GOVT. WOMEN ENGINEERING COLLEGE, AJMER

B.Tech. II Semester

I Mid-term Assessment Test Model Paper

Basic Mechanical Engineering

Time: 1 hr. Max. Marks: 20

Attempt any four questions. First question is compulsory.

1) Define the following (5M)
   a) Thermodynamic Property
   b) Extensive Properties
   c) Intensive Properties
   d) Annealing
   e) Tempering
2) Explain the following (5M)
   i) System, Surrounding and Boundary
   ii) Kelvin Plank's statement of second law of thermodynamics
3) "No engine can be made to work on Carnot Cycle". Justify the statement and explain the different processes of Carnot Cycle with the help of P-V diagram. (5M)
4) Write a short note on ferrous materials and explain the classification of ferrous materials. (5M)
5) Differentiate between alloys and composites and write any three advantages of composites. (5M)

.

.

Answers:

1). Define the following

a) **Thermodynamic Property:** A property is any measurable characteristic of a system. The common properties include: pressure (P), temperature (T), volume (V), velocity (v), mass (m), enthalpy (H), entropy (S).

b) **Extensive Properties:** The properties of a system which are dependent on mass are called extensive properties.

c) **Intensive Properties:** The properties a system which are independent on mass are called intensive properties.

d) **Annealing:** Annealing is a process by which the property of steel is enhanced to meet the machinability requirements. Annealing is a process of heating the steel slightly above the critical temperature of steel i.e. 723 Degree Centigrade and allowing it to cool down very slowly.

e) **Tempering:** Tempering is a heat treatment technique applied to ferrous alloys, such as steel or cast iron, to achieve greater toughness by decreasing the hardness of the alloy. The reduction in hardness is usually accompanied by an increase in ductility, thereby decreasing the brittleness of the metal.

2). **Explain the following**

i) **System:** A system which is under thermodynamic study is called thermodynamic system.

Surrounding: Everything external to the system is called surrounding.

Boundary: The interface separating system and surrounding is called boundary.

ii). **Kelvin Plank's statement of second law of thermodynamics**

It is impossible for a heat engine to produce net work in a complete cycle if it exchanges heat only with bodies at a single fixed temperature.

The Kelvin Plank statement tells us that it is impossible to construct an engine which, while operating cyclically, absorbs a certain amount of energy as heat from a high temperature reservoir (source) and converts all of it in to work. Thus, the Kelvin Plank statement implies that no heat engine can have 100% efficiency.

3). "No engine can be made to work on Carnot Cycle". Justify the statement and explain the different processes of Carnot Cycle with the help of P-V diagram.

Carnot cycle is a hypothetical cycle which works on the following assumption: The Carnot cycle comprises two reversible isothermal and two reversible adiabatic processes.

Both of these are ideal process which cannot be achieved in practical situations. Carnot cycle is practically not possible. It is used as a reference or model for heat engine cycles as it gives maximum efficiency. It is used to compare actual heat engine cycle efficiencies.

An engine which works on Carnot cycle is called Carnot engine. It's a hypothetical engine and is not practically possible to construct. It consist of all reversible process and engine works at a slow rate converting thermal energy to work. The concept of Carnot engine serves as a means to compare and measure the performance of other engines.

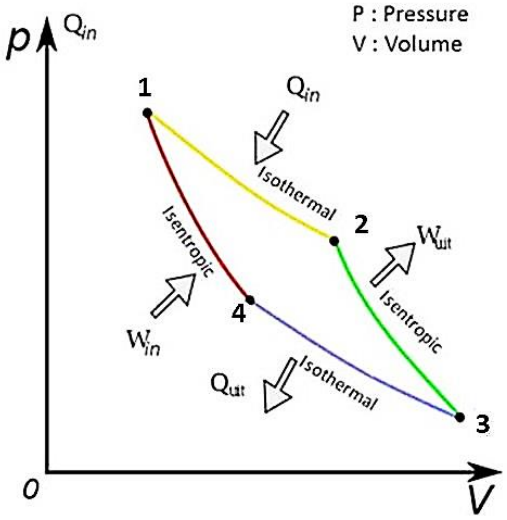
The four reversible process that make up the Carnot cycle are

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.



