B.Tech.

EME-101

FIRST SEMESTER EXAMINATION, 2010-11

MANUFACTURING PROCESSES

Time: 3 Hours *Total Marks:* **100**

SECTION—A

1. Attempt all questions. All questions carry equal marks.

Q.1. (*A*) Non-metallic elements which are basically the oxides and compounds of metal and non-metals are known as:

(*a*) Composite
(*b*) Organic Polymers
(*c*) Ceramics
(*d*) Ores [Ans. (*c*)]

Q.1. (*B*) Puddling furnace is lined inside with——.

Q.1. (*C*) Which coolant has highest cooling rate in heat treatment Process?

(*a*) Water (*b*) Sulfuric acid
(*c*) Air (*d*) Brine [Ans. (*a*)]

Q.1. (*D*) The sheet metal operation in which metal is removed in small increments:

(*a*) Perforating (*b*) Punching
(*c*) Lancing (*d*) Nibbling [Ans. (*d*)]

Q.1. (*E*) In casting process, inclusions are:

(*a*) Steel particles (*b*) Metallic particles
(*c*) Iron particles (*d*) Non metallic particles [Ans. (*b*)]

Q.1. (*F*) Reaming operation is performed to:

(*a*) Enlarge a previously drilled hole
(*b*) Finish previously drilled hole to accurate size
(*c*) Both (*a*) and (*b*)
(*d*) None of the above [Ans. (*b*)]

Q.1. (*G*) In resistance welding the time period during which current flows to rise the temperature is:

(*a*) weld time (*b*) on time
(*c*) off time (*d*) squeeze time [Ans. (*a*)]

Q.1. (*H*) In carburizing flame the maximum temperature produced is:

(*a*) about 3200 (*b*) about 3500°C
(*c*) about 3000°C (*d*) None of the above [Ans. (*b*)]

Q.1. (*I*) Inorganic non-metallic material which are used at very high temperature:

(*a*) Cement (*b*) Rubber
(*c*) Thermosetting plastic
(*d*) Ceramic [Ans. (*d*)]

Q.1. (*J*) Combination layout combines the features of:

(*a*) Product and process layout
(*b*) Jobshop and process layout
(*c*) Jobshop and product layout
(*d*) Fixed position and process layout [Ans. (*a*)]

SECTION—B (3×5=15)

2. Attempt any there questions. All questions carry equal marks.

Q.2. (A) Explain the following:

(*i*) Ductile fracture
(*ii*) Brittle fracture
(*iii*) Creep fracture
(*iv*) Fatigue fracture.

Ans. (*i*) Ductile Fracture: It is the rapture of a material after considerable amount of plastic deformation. Materials begins to neck beyond the ultimate strength, which is at the maximum point in the load elongation curve. The neck refers to the reduced cross-section of the specimen near the middle. The true stress in this region is increasing, in spite of the fall in the load and the engineering stress. Fully ductile material will continue to neckdown to an infinite similarly thin edge or a point and thus fail, as the cross section at neck becomes so small that it cannot bear the load any longer. The more common type of ductile fracture occurs when the reduced cross section has still an appreciable area. Here the cracks are found to nuclear at brittle particles : either the natural kind found in multiphase material or foreign inclusions. When a brittle particle is present, it is difficult to maintain compatibility in the neck region between the continuously deforming matrix and the non deforming particles. This results in the formation of very tiny voids near the matrix particle interface. In fracture initiate at pores in the neck region, then the voids are already present. This voids grow with increasing deformation and alternately reaches to sizes in order of mm. At this stage the material will tear apa ..

(*ii*) *Brittle Fracture:* It is the failure of a material without apparent plastic deformation. If the broken pieces of a brittle fracture are fitted together, the original shape and dimensions of the specimen are restored. An an ideal material the fracture can be visualized as the pulling apart and breaking of the interatomic bonds across two neighbouring atomic planes. A simple calculation similar to that done for the theoretical shear strength of a perfect crystal shows that the tensile stress required to break the interatomic bonds across two adjacent atomic planes is of the order of 1/6, where y is the young's modulus of the brittle material, forever break at a much lower stress, of the order of y/1000. The difference of two orders of magnitude between the calculated and the observed strengths is similar to the discrepancy between the strengths of perfect and real crystals. Just as the presence of dislocations in real crystals explains the discrepancy, here the existence of tiny cracks in brittle materials is the reason for their poor tensile strength.

(*iii*) Creep Fracture: Creep is effectively a pre failure of the material. Creep may occur under the following conditions.

1. Under a fixed level of continuous force, deformation increases with the passage of time and the deformation is not completely recovered even if the force is removed.
2. When the fixed amount of deformation is maintained for a long time, the resistance to load decrease with the passage of time.
3. If loading time is further extended, rupture occurs this is known as creep rupture.

Creep strains are of significant importance are not usually encountered until the operating temperature reaches the range of approximately 35% to 70% of the melting point on a scale of absolute temperature. The phenomenon of creep is manifested by a time dependent deformation under a constant strain. The material develops creep strain which increases with duration of loading. The instigative law of creep is stresses and total creep strains. The result is usually a system of first order differential equation with non linear coefficients.

(*iv*) Fatigue Fracture: Rotating shafts connecting rods, aircraft wings and leaf springs are some examples of structural and machine. Components that are subjected to millions of cycles of alternating stresses during service. The majority of failure of such components in service is due to fatigue. A fatigue failure can occur well below the yield stress of a material.

