I/IV B.Tech (Regular) DEGREE EXAMINATION
Scheme of evaluation

DECEMBER, 2018 **Mechanical Engineering**

First Semester **Basic Manufacturing Processes**

Time: Three Hours **Maximum :** 50 Marks

Answer Question No.1 compulsorily. (1X10 = 10 Marks)

Answer ONE question from each unit. (4X10=40 Marks)

1. Answer all questions (1X10=10 Marks)

a) What is the purpose of riser in casting?

Riser acts as a reservoir to supply additional amount of molten metal to address the shrinkage due to solidification.

b) What is directional solidification? How can it be achieved in casting

Directional solidification is to control the solidification of the molten metal such that the casting distant from liquid supply to solidify first before the last liquid region near riser is solidified. Directional solidification is achieved by using chills.

c) Differentiate semi-centrifugal and centrifuging processes

Semi-centrifugal process:

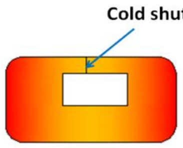
The molds are designed with risers at the center to supply feed metal to the mold cavity by centrifugal force

Centrifuging:

In centrifuge casting, the mold is designed with part cavities located away from the axis of rotation, so that the molten metal poured into the mold is distributed to these cavities by centrifugal force through runners and gates.

d) What causes cold-shut defect in casting?

When the molten metal enters into the mold from two gates and when these two streams of molten metal meet at a junction with low temperatures than they do not fuse with each other and solidifies creating a cold shut (appear as line on the casting). It looks like a crack with round edge.



e) Differentiate the two important die casting processes

There are two main types of die casting machines differentiated by how the molten metal is injected into the cavity.

(1) hot-chamber:

The metal is melted in a container attached to the machine, and a piston is used to inject the liquid metal under high pressure into the die.

(2) cold-chamber:

Molten metal is poured into an unheated chamber from an external melting container, and a piston is used to inject the metal under high pressure into the die cavity.

f) Explain the principle of resistance spot welding

When a current passes through electric resistance, it produces heat. This is same principle which is used in electric coil. The amount of heat produced is depends on resistance of material, surface conditions, current supplied, time duration of current supplied etc. This heat generation takes place due to conversion of electric energy into thermal energy.

g) Write two high energy density welding processes

1) Laser beam welding
2) Electron beam welding

h) Write short notes on forward and backward extrusion processes

Forward extrusion:

The billet that is to be extruded is placed in a container and then pushed through the die using a ram or screw. It is known as forward extrusion because the billet and the ram are moving forward in the same direction. The frictional forces are relatively high as the billet must travel the entire length of the container.

Backward extrusion:

In this process, the billet is forced through the stationary die. This is accomplished by employing a stem, which must be longer in length than the container. This process results lower friction.

i) Write the importance of clearance in designing dies and punches in sheet metal drawing

Proper clearance between the punch and die is essential for piercing a well-made hole efficiently. Too much punch and die clearance results in more rollover deformation where the punch enters the material and a large burr on the die side. With too little die clearance the fracture lines of the punch and die do not meet, thus requiring a secondary shear of the material to make the hole, and this secondary shear is at the expense of requiring more tonnage, and in severe cases within the hole it results in a second region of vertical burnish that will grip the punch as it is being extracted.

j) What is wrinkling defect in sheet metal drawing? Explain

The flange of the blank undergoes radial drawing stress and tangential compressive stress during the stamping process, which sometimes results in wrinkles.

UNIT – I

2.a) Explain patterns allowances with neat diagrams M 5

The various pattern allowances are:

1. Shrinkage or contraction allowance.

All most all cast metals shrink or contract volumetrically on cooling. The metal shrinkage is of three types:

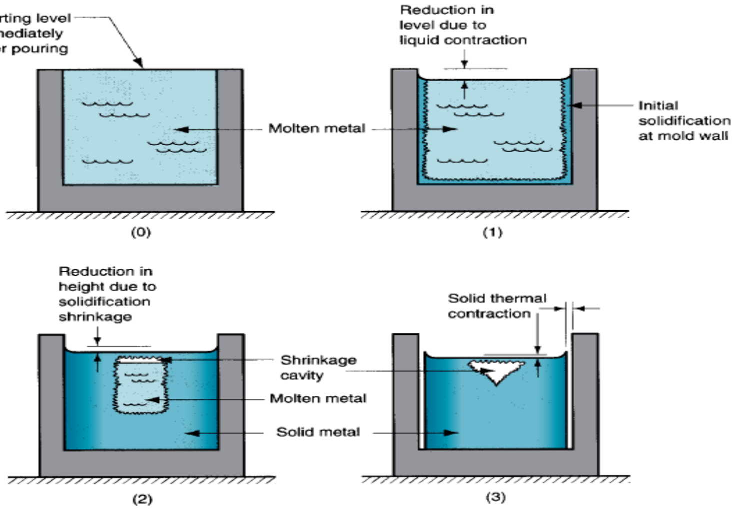
(1) liquid contraction during cooling prior to solidification;
(2) contraction during the phase change from liquid to solid, called solidification shrinkage;
(3) thermal contraction of the solidified casting during cooling to room temperature.

Liquid Shrinkage:

It refers to the reduction in volume when the metal changes from liquid state to solid state at the solidus temperature. To account for this shrinkage; risers, which feed the liquid metal to the casting, are provided in the mold.

