1 (a) Pattern - It is a replica of the final object to be made with some modifications. The mould cavity is made with the help of pattern.

(b) Prototyping - The process to make prototype which will be the first model or design of something from which other forms will be developed.

(c) Flux - A flux is a material used to prevent, dissolve, or facilitate removal of oxides and other undesirable surface substances as defined by the 'American Welding Society'. It depends on the operation and parent metals that are being welded.

(d) Solder - The filler metals that are used in soldering ~~...~~ are called solder which are essential alloys of tin & lead.

(e) Recrystallisation temperature - The approximate minimum temperature at which complete recrystallisation of a cold-worked metal occurs within a specified time.

Solution- 2)

9.4.1 Principle of Arc

An arc is generated between two conductors of electricity, cathode and anode (considering direct current, DC), when they are touched to establish the flow of current and then separated by a small distance. An arc is a sustained electric discharge through the ionized gas column, called *plasma*, between the two electrodes.

It is generally believed that electrons liberated from the cathode move towards the anode and are accelerated in their movement. When they strike the anode at high velocity, a large amount of heat is generated. Also, when the electrons are moving through the air gap between the electrodes, also called the *arc column*, they collide with the ions in the ionized gas column between the electrodes. The positively charged ions, move from the anode and impinge on the cathode, thus liberating heat. About 65 to 75% of the total heat is liberated at the anode by the striking electrons. A temperature of the order of 6000 °C is generated at the anode.

In order to produce the arc, the potential difference between the two electrodes (voltage) should be sufficient to allow them to move across the air gap. The larger air gap requires higher potential differences. If the air gap becomes too large for the voltage, the arc may be extinguished. Here, we may make use of an analogy of a person walking on the road. Suddenly, when a deep trench comes in his way, the person would try to jump across it, if it is a short one. But if it is a broader one, then he may move back a little; come running towards the trench and try to jump over it. If it is too broad, he may abandon the idea of jumping across it. The energy spent in jumping is much more than what is spent while normal walking. In the case of an arc, the extra energy spent crossing the air gap is liberated as heat.

For convenience of explanation, we have chosen a direct current arc for the above description. But even with an arc of the alternating current (AC), it would be similar, with the main difference that the cathode and anode would change continuously and as a result, the temperature across the arc would be more uniform compared to a DC arc.

③ Following are the similarities between Brazing & Soldering processes:-

a) Both are joining processes.

b) The filler metal reaches the joint by capillary action in both the processes.

c) Both are used to obtain leak proof joints.

Following are the dis-similarities between Brazing and Soldering processes

a) In Brazing the filler metal used has a temperature between 450°c and melting point of base metal but In Soldering the filler metal has a temperature below 450°C.

b) The strength of Brazed joints are more than the strength of soldered joints.

c) Filler metal used in Brazing is called spelter which is a combination of copper with Zinc, Silver or Almunium while filler metal used in soldering is called solder which is an essential alloy of Lead & Tin.

d) Most common use of Brazing is in hydraulics while that of soldering is in electronic circuits.

Solution-4

CNC is superior to conventional manufacturing in a number of ways. The superiority comes because of the programmability. These are as follows:

1. Parts can be produced in less time and, therefore, are likely to be less expensive. The idle (noncutting) time is reduced to absolute minimum. This of course depends on the way the part program for the part is written. The endeavour of the machine-tool builder is to provide facility whereby the noncutting time can be brought to the barest minimum possible. It is possible to reduce the nonproductive time in NC machine tools in the following ways:
   - by reducing the number of set-ups,
   - by reducing set-up time,
   - by reducing workpiece-handling time, and
   - by reducing tool-changing time.

These make NC machines highly productive.