Fatigue fracture occurs by crack propagation. The crack usually initiates at the surface of the specimen and propagates slowly at first into the interior. At some critical stage, the crack propagation becomes rapid culminating in fracture.

The fatigue life of the components can be improved by several methods. Good design plays an important role in increasing the fatigue life, sharp corners should be avoided in design, so that regions of stress concentration are not present. Polishing the surface of the component to a good finish also removes some of the surface irregularities which may initiate a crack shot peening of metals introduces compressive stresses at the surface and improves the fatigue strength carburizing and nitriding introduce strong surface layers and increase the resistance to crack initiation at the surface. On the other hand decarburization produces a soft surface layer that lowers the fatigue resistance. A fine grain size improves the fatigue resistance.

Q.2. (*B*) Explain different properties of modulating sand.

Ans. Properties of moulding sand. Proper moulding sand must posses following six properties.

(1) Porosity: Molten metal always contains a certain amount of dissolved gases, which was evolved when the metal freezes. Also, the molten metal, coming in contact with the moist sand, generates water vapour. If these gases and vapour evolved by the moulding sand do not find opportunity to escape completely through the mould they will form gas holes and pores in the casting.

The sand must therefore, be sufficiently porous to allow the gases or moisture present or generated within the moulds to be removed freely when the moulds are poured. This property of sand is called porosity or permeability.

(2) Flowabillty: Flowability of moulding sand refers to its ability to behave like a fluid so that, when rammed, it will flow to all portions of the mould and pack all around the pattern and take up the required shape. The sand should respond to the different moulding processes. High flowability is required of a moulding sand to get compacted to a uniform density and to obtain good impression of the pattern in the mould. Good flowability is very essential where energy for compaction during ramming is transmitted through the sand mass as in machine moulding. Flowability increases as delay and water content increase.

(3) Collapsibility: After the molten metal in the mould gets solidified, the sand mould must be collapsible so that free contraction of metal occurs, and this would naturally avoid the tearing or cracking of the contracting metal.

(4) Adhesiveness : The sand particles must be capable of adhering to another body, *i.e.*, they should cling to the sides of the moulding boxes. It is due to this property that the sand mass can be successfully held in a moulding box and it does not fall out of the box when it is removed.

(5) Cohesiveness : This the ability of the sand particles to stick together. Insufficient strength may lead to a collapse in the mould or gets partial destruction during conveying, turning over or closing. The mould may also be damaged during pouring by washing of the walls and core by the molten metal. The strength of moulding sand must, therefore, be sufficient to permit the mould to be formed to the desired shape and to retain this shape even after the hot metal is poured in the mould.

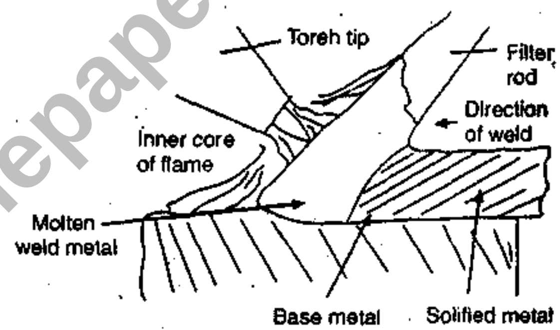
Tbis property of a sand in green or moist state is known as green strength.

The strength of a sand that has been dried or backed is called dry strength.

(6) Refractorlness: The sand must be capable of with standing the high temperature of the molten metal without fusing. Molding sands with poor refractoriness may burn on the casting. Refractoriness is measured by the center point of the sand rather than its melting point.

Q.2. (C) What is the principle of gas welding? Explain different types of oxyacetylene flames.

Ans. Principle of Gas Welding: Gas welding is done by buming a combustible gas with air or oxygen in a concentrated flame of high temperature. As with other welding methods the purpose of the flame is to heat and melt the parent mental and fuels rod of a joint. It can weld most common materials. Equipment is inexpensive, versatile, and serves adequately in many job and general repair shop.



Gas Flames: The correct adjustment of the flame is important for reliable works. When oxygen and accytylene are supplied to the torch in nearly equal volume, a natural flame is produced having a maximum temperature of 3200°C. This natural flame is desired for most welding operations, but in certain cases a slightly oxydizsing flame, in which there is an excess of O_2 or slightly carburizing flame, in which there is an excess of accetylene is needed. The condition of flame is readily determined by its appearance.

A neutral flame has two definite zones–

(*i*) A sharp brilliant cone extending a short distance from the tip of the torch and

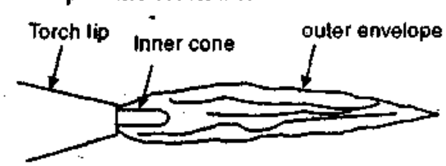


Fig. Neutral flame

(*ii*) A outer cone or envelope only faintly luminous and of a bluish colour. The first one develops heat and second protect the molten metal from oxidation. The neutral flame is widely used for welding steel, stainless steels , cast iron, copper aluminium etc.

A carburizing flame is one in which there is an excess of accetylene. The flame has three zones.

