GOVT. WOMEN ENGINEERING COLLEGE, AJMER

B.Tech. II Semester Section – C, D and E

I Mid-term Assessment Test

Basic Mechanical Engineering

Time: 1 hr. Max. Marks: 20

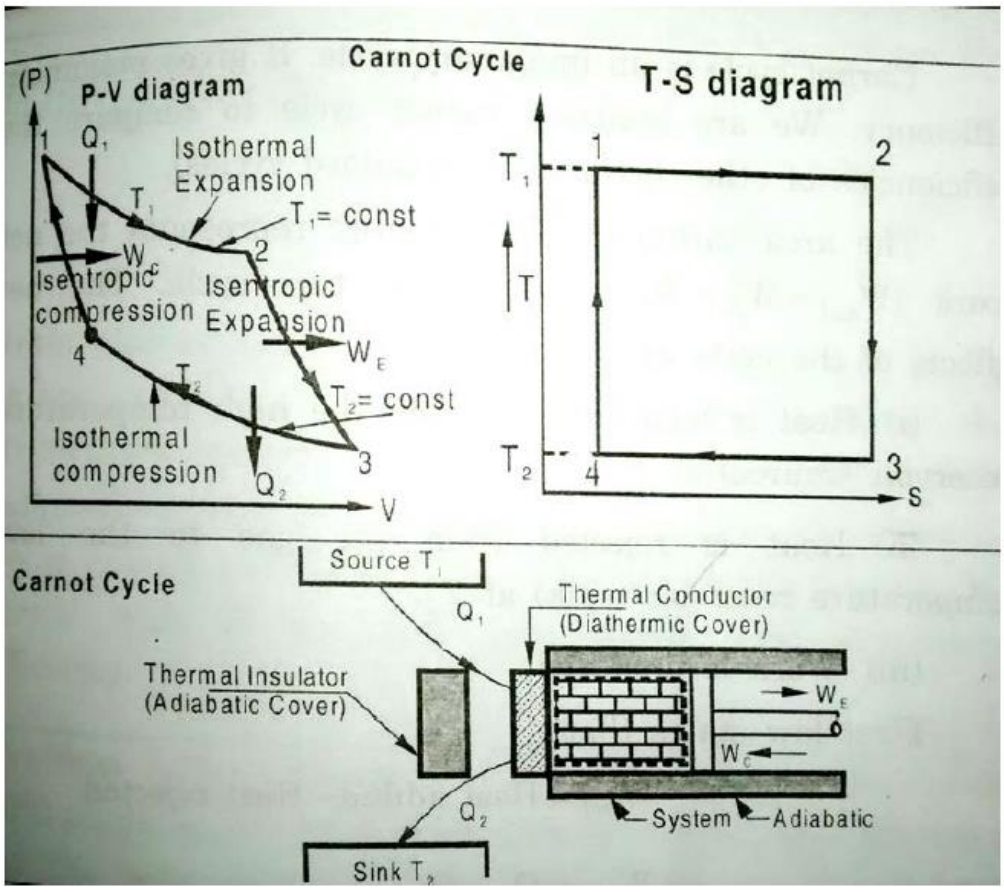
Attempt any four questions. First question is compulsory.

1) Define the following (5M)
   a) System
   b) Surrounding
   c) Boundary
   d) Enthalpy
   e) Entropy
2) Draw the P-V and T-S diagram of a *Carnot Cycle* and explain the processes. (5M)
3) Explain first law of thermodynamics, its limitations and how limitations are addressed by the second law. (5M)
4) Discuss the various mechanical properties of engineering materials. (5M)
5) What is meant by heat treatment? List any two heat treatment processes and their purpose. (5M)

Answers:

1) **Define the following**
   a) **System**
      Certain quantity of matter or region in space which is under thermodynamic study or analysis is called as a thermodynamic system.
   b) **Surrounding**
      Everything external to the system is called surroundings.
   c) **Boundary**
      Interface separating system and surroundings.
   d) **Enthalpy**
      A thermodynamic quantity equivalent to the total heat content of a system. It is equal to the internal energy of the system plus the product of pressure and volume.
   e) **Entropy**
      Entropy is a measure of the "disorder" of a system. It is represented by “S”. The higher the disorder, the greater the entropy.

2) **Draw the P-V and T-S diagram of a *Carnot Cycle* and explain the processes.**



Process 1-2 : Reversible Isothermal Expansion. Initially (state 1) the temperature of the gas is T1 and the cylinder head is in close contact with a source at temperature T1. The gas is allowed to expand slowly doing work on the surroundings. As the gas expands the temperature of the gas tends to decrease. But as soon as the temperature drops by a small amount 'dT', some heat flows from the reservoirs in to the gas, raising the gas temperature to T1. Thus, the gas temperature is kept constant at T1. Since the temperature difference between the gas and the reservoir never exceeds a differential amount 'dT' ,This is a reversible heat transfer process. It continues until the piston reaches position 2. The amount of total heat transferred to the gas during this process Q1.

