GUJARAT TECHNOLOGICAL UNIVERSITY

BE- 3 SEMESTER – OLD PAPER – S23 TO S25- QUESTION BANK & SOLUTION

Subject Name & Code:
Engineering Thermodynamics (3131905)

Unit 1: Basic Concepts

Repeated Questions:

1. **Define: System, Property, Cycle, Process, Isolated system. (03 Marks - S24, W23)**

Answer:

- **System:** A specified region or quantity of matter chosen for thermodynamic analysis, separated from surroundings by a boundary.
- **Property:** Any measurable characteristic of a system (e.g., pressure, temperature, volume) whose value depends only on the state, not the path.
- **Cycle:** A series of processes that return the system to its **initial state** (net change in properties = zero).
- **Process:** A change of state of a system from one equilibrium state to another.
- **Isolated system:** A system that exchanges **neither mass nor energy** (heat or work) with its surroundings.

2. **Explain thermodynamic equilibrium. (03 Marks - S24, S23, S25, W24)**

Answer:

Thermodynamic equilibrium is a state where a system experiences **no change** in its macroscopic properties when isolated from surroundings. It requires the simultaneous satisfaction of three conditions:

- **Mechanical equilibrium:** No pressure gradient – pressure is uniform throughout.
- **Thermal equilibrium:** No temperature gradient – temperature is uniform (zero heat transfer).
- **Chemical equilibrium:** No concentration gradient or chemical reaction – chemical potential is uniform.

➞ **Real-world application:** A thermometer placed in a hot water bath reaches **thermal equilibrium** with the water before it shows a stable reading.

3. **Explain the Zeroth law of thermodynamics and its applications. (04 Marks - S24, W23, W24)**

Answer:

Zeroth Law: If two systems (A and B) are each in **thermal equilibrium** with a third system (C), then A and B are in thermal equilibrium with each other.

Key points:

- Establishes **temperature** as a fundamental property.
- Forms the basis for **temperature measurement** using thermometers.

Applications:

1. **Calibration of thermometers:** A thermometer (C) is placed in a bath at known temperature; any body brought to the same temperature shows the same reading.
2. **Temperature scales:** Enables definition of Celsius, Kelvin, etc., by comparing with fixed points (ice point, steam point).
3. **Clinical thermometers:** The thermometer reaches equilibrium with the patient's body to indicate body temperature.

➞ **Real-world application:** When you use a digital oven thermometer, it first reaches **thermal equilibrium** with the oven air before displaying the correct temperature.

Other Important Questions:

4. S23: Discuss the type of thermodynamic system by giving suitable example. (03 Marks)

Answer:

Thermodynamic systems are classified by their interaction with surroundings:

Type	Mass Exchange	Energy Exchange	Example
Closed system	No	Yes (heat & work)	A gas trapped in a cylinder with a movable piston
Open system	Yes	Yes	A water pump or a car radiator
Isolated system	No	No	Hot coffee in a perfectly insulated thermos flask

5. S23: Explain state and property also describe intensive and extensive property. (03 Marks)

Answer:

- **State:** The condition of a system described by its properties (e.g., T = 300 K, P = 1 bar). When properties change, the state changes.
- **Property:** Any characteristic that has a definite value at a given state (e.g., pressure, volume, entropy).

Intensive vs Extensive properties:

Intensive (mass-independent)	Extensive (mass-dependent)
Pressure, Temperature, Density	Volume, Internal energy, Enthalpy
Remain same when system is divided	Divide proportionally with mass

6. W24: Define and explain: (i) Homogenous and Heterogeneous system (ii) Intensive and Extensive properties. (04 Marks)

Answer:

(i) Homogenous vs Heterogeneous system

Aspect	Homogenous system	Heterogeneous system
Definition	Uniform composition and properties throughout	Multiple distinct phases or regions with different properties
Number of phases	Single phase (e.g., all gas, all liquid)	Two or more phases (e.g., ice + water)
Example	Air (mixture of gases)	Ice cubes in water

(ii) Intensive vs Extensive properties

Intensive properties	Extensive properties
Independent of system mass	Dependent on system mass
Examples: Pressure, Temperature, Density, Viscosity	**Examples:** Mass, Volume, Total internal energy
Dividing system does not change value	Dividing system reduces value proportionally

7. W22: Discuss perpetual motion machines of first kind with neat sketch. (03 Marks)

Answer:

Definition: A perpetual motion machine of the first kind (PMM1) is a hypothetical device that produces **work output without any energy input** – violating the **First Law of Thermodynamics** (energy cannot be created or destroyed).

Why impossible?

Such a machine would create energy from nothing, which contradicts the **law of conservation of energy**.

Example claim (false): A wheel that keeps rotating forever once started, driving a generator without any fuel.

Conclusion: PMM1 is impossible. The First Law requires energy input to be equal to energy output (work + heat). Any machine claiming 100% efficiency without input is a **PMM1 fallacy**.