Fig. Carburizing flame

(*i*) The sharply defined inner cone, (*ii*) an intermediate cone of whitish colour and (*iii*) The bluish outer cone. The length of the intermediate cone in an indication of the proportion of excess accetylene in the flame. When welding steel, this will tend to give the steel in the weld a higher carbon contents then the parent metal, resulting in the hard and brittle welds.

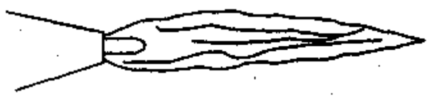


Fig. Oxidizing flame

An oxidizing flame is one in which there is an excess of O_2. This flame has two zones. (*i*) The small inner cone which has purplish tinge and (*ii*) the outer cone or envelope. In the case of oxidizing flame the inner cone is not sharply defined as that of neutral or carburizing flame. This flame is necessary for welding brass. In steel, this will result in a large grain size, increased brittleness with lower strength and elongation.

Q.2. (*D*) What are the objectives of plant layout? Explain different types of layout with their advantages and disadvantages.

Ans. Objective of Plant layout :

(*i*) Material handling and transportation is minimized and efficiently controlled.

(*ii*) Bottlenecks and points of congestions are eliminated.

(*iii*) Work stations are designed suitable and properly.

(*iv*) Suitable plates are allotted to production and service centres.

(*v*) The movement made by works can be minimized.

(*vi*) Waiting line of semifinished product is minimized.

(*vii*) Working conditions are safer and better.

(*viii*) There is the utilization of cubic space.

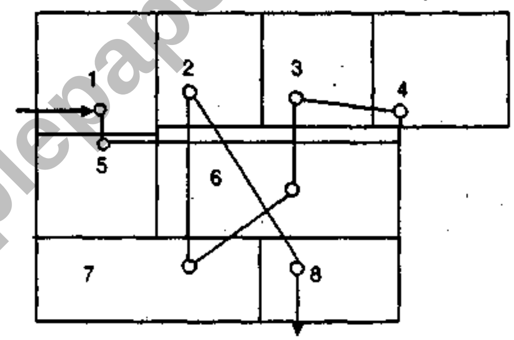
(*ix*) There are improved work methods and reduced production cycle time.

(*x*) Plant maintenance is simple.

(*xi*) There is increased productivity and better quality with reduced capital costs.

Types of Layouts

(1) Process Layout: It is also known as functional by keeping similar machines or similar operations at one location. This type of layout is generally employed for industries engaged in job order production and non repetitive kind of maintenance or manufacturing activities.



1. Store room
2. Inspection section
3. Broadcasting section
4. Milling section
5. Lathe section
6. Shaper section
7. Drill section
8. Stock room

Advantages:

(*i*) Wide flexibility exists as regards allotment of work to equipment and worker.

(*ii*) Better utilization of available equipments.

(*iii*) Less no. of machines are needed.

(*iv*) Better product quality.

(*v*) Varieties of job, make work more interesting.

Disadvantages:

(i) For same amount of Production it will need more space.

(*ii*) Automatic material handling is extremely difficult

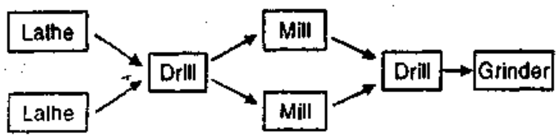
(*iii*) More imprecise inventory exists.

(*iv*) Completion of same product takes more time

(*v*) Production control becomes difficult

(*vi*) It needs more inspection and efficient designations

(*d*) Product Layout: It also known as line layout. It implies that various operations on raw material are performed in a sequence and the machines are placed along the product flow line. This type of layout is preferred for continuous production, *i.e.*, involving a continuous flow of in process material towards the finished product stage.



Advantages:

(*i*) Less space requirements for the same volume of production.

(*ii*) Automatic material handling is very easy

(*iii*) Less in process inventory.

(*iv*) Product completes in lesser times

(*v*) Better co-ordination and simple production planning and control.

(*vi*) Smooth and continuous work flow.

(*vii*) Less skilled workers may serve the purpose

Disadvantages:

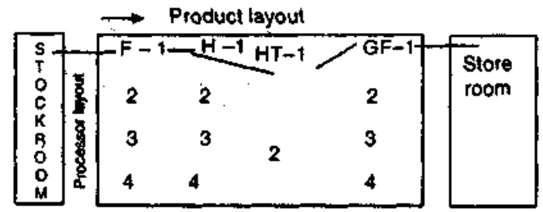
(*i*) The flexibility of layout is reduced.

(*ii*) The production rate well depends upon the slowest machine.

(*iii*) The failure of one machine hamper the line.

(*iv*) It is difficult to increase production capacities of the production lines.

(3) Combination Layout: It is the combination of product and process layouts. In this most of the manufacturing sections are arranged in process layout with manufacturing lines occurring here and there where ever the conditions permit. A combination layout is possible where an item is being made in different types and sizes. In such cases machines are arranged in a process layout but the process grouping is then arranged in a sequence to manufacture various types and sizes of product. The point to note is that no matter the product varies in size and types, the sequence of operations remains same or similar.



F = Forging H = Hobbing Ht = Heat treatment GF = Gear finishing.

It has all the advantages of product and process layout.

4. Fixed Position Layout: Layout by fixed position of product is inherent in ship building, aircraft maintenance and big pressure vessels fabrication. In this type of layout men and equipment are moved to the material, which remains at one place and the product is complitated at that place.