Process 2-3: Reversible Adiabatic Expansion. At state 2, the reservoir that was in contact with the cylinder head is removed and replaced by insulation so that the system becomes adiabatic. The gas continues to expand slowly, doing work on the surroundings until its temperature drops from T1 to T2.(State 3).

Process 3-4: Reversible Isothermal Compression. At state 3, the insulation at the cylinder head is removed, and the cylinder is brought in to contact with a sink at temperature T2. Now piston is pushed inward by an external force, doing work on the gas. As the gas is compressed, its temperature tends to rise. But as soon as it rises by a small amount dT, heat flows from the gas to the sink, causing the gas temperature to drop toT2. Since the temperature difference between the gas and the sink never exceeds a differential amount dT, this is a reversible heat transfer process. It continues until the piston reaches state 4. The amount of heat rejected from the gas during this process is Q2

Process 3-4: Reversible Adiabatic Compression. State 4 is such that the low temperature reservoir is removed and the insulation is put back on the cylinder head, and as a result the gas is compressed in a reversible manner, the gas returns to its initial state (state 1). The temperature rises from T2 to T1.

3) Explain first law of thermodynamics, its limitations and how limitations are addressed by the second law.

The first law of thermodynamics is an expression of the principle of conservation of energy. The first law expresses that energy can be transformed (i.e. changed from one form to another), but cannot be created or destroyed. The first law of thermodynamics can be stated as: whenever a system undergoes a cyclic change, however complex the cycle may be, the algebraic sum of the work transfers is equal to the algebraic sum of energy transfers as heat.

LIMITATIONS OF FIRST LAW OF THERMODYNAMICS

- The first law of thermodynamics is a law of conservation of energy only. It does not specify the direction of the process.
- First law of thermodynamics does not stipulate any restriction in the efficiency of heat to work conversion.
- All spontaneous process proceed in one direction only. The first law of thermodynamics does not deny the feasibility of a spontaneous process reversing itself.

- The spontaneous processes proceed in one direction only and they never proceed in the reverse direction on their own. Het always flows from a body at a higher temperature to a body at a lower temperature, water always flows downwards. The reverse of these never happens spontaneously. The first law of thermodynamics does not rule out the feasibility of spontaneous process reversing on its own. Therefore, to explain the phenomenon of certain processes proceeding in one particular direction only, we need another law. This law is called second law of thermodynamics.

SIGNIFICANCE OF SECOND LAW OF THERMODYNAMICS

- First law of thermodynamics does not stipulate any restriction in the efficiency of heat to work conversion.

- The Clausius statement of second law of thermodynamics tells that spontaneous process cannot proceed in the reverse direction.

4) Discuss the various mechanical properties of engineering materials.

Mechanical properties refer to the physical properties of a material when it is deformed by elastic or inelastic behavior when mechanical forces are used.
There are many mechanical properties of materials and some key properties among them are given below.

a. Strength

The capacity of a material to withstand the mechanical loads applied on it without bowing, breaking, or deformation is known as strength.

b. Elasticity

The capacity of a material to oppose a bending impact or push and come back to its unique size and shape when the load is evacuated is known as elasticity.

c. Plasticity

The capacity in changing the material shape and size permanently without breaking is known as plasticity.

d. Ductility

The capacity of a material to change shape (misshape) ordinarily by extending along its length is known as ductility.

e. Tensile strength

The capacity of a material to extend without breaking is known as tensile strength.

5) What is meant by heat treatment? List any two heat treatment processes and their purpose.

The term heat treatment may be defined as an operation or a combination of operations, involving the heating and cooling of a metal or an alloy in the solid state for the purpose of obtaining certain desirable conditions or properties without change in chemical composition.

***Normalising*.** The main objects of normalising are:

i. To refine the grain structure of the steel to improve machinability, tensile strength and structure of weld.

ii. To remove strains caused by cold working processes like hammering, rolling, bending, etc., which makes the metal brittle and unreliable.

iii. To remove dislocations caused in the internal structure of the steel due to hot working.

iv. To improve certain mechanical and electrical properties.

The process of normalising consists of heating the steel from 30 to 50°C above its upper critical temperature. It is held at this temperature for about fifteen minutes and then allowed to cool down in still air.

***Hardening*.** The main objects of hardening are :

i. To increase the hardness of the metal so that it can resist wear.

ii. To enable it to cut other metals *i.e*. to make it suitable for cutting tools.

The process of hardening consists of

(*a*) heating the metal to a temperature from 30 to 50°C above the upper critical point for hypoeutectoid steels and by the same temperature above the lower critical point for hypereutectoid steels.

(*b*) keeping the metal at this temperature for a considerable time, depending upon its thickness.

(*c*) quenching (cooling suddenly) in a suitable cooling medium like water, oil or brine.

It may be noted that the low carbon steels cannot be hardened appreciably, because of the presence of ferrite which is soft and is not changed by the treatment. As the carbon content goes on increasing, the possible obtainable hardness also increases.