Solid Shrinkage:

it refers to the reduction in volume caused when metal loses temperature in solid state. To account for this, shrinkage allowance is provided on the patterns.



2. **Machining or finish allowance.**

An allowance for machining is provided to the pattern due to:

i. Castings get oxidized in the mold and during heat treatment. These oxides, scales etc., need to be removed.
ii. It is the intended to remove surface roughness and other imperfections from the castings.
iii. It is required to achieve exact casting dimensions.
iv. Surface finish is required on the casting.

How much machining allowance should be provided depends on:

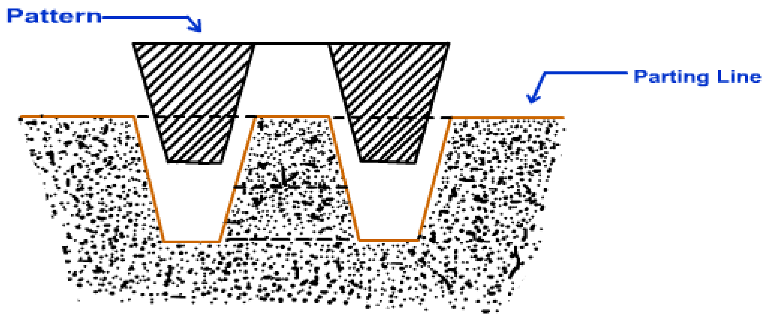
i. Nature of metals.
ii. Size and shape of casting.
iii. The type of machining operations to be employed for cleaning the casting.
iv. Casting conditions.
v. Molding process employed

3. **Draft of tapper allowances.**

- It is given to all surfaces perpendicular to parting line.
- Draft allowance is given so that the pattern can be easily removed from the molding material tightly packed around it with out damaging the mould cavity.

The amount of taper depends upon:

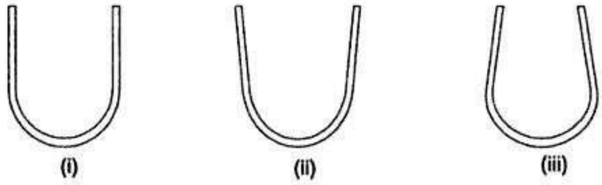
i. Shape and size of pattern in the depth direction in contact with the mould cavity.
ii. Moulding methods.
iii. Mould materials.
iv. Draft allowance is imparted on internal as well as external surfaces



4. **Distortion or chamber allowance.**

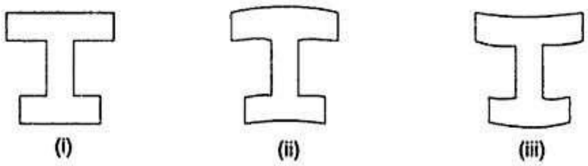
A casting will distort if:

i. It is of irregular shape,
ii. All it parts do not shrink uniformly i.e., some parts shrinks while others are restricted,
iii. It is u or v-shape,
iv. The arms possess unequal thickness,
v. It has long, rangy arms
vi. It is a long flat casting,
vii. One portion of the casting cools at a faster rate as compared to the other.



(a) *U-shaped Casting*

(i) Required shape of casting
(ii) Casting produced with distortion
(iii) Pattern provided with Camber allowance



(b) *I-section Casting*

5. **Shake or rapping allowance.**
    - A patter is shaken or rapped by striking the same with a wooden piece from side to side. This is done so that the pattern a little is loosened in the mold cavity and can be easily removed.
    - In turn, therefore, rapping enlarges the mould cavity which results in a bigger sized casting.
    - Hence, a – ve allowance is provided on the pattern i.e., the pattern dimensions are kept smaller in order to compensate the enlargement of mould cavity due to rapping.
    - The magnitude of shake allowance can be reduced by increasing the tapper.

2.b) What are the important properties required for a sand to be used as mould material? Explain M 5

GREEN STRENGTH:

- It is the strength of the sand in moist condition.
- Sufficient strength along with toughness.
- Not destroyed or collapsed even after removing the pattern
- Poor dimensional stability and accuracy with poor green strength

DRY STRENGTH:

- Strength of the moulds in the dry condition (moisture free)
- Dry sand must have strength to resist erosion and also the static pressure of the molten metal.
- Should resist the mold enlargement

HOT STRENGTH:

- Retaining the strength at the elevated temperatures in the presence of hot molten metal
- Metalloid static pressure of the liquid metal may cause mold enlargement,
- During metal flow, erosion, cracks, or breakages may occur unless the sand posses adequate hot strength

PERMEABILITY:

- Evolving steam and other gases
- The mold must be permeable, i.e. , porous to permit the gases to escape.
- Depends on the size, shape, moisture content etc.

THERMAL STABILITY:

- Heat from the casting causes rapid expansion of the sand surface at the mold-metal interface.
- The mold surface may crack or buckle unless the molding sand is relatively stable dimensionally under rapid heating.

REFRACTORINESS:

- Resistance to withstand its physical, mechanical and chemical properties at high temperature
- The absence of melting, softening, or adherence of the sand to the casting makes for better casting surface and easier cleaning of the casting.

FLOWABILITY:

- The sand should pack well/flow under load.
- Sands of low flowability may result in non-uniform hardness.
- After removing the load, the sand should hold the shape.