Advantages:

(*i*) It is possible to assign one or more skilled worker to a project from start to finish in order to ensure continuity of work.

(*ii*) It involves least movement of materials

(*iii*) There is maximum flexibility

(*iv*) A no. of quite different projects can be taken with same layout.

Disadvantages:

(*i*) It usually involves a low contents of work in process.

(*ii*) There appears to be low utilization of labour and equipments.

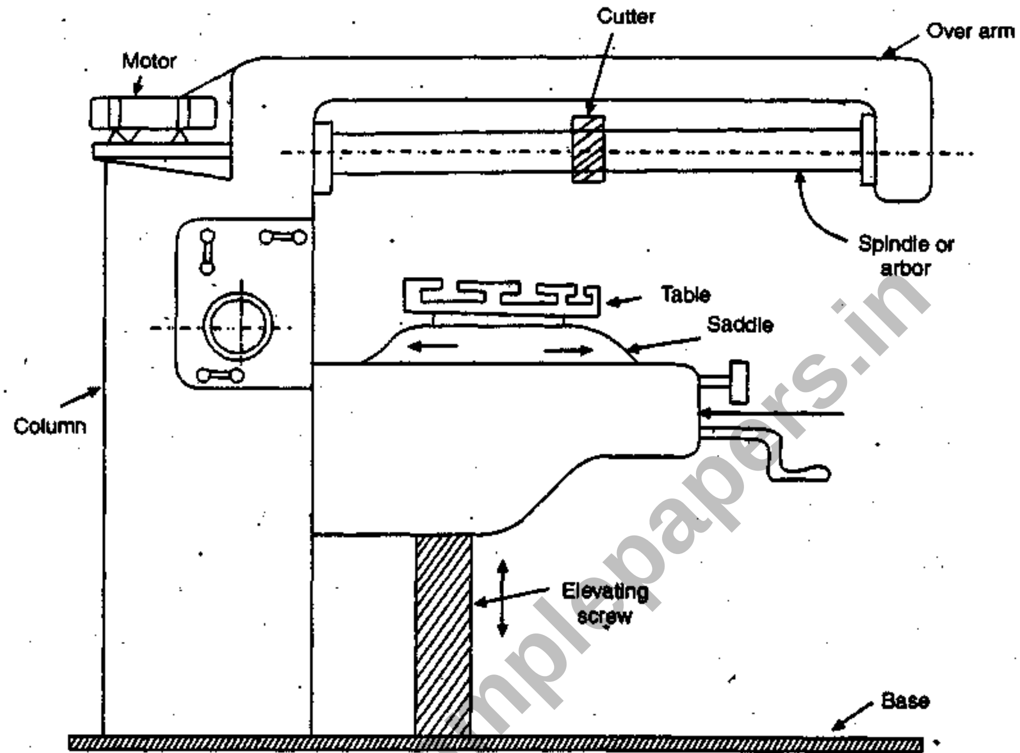
(*iii*) It involves high equipment handling costs.

Q.2. (*E*) Explain the working principle and operation of a Milling machine with neat diagram.

Ans. Milling is the process of removing metal by feeding work past a rotating milling cutter. In milling operation the rate of metal removal is rapid as the cutter rotates at a high speed and has many cutting edges. Thus the jobs are machined at a faster rate than with single point tools and surface finish is also better due to multicutting edges.

Operation and construction of milling machine.

(*i*) **Base :** It is the foundation of the machine and is that part upon which all other parts are mounted. It gives the machine rigidity and strength. Sometimes it also serves as a reservoir for cutting fluid.



(*ii*) **Column:** It is the main supporting frame. The motor and other driving mechanisms are contained within it. The front is a machined surface called the column face. It supports and guides the knee in its vertical travel.

(*iii*) **Knee:** The knee projects from the column and slides up and down on its face. It supports the saddle and table and is partially supposted by the elevating screw which adjust its height

(*iv*) **Saddle:** The saddle supports and carries the table and is adjustable transversely on ways on top of the knee. It is provided with graduations for exact movement and can be operated by hand or power.

(*v*) **Table:** The table rests on ways on the saddle and travels longitudinally in a horizontal plane. It supports the work pieces, fixture and all other equipments.

(*vi*) **Overarm :** The over arm is mounted on and guided by the top of the column. It is adjusted in and out by hand to the position of maximum support for the arbor and then clamped.

(*vii*) **Spindle:** It obtain its power from the motor through belts, gears and a clutch and transmits it to an arbor or sub arbor. Cutters are mounted directly in the spindle nose.

(*viii*) **Arbor :** It is an accurately machined shaft for holding and driving the arbor type cutter. It is tapered at one end to fit the spindle nose and has two slots to fit the nose keys for locating and driving it.

Operation performed are as follows:

(1) All kinds of grooves, straight, spiral, vertical and formal
(2) Splines and key ways on the shafts.
(3) Slots for inserting teeth in milling cutters.
(4) Flat surfaces of all kinds at any angle.
(5) Contours of infinite variety spiral elements.
(6) Concave and convex surfaces
(7) Facing operations of all kinds.
(8) Plate and barrel cams
(9) Cavities for plastic, glass or die casting moulds
(10) Forging and punch press dies

(11) Templets
(12) Jet and steam turbine buckets, root and bucket surfaces
(13) Indexing operations of all kinds: Gear teeth, slots flutes in twist drills and holes etc.