2. Parts can be produced more accurately even for smaller batches. In the conventional machine tools, precision is largely determined by the human skill. NC machines, because of automation and the absence of interrelated human factors, provide much higher precision and thereby promise a product of consistent quality for the whole batch.
3. The operator involvement in part manufacture is reduced to a minimum and as a result, less scrap is generated due to operator errors. No operator skill is needed except in setting up of the tools and the work. Even here, the set-up has been simplified to a very great extent.
4. Since the part program takes care of the geometry generated, the need for expensive jigs and fixtures is reduced or eliminated, depending upon the part geometry. Even when the fixture is to be used, it would be very simple compared to a conventional machine tool. It is far easier to make and store part programs (tapes).
5. Inspection time is reduced, since all the parts in a batch would be identical, provided proper care is taken about the tool compensations and tool wear in part-program preparation and operation. With the use of inspection probes in the case of some advanced CNC controllers, the measurement function also becomes part of the program.
6. The need for certain types of form tools is completely eliminated in NC machines. This is because the profile to be generated can be programmed, even if it involves three dimensions.
7. Lead times, needed before the job, put on the machine tool, can be reduced to a great extent depending upon the complexity of the job. More complex jobs may require fixtures or templates, if they are to be machined in the conventional machine tools, which can be reduced to a large extent.

8. CNC-machining centres can perform a variety of machining operations that have to be carried out on several conventional machine tools, thus reducing the number of machine tools on the shop floor. This saves the floor space and also results in less lead time in manufacture. This results in the overall reduction in production costs.
9. Set-up times are reduced in a number of situations, since the set-up involves simple location of the datum surface and position. Further, the number of set-ups needed can also be reduced. All this translates into lower processing times. Many a times, a component could be fully machined in a single machining centre or turning centre, each of which having wider machining capabilities. In conventional manufacture, if the part has to be processed through a number of machine tools located in different departments, the time involved in completion and the resultant in-process inventory would be large. This would be greatly eliminated by the use of NC machine tools.
10. Machining times and costs are predictable to a greater accuracy, since all the elements involved in manufacturing would have to be thoroughly analysed before a part program is prepared.
11. Operator fatigue does not come into picture in the manufacturing of a part. The NC machine tool can be utilised continuously since these are more rigid than the conventional machine tools.
12. Tools can be utilised at optimum feeds and speeds that can be programmed.
13. The modification to part-design can be very easily translated into manufacture by the simple changes in part programs without expensive and time-consuming changes in jigs, fixtures and tooling. This adds to the flexibility of manufacture.
14. The capability (metal removal) of NC machines is generally high because of the very rigid construction employed in machine-tool design compared to the conventional machine tools.

⑤ Different manufacturing processes employed in industries are as follows:-

a) Casting - It is one of the earliest metal-shaping methods known. It is the process to pour molten metal into a refractory mould with a cavity of the shape to be made and allowing it to be solidified.

b) Forming - It is the process of plastic deformation of the metal which is achieved by application of large amount of mechanical force only or by heating the metal and then applying the small force.
Forging, Rolling, Sheet metal operations, Extrusion, Drawing comes under forming processes.

c) Joining - It is a fabrication process in which two ore more elements are joined to make a single part with the help of temperature and pressure, or mechanical joining by means of bolts, screws and rivets.
Welding, Brazing, Soldering, Riveting etc. comes under joining processes.

d) Advanced manufacting processes - These are new age, mordern manufacturing practices which are employed to attain the best accuracy, more production with the help of CNC's, NC's, additive manufacturing etc.

e) Machining - It is a process in which metal is removed to attain the desired shape & size. Metal cutting, working on lathe, shaper are the examples of machining processes.

Solution - 6

3.1.2 Advantages and Limitations of Casting processes -

The casting process is extensively used in manufacturing because of its many advantages. [Molten material flows into any small section in the mould cavity and as such, any intricate shape—internal or external—can be made with the casting process. It is possible to cast practically any material, be it ferrous or non-ferrous. Further, the necessary tools required for casting moulds are very simple and inexpensive. As a result, for trial production or production of a small lot, it is an ideal method. It is possible in casting process, to place the amount of material where it is exactly required. As a result, weight reduction in design can be achieved. Castings are generally cooled uniformly from all sides and therefore they are expected to have no directional properties. There are certain metals and alloys, which can only be processed by casting and not by any other process like forging because of the metallurgical considerations. Castings of any size and weight, even up to 200 tons can be made.

However, the dimensional accuracy and surface finish achieved by normal sand-casting process would not be adequate for final application in many cases. To take these cases into consideration, some special casting processes such as diecasting have been developed, the details of which are given in later chapters. Also, the sand-casting process is labour intensive to some extent and therefore many improvements are aimed at it, such as machine moulding and foundry mechanization. With some materials it is often difficult to remove defects arising out of the moisture present in sand castings.