COLLAPSIBILITY:

- The molding sand should also have collapsibility so that during the contraction of the solidified casting it does not provide any resistance, which may result in cracks in the castings.
- Besides these specific properties the molding material should be cheap and reusable

ADHESIVENESS:

- Adequate bonding between the sand and the flask
- This enable the mould to retain in a box

COHESIVENESS:

- Ability of the sand particles to stick each other
- Poor cohesiveness results breaking of mould when molten metal is poured
- This depends on grain size and clay content.

(OR)

3.a) What is core? and explain the properties required for a core sand M 5

Cores:

- Castings are often required to have holes, recesses etc. of various sizes and shapes.
- Cores are used for making holes or cavities or recesses, which cannot normally be produced by pattern alone.
- These cores are obtained by using core sand; cores are separately made, in boxes known as core boxes.

Characteristics of Core and Core Sand:

- *Green strength:* Core sand should be strong enough to retain the shape till it goes for baking.
- *Dry strength:* It should have adequate dry strength so that when the core is placed in the mould, It should be able to resist the metal pressure acting on it.
- *Refractoriness:* Since in most cases, the core is surrounded all around it is desirable that the core material should have higher refractoriness.
- *Permeability:* Some of the gases evolving from the molten metal and generated from the mould may have to go through the core to escape out of the mould. Hence cores are required to have higher permeability.
- *Collapsibility:* As the casting cools, it shrinks, and unless the core has good collapsibility it is likely to provide resistance to against shrinkage and thus cause hot tears.
- *Smoothness:* The surface of the core should be smooth so as to provide a good surface finish to the castings

3.b) Discuss briefly: i) loose piece pattern, ii) cope and drag pattern, iii) skeleton pattern, iv) sweep pattern and v) gated pattern. M 5

UNIT – II

4.a Explain i) hot chamber and ii) cold chamber die casting processes. M 5

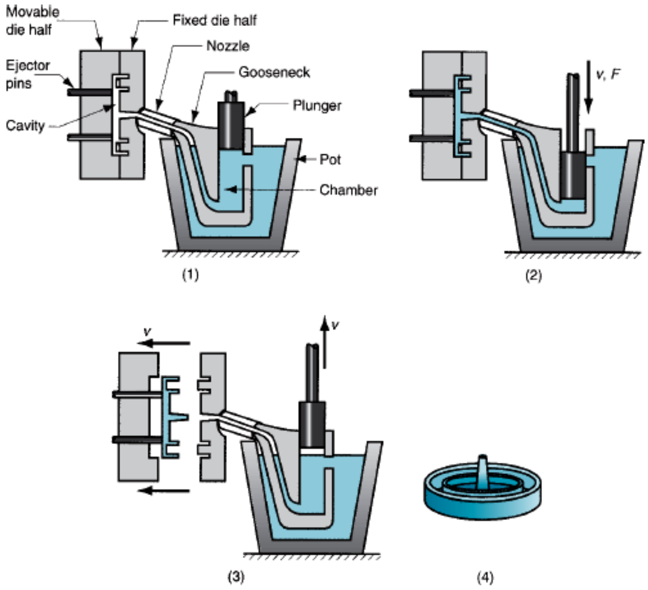
There are two main types of die casting machines differentiated by how the molten metal is injected into the cavity.

Hot chamber casting:

(1) with die closed and plunger withdrawn, molten metal flows into the chamber;

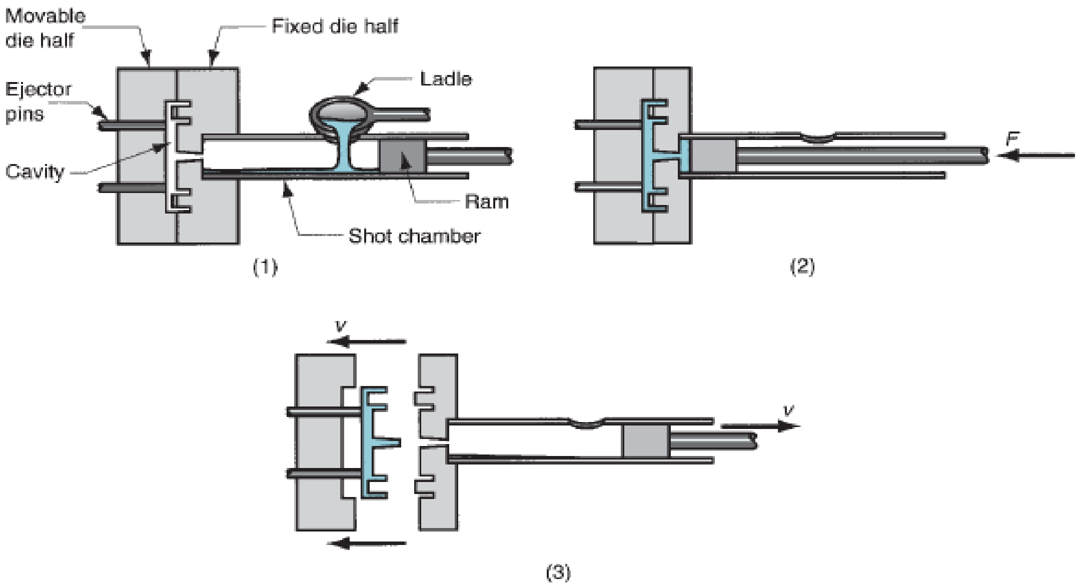
(2) plunger forces metal in chamber to flow into die, maintaining pressure during cooling and solidification;

(3) plunger is withdrawn, die is opened, and solidified part is ejected. Finished part is shown in (4).