SECTION—C (2×5=10)

3. Attempt any two parts

Q.3. (A) Classify steel on the basis of carbon percentage. Also write properties and uses of them.

Ans. Classification of steel on the basis of C%

(1) Dead Mild steel	—	0.05–0.15	Chains, stampinds, rivits and nails etc.
(2) Mild steel	—	0.10–0.20	Structural steel universal beams screws etc.
	—	0.20–0.30	Machine and structural works, gears shaftings forging etc.
(3) Medium carbon steel	—	0.30–0.40	Connecting rods, axles crank hooks etc.
	—	0.40–0.50	Crank shaft, axle, Gear shaft, gears etc.
	—	0.50–0.60	Locotyres, Rail, wire ropes etc.
(4) High carbon steel,	—	0.60–0.70	Drop hammer dies, saws screw drivers.
		0.7–0.8	Band saw, anvil faces hammers, wrenches, laminated springs, cable wire, large dies for cold press.
		0.8–0.9	Rocks drills, Axes, canvas drill, taps, screw ring etc.
(5) Tool steel	—	0.9–1.10	Dies, picks, Ball bearings files, broaches, razors
	—	1.10–1.50	Boring and finishing tools, machine parts where resistance to wear is essential

Properties of Steel

Steel with C% 0.08: It has good ductility with reasonably low yield stress. It can be pressed accurately in to shapes, essentially around sharp corners.

Steel with C% 0.18: It has good impact strength in bending and torsion surface layer can be hardened to improve resistance to wear.

Steel with 1% Carbon: It is capable of being rolled into rods. It has good ductility and coils can be formed.

Q.3. (*B*) What do you mean by case-hardening? Explain different method of case hardening in detail.

Ans. This process is used to produce a high surface hardness for wear resistance supposted by a tough, shock resistance core.

It is the process of carburization, *i.e.*, saturating the surface layer of steel with carbon to about 0.9%, or some other process by which, case is hardened and core remains soft. The carburized steel is then heated and quenched, so that only the surface layers well respond, and the core remaining soft and tough since, its carbon content is low.

Different Methods of Case Hardening:

(1) Carburization: In this process, is mearly heating iron or steel or red heat, in contact with some carbonaceous materials such as wood, bone or leather charcoal, with compounds such as carbonates of barium, calcium, or sodium which are termed 'energizers'. These energizers are added with the materials to increase the concentration of carbon monoxide and thus improve the rate of carburising. Iron, at temperature close to and above its critical temperature, has an affinity for carbon. The carbon thus enters to the metal to form a solid solution with iron and converts the outer surface into a high carbon steel.

On the completion of above process the composite steel, having high carbon case and low carbon core, heated in different ways depending on the results desired. Since there is some grain growth in the steel during the prolonged carburizing treatment, the work should be heated to the critical temperature of the core and then cooled, thus, refining the core structure.

Cyaniding: In this process the low or medium carbon steel are immersed in to the molten salt bath containing cyanide maintained at 800°C to 900°C and the quenching it in oil or water. The hardness produced by this treatment is due to the presence of compounds of nitrogen as well as of carbon in the surface layer.

A bath containing $^1/_3$ each of sodium chloride, sodium carbonate, and sodium cyanide is used for the cyaniding treatment. Under average conditions, a depth of case of 0.125 mm will be produced in about 15 min at 850°C, but special salt compositions are available which enables much thicker cases to be obtained, if required.

Nitriding: It is the process of producing hard surface layer on alloys steels only. Nitriding consists essentially of heating the steel in an atmosphere of ammonia gas at temperature of 500°C to 650°C without further heat treatment. The ammonia is dissociated and the nascent nitrogen combines with elements in the steel to form nitrides. These nitrides gives extreme hardness of the surface. A hard surface layer usually from 0.2 to 0.4 mm in depth is produced in 50 hours.

Nitriding is the last operation after shaping and heat treatment process. Thus, after forging, the sequence of operations is

(*a*) oil hardening at 850°C to 900°C

(*b*) tempering at 600°C to 650°C

(*c*) Rough machining

(*d*) Stabilizing at 525°C to 550°C

(*e*) Final machining and ultimately

(*f*) Nitriding

Induction Hardening: Induction hardening has proved satisfactory for many operations as required on the bearing areas of the crankshaft, camshaft, axle shafts etc.

In this process, a high frequency current of about 2000 hertz is passed through a copper inductor block which acts as primary coil of a transformer. The block is placed around but does not touch the surface to be hardened. The hardening effects is due to the eddy current and hysteresis loss in the surface of material. The hardening temperature is about 750°C to 760°C and 790 to 800°C for alloy steel. The heated area then quenched immediately by sprays of oil through numerous small holes in the block. A depth of case approximately 3 mm is obtained in about 5 seconds.

Flame Hardening: The process of hardening steel by heating it with the flame of an oxyacetylene torch is known as flame hardening which, like the induction hardening process, is based on rapid heating and quenching of the water surface. The flame is directed to the desired part without heating the remainder of the work efficiently too affect it.

Q.3. (*C*) Differentiate cast Iron on the basis of percentage of carbon. Explain with neat diagram the construction and working of cupola furnace.

