B. TECH.
THEORY EXAMINATION (SEM–IV) 2016-17
THERMODYNAMICS-I

Time : 3 Hours   *Max. Marks : 100*

Note : *Be precise in your answer. In case of numerical problem assume data wherever not provided.*

SECTION – A

1. **Attempt all parts of the following questions:**   **10 x 2 = 20**

   (a) Define volume expansivity.

   (b) What do you mean by reversible process?

   (c) Give SI units of heat, work, kinetic energy and pressure.

   (d) List the four maxewell's equation.

   (e) State the third law of thermodynamics.

   (f) Write down the van der Waals equation of state.

   (g) What are the common statements of the second law of thermodynamics?

   (h) Define refrigeration process.

   (i) Differentiate between open system and closed system.

   (j) What is compressibility factor?

SECTION – B

2. **Attempt any five parts of the following questions:**   **5 x 10 = 50**

   (a) A rigid and insulated tank of volume 1 m^3 contains an ideal gas ($\gamma = 1.4$) at 0.1 MPa and 300 K. The tank is connected to a pipeline carrying the same gas at 3 MPa and 500 K. The valve at the top of the tank is opened allowing the gas to enter the tank till the pressure reaches 3 MPa and then close. Determine the final temperature of the gas inside the tank and the amount of gas that entered the tank.

   (b) Show that for an ideal gas $\Delta h + \Delta V^2/2 + g\Delta z = q - w$ (The symbols have their usual meaning)

   (c) 220 kg of CO_2 gas at 27°C and 1 atm is compressed adiabatically to 1/5th of its volume. It is then cooled to its original temperature at constant volume. Find Q, ΔU and W for each step.

   (d) An ideal gas ($\gamma=1.4$) at 700K and 0.5 MPa enters a reversible and adiabatic nozzle with negligible velocity and leaves at 0.1 MPa .Calculate the exit velocity of the gas and show   that it is given by
   $$V_2 = \{2C_P T_1\{[1-(P_2/P_1)^{\gamma-1/\gamma}]\}^{1/2}.$$

   (e) A gas is confined in a 0.47 m diameter cylinder by a piston, on which rests a weight. The mass of the piston and weight together is 150 kg. The acceleration of gravity is 9.81 m/s2 and atmospheric pressure is 101.57 KPa.

      (i) What is the force exerted on gas by the atmosphere the piston and the weight?

      (ii) What is the pressure of the gas?

      (iii) If the gas in the cylinder is heated .it expands, pushing the piston and weight upward. If the piston and weight are raised 0.83 m, what is the work done by the gas?

   (f) Prove that $dU = C_v dT + [T | \partial P/\partial T |_v - P].dV$

   (g) A Carnot heat engine operates between a source at 1000 K and a sink at 300 K. If the heat engine is supplied with heat at a rate of 800 kJ/min, determine:

      (i) The thermal efficiency

      (ii) The power output of this heat engine

(h) Define and explain the following:

    (i)   Heat pump   (ii)   Heat of combustion

    (iii)   Effect of temperature on heat of reaction   (iv)   Sensible and latent heat

SECTION – C

Attempt any two parts of the following questions: **2 x 15 = 30**

3   Describe the internal combustion engines .Explain the air-standard Otto cycle. Obtain an expression for thermal efficiency in terms of compression ratio.

4   Define coefficient of performance for a Vapor compression cycle. Also obtain an expression for thermal efficiency.

5   Compare the Linde process with the Claude process for air liquefaction.