Cold-chamber casting:

(1) with die closed and ram withdrawn, molten metal is poured into the chamber;
(2) ram forces metal to flow into die, maintaining pressure during cooling and solidification; and
(3) ram is withdrawn, die is opened, and part is ejected. (Gating system is simplified.)



4.b Define and discuss the reasons and remedies of casting defects: i) misrun, ii) drop, iii) pin holes, iv) metal penetration and v) hot tears M 5

i). Misrun

When the molten metal solidifies before completely filling the mold cavity and leaves a space in the mold called as misrun.

Causes

(i) Low fluidity of the molten metal.
(ii) Low temperature of the molten metal which decreases its fluidity.
(iii) Too thin section and improper gating system.

Remedies

(i) Increasing the pouring temperature of the molten metal increases the fluidity.
(ii) Proper gating system
(iii) Too thin section is avoided.

ii). Drop

Drop defect occurs when there is cracking on the upper surface of the sand and sand pieces fall into the molten metal.

Causes

(i) Soft ramming and low strength of sand.

(ii) Insufficient fluxing of molten metal. Fluxing means addition of a substance in molten metal to remove impurities. After fluxing the impurities from the molten metal can be easily removed.

(iii) Insufficient reinforcement of sand projections in the cope.

Remedies

(i) Sand of high strength should be used with proper ramming (neither too hard nor soft).

(ii) There should be proper fluxing of molten metal, so the impurities present in molten metal is removed easily before pouring it into the mold.

(iii) Sufficient reinforcement of the sand projections in the cope.

iii). Pinholes

They are very small holes of about 2 mm in size which appears on the surface of the casting. This defect happens because of the dissolution of the hydrogen gases in the molten metal. When the molten metal is poured in the mold cavity and as it starts to solidify, the solubility of the hydrogen gas decreases and it starts escaping out the molten metal leaves behind small number of holes called as pinholes.

Causes

(i) Use of high moisture content sand.

(ii) Absorption of hydrogen or carbon monoxide gas by molten metal.

(iii) Pouring of steel from wet ladles or not sufficiently gasified.

Remedies

(i) By reducing the moisture content of the molding sand.

(ii) Good fluxing and melting practices should be used.

(iii) Increasing permeability of the sand.

(iv) By doing rapid rate of solidification.

iv). Metal Penetration

These casting defects appear as an uneven and rough surface of the casting. When the size of sand grains is larges, the molten fuses into the sand and solidifies giving us metal penetration defect.

Causes

(i) It is caused due to low strength, large grain size, high permeability and soft ramming of sand. Because of this the molten metal penetrates in the molding sand and we get rough or uneven casting surface.

Remedies

(ii) This defect can be eliminated by using high strength, small grain size, low permeability and soft ramming of sand.

v). Hot Tears or Hot Cracks

when the metal is hot it is weak and the residual stress (tensile) in the material cause the casting fails as the molten metal cools down. The failure of casting in this case is looks like cracks and called as hot tears or hot cracking.

Causes

(i) Improper mold design.

Remedies

(i) Proper mold design can easily eliminate these types of casting defects.

(ii) Elimination of residual stress from the material of the casting.

(OR)

5.a Discuss briefly any 5 design considerations for designing of gating systems in casting M 5

The following considerations are crucial while designing a gating system.

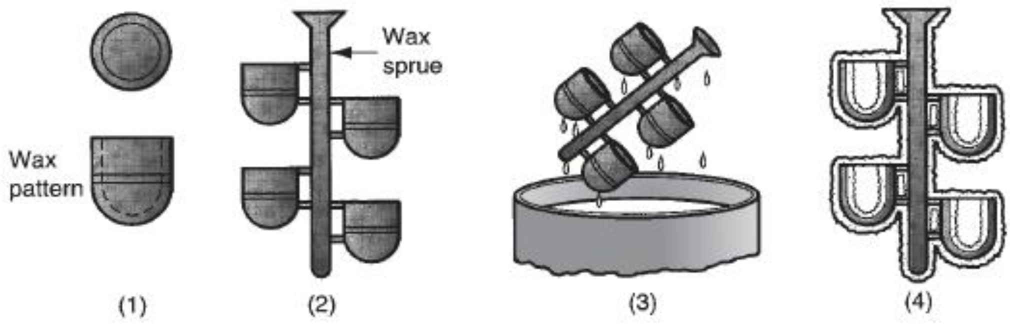
- To minimize turbulence to avoid trapping gasses into the mold
- To get enough metal into the mold cavity before the metal starts to solidify
- To avoid shrinkage
- Establish the best possible temperature gradient in the solidifying casting so that the shrinkage if occurs must be in the gating system not in the required cast part.
- Incorporates a system for trapping the non-metallic inclusions
- If **liquid metal pouring rate** is lower more time is required to fill the mold and solidification may start before filling the mold cavity
- **Super heating** can decrease the early solidification lead to more gas solubility into the molten metal
- High velocity of the molten metal erodes the surface of the mold cavity therefore needs optimum velocity