Ans. Differentiation of cast iron on the basis of C% :

(1) Grey cast Iron — 2.5 to 3.75%

(2) Malleable cast Iron — 2.20 to 3.60 %

(3) White case iron — 1.75 to 2.30%

In the grey cast iron the C is in the form of flacks

In Malleable cast iron the C is in the form of temperature

In white cast iron the C is in the form of carbide.

Cupola Furnace: Construction : A cupola is similar to a small scale blast furnace with the exception that its upper portion does not have to reduce iron oxide. For this reason, coke charges in a cupola compared to those in a blast furnace, are much smaller in proportion to the metal charges. A cupola is essentially a refractory lined vertical cylinder, open at both its top and bottom. Sizes, or inside diameters, of cupolas range from a few inches to 7 feets. Sizes down to 3 inches have been built and operated for demonstration and experimental purposes. Another shell or casing of relatively thin steel plate gives support and protection to the refractory linking. Air, from a suitable blower, comes through the blast pipe and enters a chamber called the wind box". The wind box completely encircles the cupola, and its purpose is to supply air evenly to all of buyers. From the wind box, opening called "buyers" extend through the steel shell and refractory wall to the combustion zone.

Operation: When starting up a cupola, a bottom is first prepared by closing the bottom doors and ramming in a molding sand bottom, which slopes gently toward the tap hole. Upon this sand bottom, the correct amount of coke is charged, extending upward to a predetermined height. This is the coke bed, within which the combustion will occur. When

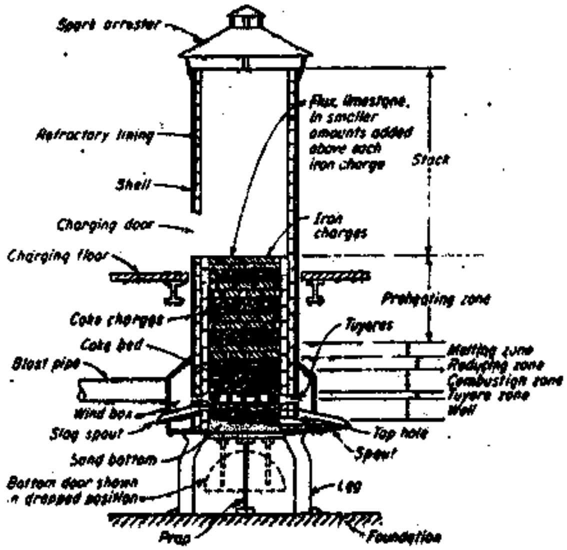


Fig. Cross-sectional view of a cupola showing principal pares and the different zones.

starting a cupola, it is important that the coke bed be built up to the correct height and ignited uniformly throughout. To accomplish this, the coke bed should be ignited near its bottom, through either the taphole or smoother opening level with the bottom. After the coke bed is properly ignited, alternate charges of lime stone, iron, and coke are charged until level with the charging door. Then the air blast is turned on, and combustion occurs rapidly with in the coke bed. With in 5 or 10 minutes after the blast is turned on, the first molten iron should appear at the taphole. Precaution should be taken to prevent the first iron from freezing in the taphole, because the taphole has not yet become adequately heated. The first iron out is often too cold to pour into sand moulds. During the cupola operation, molten iron may be tapped about every 10 min, depending upon the melting rate and the capacity of the well. As the cupola is operated, additional charges of lime stone, iron and coke are charged through the charging door when there is sufficient room for them. All of the O_2 in the air blast is consumed by the compulsion, which is completed under a curved boundary at the upper limit of the combustion zone. The chemical reaction which takes place there is

$$C + O_2 \longrightarrow CO_2 + \text{heat}$$

4. Attempt any two parts:

(A) Define weldability. Explain in brief the electric are welding and different equipment used in electric arc welding. Also explain its advantages and disadvantages.

Ans. Weldability: It has been defined as the capacity of being welded in to inseparable joints having specified properties such as definite weld strength, proper structure etc. This means, of course that it must be welded readily so as to perform satisfactory in the fabricated structure. However, the real criterion in deciding on the weldability of a metal is the weld quality and the case with which it can be obtained.

Weldability depends on one or more of five major factors.

(1) Melting point (2) Thermal conductivity (3) Thermal expansion (4) Surface condition (5) Change in microstructure.

If these metallurgical, chemical, physical and thermal characteristics of a metal are considered undesirable with respect to weldability, they may be corrected by proper fluxing material, proper fulls metal proper welding procedure, and in some cases by proper heat treatment of the metal before and after deposition.

Electric arc Welding: It is the most extensively employed method of joining metal parts. Here, the source of heat is electric arc.

The arc column is generated between an anode, which is the positive pole of dc (direct current), power supply, and the cathode, the negative pole. When these two conductors of an electric circuit are brought together and separated for a small distance (2 to 4 mm) such that the current continues to flow through a path of ionized particles (gaseous medium), called plasma, an electric arc is formed. The ionized gas column acts as a high resistance conductor that enables more ions to flow from the anode to the cathode. Heat is generated as the ions strike to cathode. However, the electrical energy is converted in to heat. Approximately 1 kwh of electricity will create 250 calories, the temperature at the centre of the arc, being 6000 to 7000°C. The

a = depth of fusion

(1) = parent metal

(2) = deposited metal

(3) = crater

(4) = electrode

temperature of electric arc of course, depends, upon the type of electrode between which it is struck.

