel ball = 0.5 kJ/kg K. **(10 Marks)**

6 a. Define dryness fraction of steam? What are methods used to measure dryness fraction? With neat sketch explain any one method. **(10 Marks)**

b. A rigid vessel of 2 m^3 volume is filled with superheated steam at 20 Bar and 350°C. The vessel is cooled until the steam is just dry saturated. Calculate the mass of steam in the vessel; the final pressure of steam and amount of energy transferred as heat to the surroundings. **(10 Marks)**

7 a. Write Maxwell relations and explain the terms involved. **(04 Marks)**

b. Show that the change in entropy when a perfect gas undergoes a polytropic change PV^n = Constant is given by the expression

$$(S_2 - S_1) = C_v\left(\frac{r-n}{n}\right)\ell n\left(\frac{P_1}{P_2}\right)$$ **(06 Marks)**

c. 0.2 kg of air with pressure 1.5 bar and temperature 27°C is compressed to a pressure of 15 bar according to the law $PV^{1.25}$ = constant. Determine (i) work done on or by the air (ii) Heat flow to or from the air (iii) Change of entropy stating whether it is an increase or decrease in entropy. For air R = 0.287 kJ/kg K, r = 1.4, C_V = 0.718 kJ/kg K. **(10 Marks)**

8 a. Write notes on the following :
(i) Dalton's law of partial pressures
(ii) Vander Waal's equation of states
(iii) Generalized compressibility chart **(12 Marks)**

b. Determine the pressure exerted by carbon dioxide in a container of 1.5 m^3 capacity when it contains 5 kg at 27°C by using
(i) Ideal gas equation (ii) Vander Waal's equation
Take the Vander Waal's constant a = 365.6 kN-m^4 / $(kgmol)^2$; b = 0.0428 m^3/kgmol
Universal gas const = $\overline{R}$ = 8.3144 kJ/kgmol K. **(08 Marks)**

* * * * *