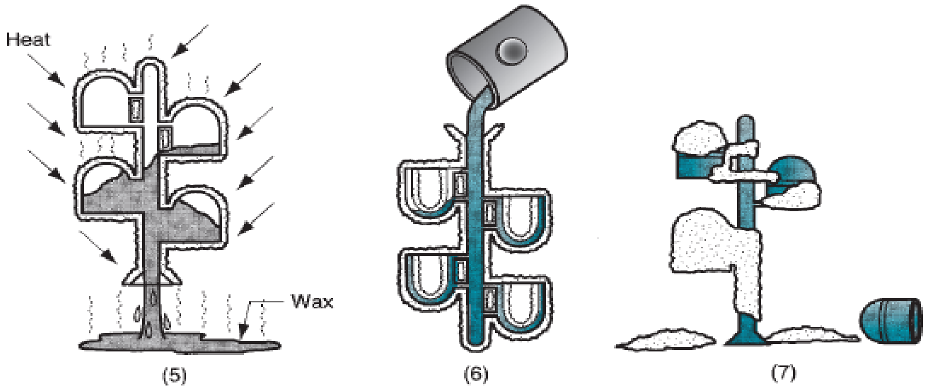
5.b Discuss with neat diagrams about investment casting with advantages and limitations M 5

In investment casting, a pattern made of wax is coated with a refractory material to make the mold, After which the wax is melted away prior to pouring the molten metal. The term investment comes from one of the less familiar definitions of the word invest, which is ''to cover completely,'' this referring to the coating of the refractory material around the wax pattern. It is a precision casting process, because it is capable of making castings of high accuracy and intricate detail. The process dates back to ancient Egypt and is also known as the lost-wax process, because the wax pattern is lost from the mold prior to casting

Steps in investment casting:

1) wax patterns are produced;
2) several patterns are attached to a sprue to form a pattern tree;
3) the pattern tree is coated with a thin layer of refractory material;
4) the full mold is formed by covering the coated tree with sufficient refractory material to make it rigid;
5) the mold is held in an inverted position and heated to melt the wax and permit it to drip out of the cavity;
6) the mold is preheated to a high temperature, which ensures that all contaminants are eliminated from the mold; it also permits the liquid metal to flow more easily into the detailed cavity; the molten metal is poured; it solidifies; and the mold is broken away from the finished casting. Parts are separated from the sprue.





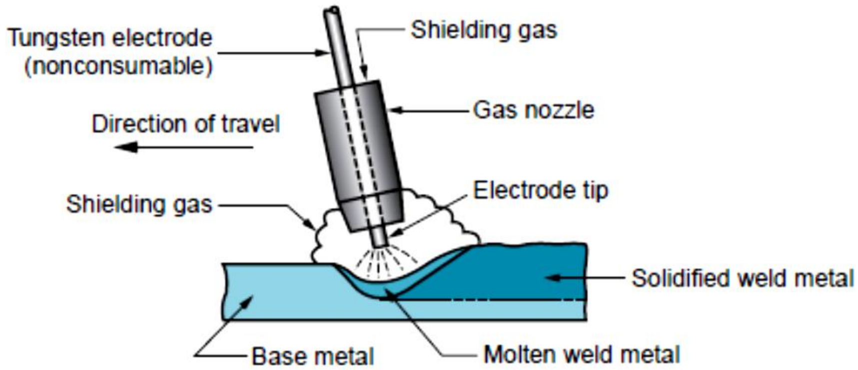
UNIT – III

6.a Explain TIG welding and discuss any two modes of polarities used in TIG welding M 5

Gas tungsten arc welding (GTAW) uses a nonconsumable tungsten electrode and an inert gas for arc shielding. The term TIG welding (tungsten inert gas welding) is often applied to this process. GTAW can be implemented with or without a filler metal. When a filler metal is used, it is added to the weld pool from a separate rod or wire, being melted by the heat of the arc rather than transferred across the arc as in the consumable electrode. Tungsten is a good electrode material due to its high melting point of 3410°C. Typical shielding gases include argon, helium, or a mixture of these gas elements. GTAW is applicable to nearly all metals in a wide range of stock thicknesses. It can also be used for joining various combinations of dissimilar metals. Its most common applications are for aluminum and stainless steel. Cast irons, wrought irons, and of course tungsten are difficult to weld by GTAW. In steel welding applications, GTAW is generally slower and more costly than the consumable electrode AW processes, except when thin sections are involved and very-high-quality welds are required. When thin sheets are TIG welded to close tolerances, filler metal is usually not added. The process can be performed manually or by machine and automated methods for all joint types. Advantages of GTAW in the applications to which it is suited include high-quality welds, no weld spatter because no filler metal is transferred across the arc, and little or no post weld cleaning because no flux is used.