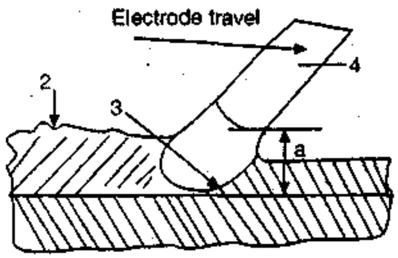


Fig. Arc welding

Equipments used in Electric Arc Welding: The most commonly used equipment for arc welding, consists of the following:

(1) AC or DC machine
(2) Electrode
(3) Electrode holder
(4) Cables, cable connectors
(5) Cable lug
(6) Chipping hammer
(7) Earthing clamps
(8) Wire Brush
(9) Helmet
(10) Safety goggles
(11) Hand gloves
(12) Aprons, sleeves, etc.

Advantages:

(*i*) Heat input to the work piece can be easily controlled by changing the arc length.

(*ii*) Workpiece distortion is negligible

(*iii*) Process can be easily mechanised.

(*iv*) Process is simple and good welding skill can be acquired in short time.

(*v*) Total welding cost is less as compared to other welding processes.

(*vi*) Equipment required for carbon arc welding is simple and easily available.

(*vii*) Process is very suitable but for welding of thinner work pieces (1 – 2 mm thickness)

Disadvantages:

(*i*) There are chance of carbon being transferred from electrode to weld metal, thus causing a harder weld deposit in case of ferrous metals.

(*ii*) In the absence of proper electrode geometry and in confined spaces arc blow results which gives poor welds with blow holes and porosity.

(*iii*) A separate files metal is needed; which (when used) slows down the welding speed.

Q.4. (*B*) Write short notes on any three of the following:

(*i*) **Soldering**
(*ii*) **Brazing**
(*iii*) **Centrifugal casting**
(*iv*) **Die casting process.**

Ans. (*i*) Soldering: It is a method of uniting two or more pieces of metal by means of a fusible alloy or metal called solder, applied in the molten state.

Soft soldering is used extensively in sheet metal work for joining parts that are not exposed to the action of high temperature and are not subjected to extensive loads. The solder mostly composed of lead and tin, hard melting range of 150 to 350°C. A suitable flux is always used in soft soldering. Its function is to prevent oxidation of the surfaces to be soldered or to dissolve oxides that settle on the metal surfaces during the heating process. A blow torch or soldering iron constitutes the equipment for heating the base metals and melting the solder and the flux.

Hard soldering employs solders which melts at higher temperature and are stronger than those used in soft soldering. In this silver alloyed with tin are used are in form of paste and are applied to the joint with a brush before heating. In hard soldering the blow torch constitutes the equipments.

(*ii*) Brazing: It is essentially similar to soldering but it gives a much stronger joint than soldering. The principal difference is the use of a harder filter metal, commercially known as spelter, which fuses at some temperature above the red heat, but below the melting temperature of the parts to be joined. Filler metals used in this process may be divided into two classes: (*i*) Cu base alloys (*ii*) Silver base alloys.

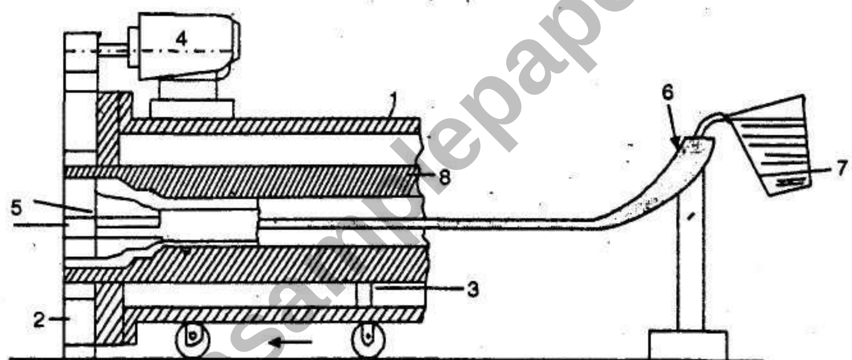
Silver base alloys having a melting range of 600 to 850°C are suitable for brazing any metals capable of being brazed. They give a clean finish and a strong ductile joint.

The parts to be joined by brazing are case fully cleaned, the flux applied, and the parts clamped in position for joining. Borax is widely used flux.

They are then heated to a temperature above the melting point of the spelter to be used, and molten spelter is allowed to flow by capillary action into the space between the parts and to cool slowly.