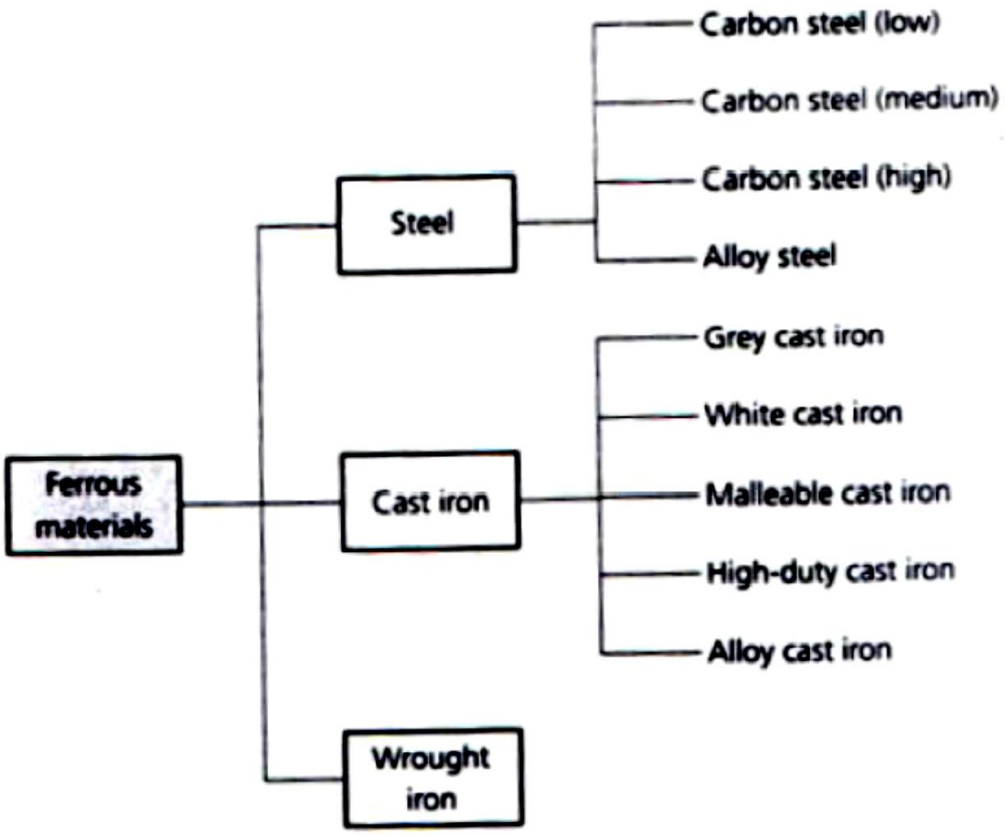
P-V Diagram of Carnot Cycle

4). Write a short note on ferrous materials and explain the classification of ferrous materials.

Ferrous Materials:

- These are the metals and alloys containing a high proportion of the element iron.
- They are the strongest materials available and are used for applications where strength is required at relatively low cost and where weight is not of primary importance.
- These ferrous materials are used in bridge buildings and railway lines etc.

These ferrous materials can be classified in different families as shown below



5). Differentiate between alloys and composites and write any three advantages of composites.

Alloys and composites are similar in that they both consist of a mixture of at least two components. An alloy is a mixture of two or more components with at least of those two components being a metal. When these two components are put together, they have significantly different qualities than they would if they were on their own. One of the most common examples of an alloy is steel, which is a combination of iron and carbon. The addition of carbon makes steel stronger than iron, and it also changes the hardness ductility, and strength of the resulting alloy. Brass, a combination of copper and zinc, is another common alloy.

A composite is, like an alloy, a mixture of two or more components, but it does not include any metal in it. The components are chemically and physically different from one another, and in most cases, they are combined to create a composite that is stronger than the original components would be on their own. Some composites occur naturally, while others are synthetic. And while alloys

can involve either a homogenous or a heterogeneous mixture, composites are always heterogeneous.

Advantages of Composites:

i) Light Weight: Composites are light in weight, compared to most woods and metals.

ii) Corrosion Resistance: Composites resist damage from the weather and from harsh chemicals that can eat away at other materials. Composites are good choices where chemicals are handled or stored.

iii) Nonconductive: Composites are nonconductive, meaning they do not conduct electricity. This property makes them suitable for such items as electrical utility poles and the circuit boards in electronics.