Straight polarity: electrode negative and workpiece positive

Reverse polarity: electrode positive and workpiece negative



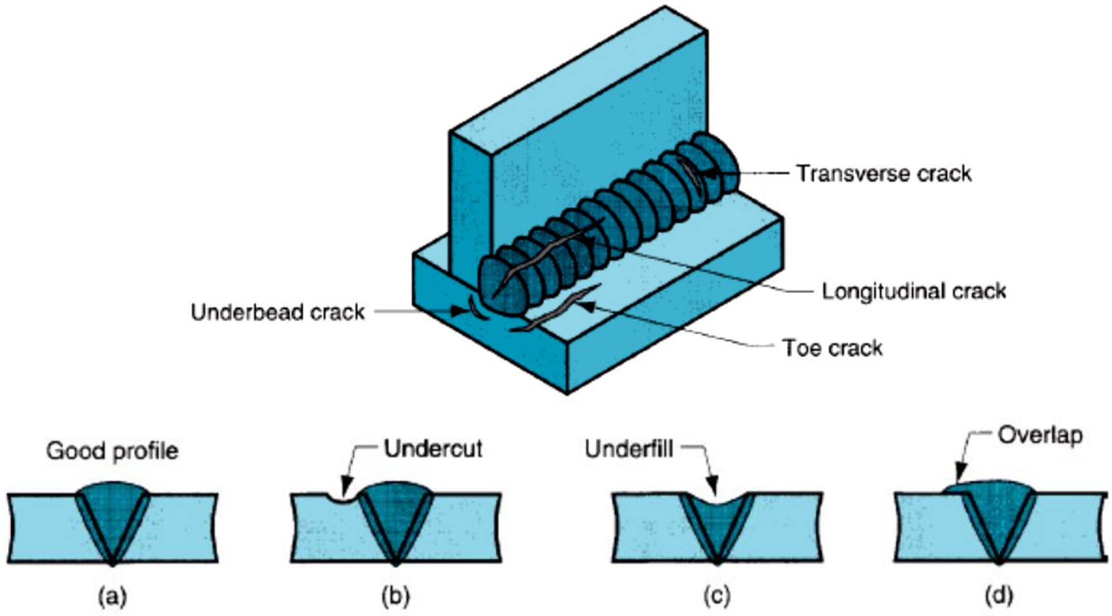
6.b Briefly discuss any five welding defects and remedies with neat diagrams M 5

Cracks. Cracks are fracture-type interruptions either in the weld itself or in the base metal adjacent to the weld. This is perhaps the most serious welding defect because it constitutes a discontinuity in the metal that significant reduces weld strength. Several forms are defined in Figure 30.32.Welding cracks are caused by embrittlement or low ductility of the weld and/or base metal combined with high restraint during contraction. Generally, this defect must be repaired.

Cavities. These include various porosity and shrinkage voids. **Porosity** consists of small voids in the weld metal formed by gases entrapped during solidification. The shapes of the voids vary between spherical (blow holes) to elongated (worm holes). Porosity usually results from inclusion of atmospheric gases, sulfur in the weld metal, or contaminants on the surfaces. **Shrinkage voids** are cavities formed by shrinkage during solidification. Both of these cavity-type defects are similar to defects found in castings and emphasize the close kinship between casting and welding.

Solid inclusions. These are nonmetallic solid materials trapped inside the weld metal. The most common form is slag inclusions generated during arc-welding processes that use flux. Instead of floating to the top of the weld pool, globules of slag become encased during solidification of the metal. Another form of inclusion is metallic oxides that form during the welding of metals such as aluminum, which normally has a surface coating of Al2O3. **Incomplete fusion.** Several forms of this defect are illustrated in Figure 30.33. Also known as lack of fusion, it is simply a weld bead in which fusion has not occurred throughout the entire cross section of the joint.Arelated defect is lack of penetration which means that fusion has not penetrated deeply enough into the root of the joint.

Imperfect shape or unacceptable contour. The weld should have a certain desired profile for maximum strength, as indicated in Figure 30.34(a) for a single V-groove weld. This weld profile maximizes the strength of the welded joint and avoids



(OR)

7.a Explain principles of oxyacetylene welding with neat diagrams M 5

Oxyacetylene welding (OAW) is a fusion-welding process performed by a high-temperature flame from combustion of acetylene and oxygen. The flame is directed by a welding torch. A filler metal is sometimes added, and pressure is occasionally applied in OAW between the contacting part surfaces.

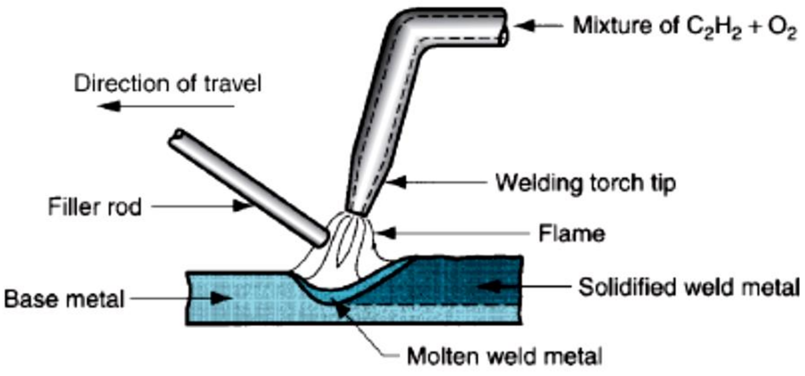
Acetylene (C2H2) is the most popular fuel among the OFW group because it is capable of higher temperatures than any of the others up to 3480°C. The flame in OAW is produced by the chemical reaction of acetylene and oxygen in two stages. The first stage is defined by the reaction

C2H2 + O2 → 2CO + H2 + heat

the products of which are both combustible, which leads to the second-stage reaction.