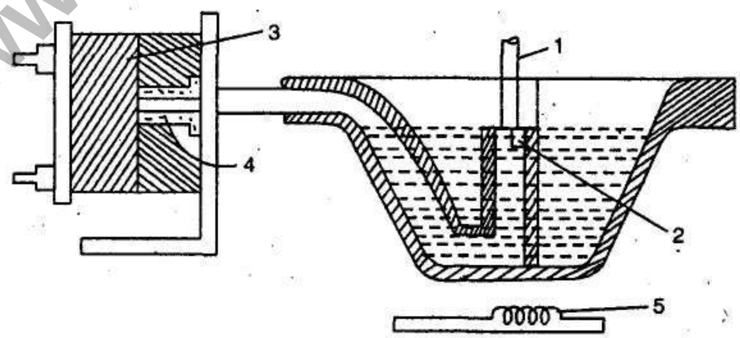
***(iii)* Centrifugal Casting :** In this casting, molten metal is poured into moulds while they are rotating. The metal falling into the centre of mould at the axis of rotation is thrown out by the centrifugal force under sufficient pressure towards the periphery, and the contaminants or impurities present being lighter in weight are also pushed towards the centre. This is often machined out any way. Solidification progresses from the outer surface to inwards, thus developing the area of weakness in the centre of the wall. This is caused by the meeting of the grain boundaries at the final solidification and the entrapment of impurities in the central section. The grain is refined and the castings are completely free from the porosity defects by the forced movement of the molten metal, thus making dense and sound casting which are less subjected to directional variations than static castings. The list of gate, feeders, and cores is eliminated, making the method less expensive and complicated.

Hollow cylindrical bodies such as cast iron, water supply and sewage pipes, steel gun barrels and other symmetrical objects such as gears, disks wheels, pulleys, are conveniently cast without core by the centrifugal casting.



(1) Casting (2) Toothed rim (3) Roller (4) Motor (5) Core (6) In gate (7) Ladle (8) Rotating mould.

***(iv)* Die Casting Process:** It is the art of rapidly producing accurately dimensional parts by forcing molten metal under pressure into split metal dies which resemble a common type of permanent mould within a fraction of a second, the fluid alloy fills the entire die including all the minute details. Because of low temperature of the die (it is water cooled), the casting solidifies quickly, permitting the die halves to be separated and the casting ejected. If the parts are small several parts may be cast at one time in what is known as multiple cavity die.



1 – Plunges

2 – Holes

3 – die

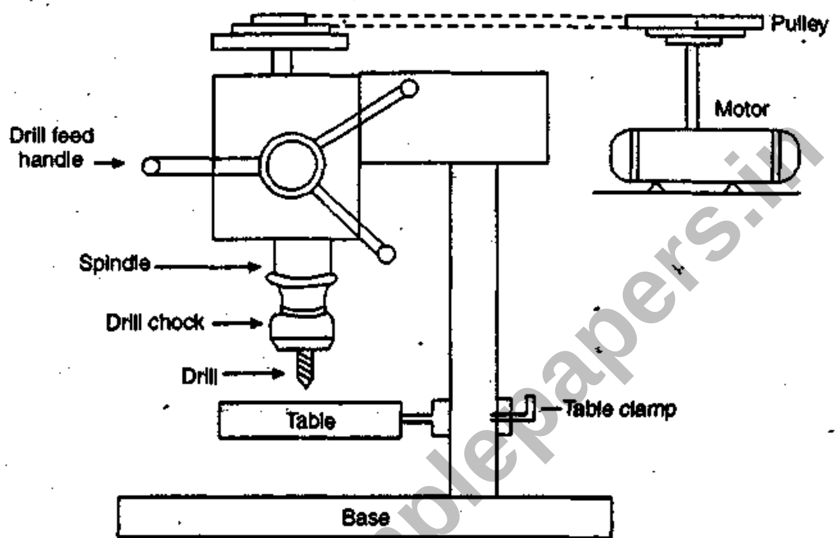
4 – Ingate

5 – Heater

This process is particularly suitable for lead, magnesium, tin and zinc alloys. The advantages of die casting practice lie in the possibility of obtaining casting of sufficiently sections that can not be produced by any other casting methods.

Q.4. (*C*) With the help of schematic diagram, describe the basic working principle and important parts of drilling machine. Also describe drilling operations.

Ans. Drilling machine is one of the simplest, moderate and accurate machine tools used in the production shop and tool room. It consists of a spindle which imparts rotary motion to the drilling tool, a mechanism for feeding the tool into the work, a table on which the work rests on a frame. It is oonsidered as single purpose machine tool since its chief function is to make holes. However, it can and does perform operations other than drill also.



Drilling is a process of making holes or enlarging a hole in an object by forcing a rotating tool called Drill. The same operation can be accomplished in some other machine by holding the drill stationary and rotating the work. The most general example of this class is drilling in a lathe, in which is drill is held in the tail stock and the work is held and rotated by a chuck.

The operation performed on the drilling machine are as follows:

(*i*) **Reaming:** It is the operation of sizing and finishing a hole by means of a reamer having several cutting edges.

(*ii*) **Boring:** It is the operation of enlarging a hole by means of an adjustable cutting tool with only one cutting edge.

(*iii*) **Counter boring:** It is the operation of enlarging the end of a hole cylindrical, in order to accommodate the screw head to that it does not protrude outside.

(*iv*) **Countersinking :** It is the operation of a cone shaper encouragement of the end of a hole.

(*v*) **Spot facing:** It is the operation of smoothing and squaring the surface around hole, as for the seat for a nut or the head of a cap screw.

(*vi*) **Tapping :** It is the operation of farming internal threads by means of a tool called a tap.

(*vii*) **Trepanning:** It is a hole making operation in which an annular groove is produced leaving a solid cylindrical case in the centre. A cutter consisting of one or more cutting edges placed along the circumference of a circle is used to produce the annular groove. It is used for holes more than 50 mm in diameter.

(*viii*) **Drilling :** It is the operation of producing a circular hole, using a drill, by removing solid metal.