B. M. S. College of Engineering, Bengaluru - 560019

Autonomous Institute Affiliated to VTU

August 2024 Supplementary Examinations

Programme: B.E. **Semester: III**
Branch: Chemical Engineering **Duration: 3 hrs.**
Course Code: 19CH3DCTD1 **Max Marks: 100**
Course: Process Engineering Thermodynamics-I

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

UNIT - I

1. a) Explain the intensive and extensive properties with examples. **06**

   b) How many degrees of freedom does each of the following systems have? **06**
      i. Liquid water in equilibrium with its vapor.

      ii. Liquid water in equilibrium with a mixture of water vapor and nitrogen.

      iii. A liquid solution of alcohol in water in equilibrium with its vapor.

   c) Explain the state and path functions. **08**

UNIT - II

2. a) Explain the Joule's paddle wheel experiment. **06**

   b) Differentiate between the reversible and irreversible processes with examples. **06**

   c) A system consisting of some fluid is stirred in a tank. The rate of work done on the system by the stirrer is 2.25 hp. Heat generated due to stirring is dissipated to the surroundings. If the heat transferred to the surroundings is 23400 kJ/h, determine the change in the internal energy. **08**

OR

3. a) Define first law of thermodynamics for cyclic process, and how do you state the first law of thermodynamic that can be used for solving steady state fluid flow problems. **10**

   b) Water falls from a height of 100 m. Take 1 kg of water as the system and assume that it does not exchange heat with its surroundings. **10**

i) What is the PE of the water at the top of the falls with respective base of the falls?

ii) What is the kinetic energy of the water before it strikes the bottom?

iii) After the 1 kg of water enters the river below the falls, what change has occurred in its state?

UNIT - III

4. a) Derive and explain the heat capacity at constant pressure and volume. **08**

    b) A stationary mass of gas is compressed from initial state of 0.3 m^3 and 0.105 MPa to final state of 0.15 m^3 and 0.105 MPa. There is a transfer of 37.6 kJ of heat from the gas during the process. How much is the change in internal energy of the gas? **06**

    c) Derive equations to find the change in internal energy and work during adiabatic and constant pressure process. **06**

OR

5. a) Explain and derive the van der Waals equation of state. **10**

    b) Draw and explain the PV diagram for a pure fluid. **10**

UNIT - IV

6. a) Pure CO is mixed with 100% excess air and completely burned at constant pressure. The reactants are originally at 400 K. Determine the heat added or removed if the products leave at 600 K. The standard heat of reaction at 298 K is 283.028 kJ/mol CO burned. The mean specific heats applicable in the temperature range of this problem are 29.10, 29.70, 29.10 and 41.45 J/mol K, respectively for CO, O_2, N_2, and CO_2. **10**

    b) Derive the temperature dependence of standard heat of reactions. **10**

UNIT - V

7. a) Consider two Carnot engines in series producing same amount of work. Show that the temperature difference across each engine is equal. **06**

    b) Explain the concept of entropy and derive Clausius inequality. **08**

    c) Explain the mathematical statement of second law of thermodynamics. **06**

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