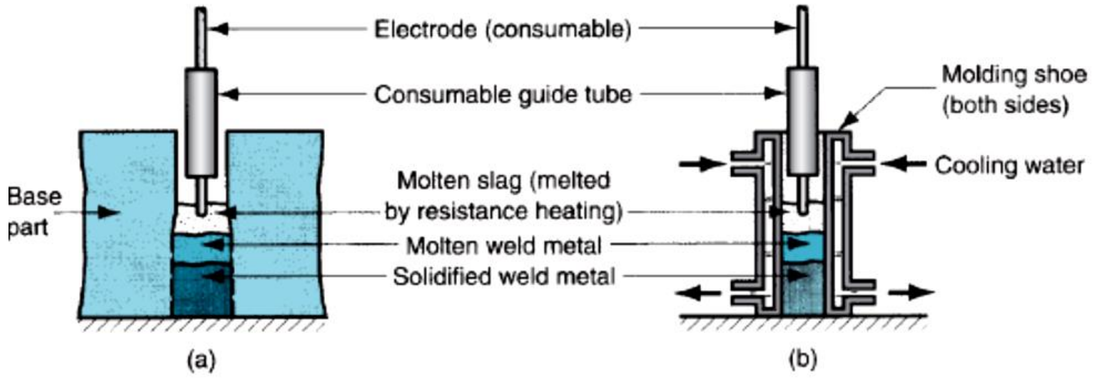
2CO + H2 + 1:5O2 → 2CO2 + H2O + heat

The two stages of combustion are visible in the oxyacetylene flame emitted from the torch.



7.b What is electro slag welding? Explain with neat diagram M 5

This process uses the same basic equipment as in some arc-welding operations, and it utilizes an arc to initiate welding. However, it is not an AW process because an arc is not used during welding. Electroslag welding (ESW) is a fusion-welding process in which coalescence is achieved by hot, electrically conductive molten slag acting on the base parts and filler metal. As shown in Figure, the general configuration of ESW is similar to electrogas welding. It is performed in a vertical orientation (shown here for butt welding), using water-cooled molding shoes to contain the molten slag and weld metal. At the start of the process, granulated conductive flux is put into the cavity. The consumable electrode tip is positioned near the bottom of the cavity, and an arc is generated for a short while to start melting the flux. Once a pool of slag has been created, the arc is extinguished and the current passes from the electrode to the base metal through the conductive slag, so that its electrical resistance generates heat to maintain the welding process. Since the density of the slag is less than that of the molten metal, it remains on top to protect the weld pool. Solidification occurs from the bottom, while additional molten metal is supplied from above by the electrode and the edges of the base parts. The process gradually continues until it reaches the top of the joint.



UNIT – IV

8.a Discuss i) hot working and ii) cold working of metals M 5

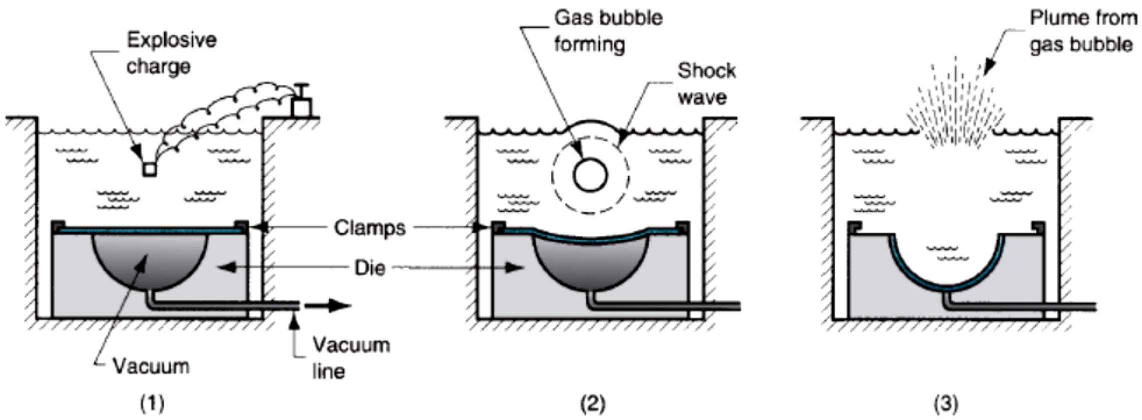
i). **Hot working** (also called hot forming) involves deformation at temperatures above the recrystallization temperature (Section 3.3). The recrystallization temperature for a given metal is about one-half of its melting point on the absolute scale. In practice, hot working is usually carried out at temperatures somewhat above 0.5Tm. The work metal continues to soften as temperature is increased beyond 0.5Tm, thus enhancing the advantage of hot working above this level. However, the deformation process itself generates heat, which increases work temperatures in localized regions of the part. This can cause melting in these regions, which is highly undesirable. Also, scale on the work surface is accelerated at higher temperatures. Accordingly, hot working temperatures are usually maintained within the range 0.5Tm to 0.75Tm.

ii). **Cold working** (also known as cold forming) is metal forming performed at room temperature or slightly above. Significant advantages of cold forming compared to hot working are (1) greater accuracy, meaning closer tolerances can be achieved; (2) better surface finish; (3) higher strength and hardness of the part due to strain hardening; (4) grain flow during deformation provides the opportunity for desirable directional properties to be obtained in the resulting product; and (5) no heating of the work is required, which saves on furnace and fuel costs and permits higher production rates. Owing to this combination of advantages, many cold forming processes have become important mass-production operations. They provide close tolerances and good surfaces, minimizing the amount of machining required so that these operations can be classified as net shape or near net shape processes

8.b Discuss i) explosive forming ii) electromagnetic forming with neat diagrams M 5

i). i) explosive forming

Explosive forming involves the use of an explosive charge to form sheet (or plate) metal into a die cavity. One method of implementing the process is illustrated in Figure 20.45. The workpart is clamped and sealed over the die, and a vacuum is created in the cavity beneath. The apparatus is then placed in a large vessel of water. An explosive charge is placed in the water at a certain distance above the work. Detonation of the charge results in a shock wave whose energy is transmitted by the ater to cause rapid forming of the part into the cavity. The size of the explosive charge and the distance at which it is placed above the part are largely a matter of art and experience. Explosive forming is reserved for large parts, typical of the aerospace industry.



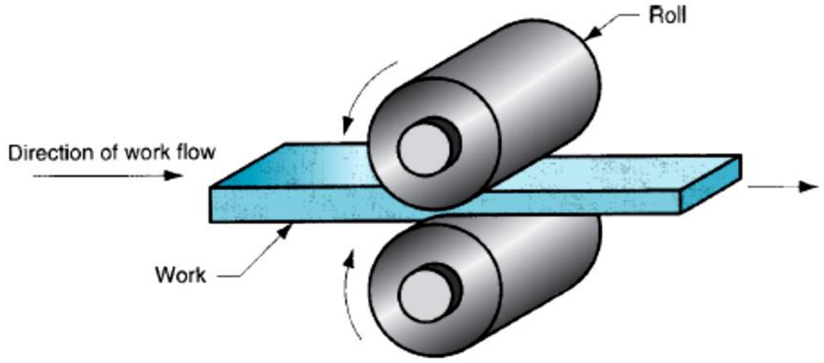
ii). electromagnetic forming

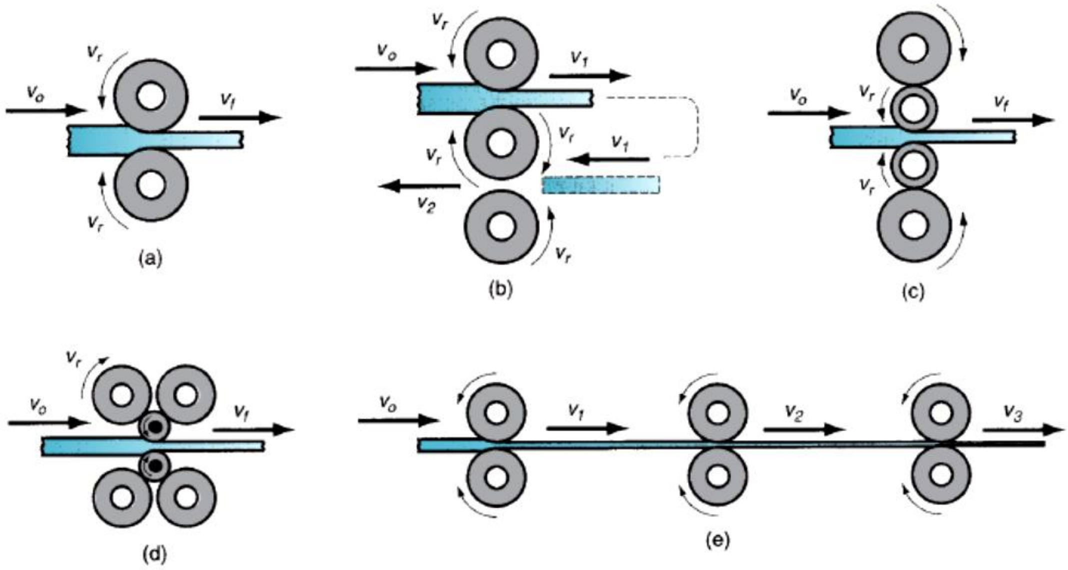
Electromagnetic forming, also called magnetic pulse forming, is a process in which sheet metal is deformed by the mechanical force of an electromagnetic field induced in the workpart by an energized coil. The coil, energized by a capacitor, produces a magnetic field.This generates eddy currents in the work that produce their own magnetic field. The induced field opposes the primary field, producing a mechanical force that deforms the part into the surrounding cavity. Developed in the 1960s, electromagnetic forming is the most widely used HERF process. It is typically used to form tubular parts.

(OR)

9.a What is rolling? Discuss various types of rolling mills with neat diagrams

Rolling is a deformation process in which the thickness of the work is reduced by compressive forces exerted by two opposing rolls. The rolls rotate as illustrated in Figure to pull and simultaneously squeeze the work between them. The basic process shown in our figure is flat rolling, used to reduce the thickness of a rectangular cross section M 5





Various configurations of rolling mills: (a) 2-high, (b) 3-high, (c) 4-high, (d) cluster mill, and (e) tandem rolling mill.

9.b Discuss the methodology to measure cutting forces in i) blanking and ii) punching M 5

Estimates of cutting force are important because this force determines the size (tonnage) of the press needed. Cutting force F in sheet metalworking can be determined by

$$F = StL$$

where S = shear strength of the sheet metal, MPa (lb/in2); t = stock thickness, mm (in), and L= length of the cut edge, mm (in). In blanking, punching, slotting, and similar operations, L is the perimeter length of the blank or hole being cut. The minor effect of clearance in determining the value of L can be neglected. If shear strength is unknown, an alternative way of estimating the cutting force is to use the tensile strength:

$$F = 0:7(TS)tL$$