CBCS Scheme

USN 1 Q R 1 7 M E 4 2 1 **15ME35A**

Third Semester B.E. Degree Examination, Dec.2017/Jan.2018
Metal Casting and Welding

Time: 3 hrs. Max. Marks: 80

Note: ***Answer FIVE full questions, choosing one full question from each module.***

Module-1

1 a. What is Casting? Briefly discuss steps involved in making of castings. **(06 Marks)**
b. What is Pattern? What are the functions of pattern? **(04 Marks)**
c. What are the different allowance given to the pattern? Explain briefly. **(06 Marks)**

OR

2 a. What are the ingredients of moulding sand? Explain briefly. **(04 Marks)**
b. With a neat sketch, explain Shell moulding process. **(06 Marks)**
c. Describe the working operation of squeeze type moulding machine. **(06 Marks)**

Module-2

3 a. What are the zones in cupola? With a neat sketch, explain cupola furnace. **(08 Marks)**
b. What is the principle of Electric Arc Furnace? Explain with sketch. **(08 Marks)**

OR

4 a. Differentiate between Gravity and pressure die casting. **(04 Marks)**
b. With a neat sketch, explain the working principle of Hot – Chamber die casting method. **(06 Marks)**
c. Explain with neat sketch, Centrifugal casting process. **(06 Marks)**

Module-3

5 a. Define Solidification. **(02 Marks)**
b. Explain Nucleation process in Solidification of metals. **(06 Marks)**
c. What is Degasification in liquid metals? Explain the methods of Degasification, with neat sketches. **(08 Marks)**

OR

6 a. Explain briefly Sand Casting defects. **(04 Marks)**
b. What are the advantages and limitations of Aluminum castings? **(06 Marks)**
c. Sketch and explain Stir casting setup. **(06 Marks)**

Module-4

7 a. How welding process is classified? **(04 Marks)**
b. Explain with sketch, principle of Flux Shielded Metal Arc Welding. **(06 Marks)**
c. Explain Submerged Arc Welding. **(06 Marks)**

OR

8 a. Explain principle of Resistance Welding. **(04 Marks)**
b. With a neat sketches, explain : i) Spot Welding ii) LASER Welding. **(08 Marks)**
c. Explain Thermit Welding. **(04 Marks)**

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

Module-5

9 a. Explain different zones which are formed during welding process. (08 Marks)

b. What are Welding defects? Explain the methods to detect the welding defects. (08 Marks)

OR

10 a. Differentiate between Soldering and Brazing. (04 Marks)

b. Explain with a sketch, Principle of Oxy – Acetylene Welding. (06 Marks)

c. Explain the methods used for Inspection of casting and welding. (06 Marks)

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Module : 01

1. (a) Where solid metal is melted to proper temperature and is then poured into a Refractory mould with a cavity of the shape to be made and allowing it to solidify for pre-determined time so as to take the shape of the mould. After complete solidification, it is taken out from the Refractory mould either by breaking the mould or by taking the mould part. the solidified object is known as casting.

Steps Involved in Making of casting.

(i) Mould sand preparation.

Mould sand mixture is prepared by using base sand. binder, water and other ingredients and this mixture is used to prepare mould cavity with the help of pattern.

(ii) pattern Making.

It is the duplicate copy of the object to be cast and is made up of wood. metal, wax or other materials with the help of special tools.

(iii) preparation of Mould.

Mould is produced by Ramming sand mixture around a pattern placed in a support or flask.

(iv) core preparation.

If the casting is to be hollow. Additional patterns are called core. that are placed in the mould cavity to form the interior surfaces and sometimes the External surfaces as well of the casting.

(v) Melting and pouring.

Metal is Melted in the furnace. the molten Metal is poured into the Mould cavity and allowed to solidify.

(vi) cleaning.

Includes all the operations Required to Remove the gates and Risers that constitute the gating or feeding System and to Remove the adhering Sand.

(vii) Inspection and testing.

Inspection follows, to check for defects in the casting as well as to ensure that the casting has the dimensions Specified on the drawing and or Specifications.

(b) A pattern is a Replica of the product, constructed in Such a way that it can be used for forming an impression of Required Shape and Size called mould cavity in Sand damp.

Functions of pattern

⇒ pattern is used to prepare mould cavity for casting.

⇒ Runner, gats, and Riser are incorporated in the pattern and may form a part of the pattern.

⇒ core prints are Required to develop on pattern to provide Seats for cores.

⇒ pattern is need to Establish parting line and parting Surface in the mould.

⇒ Good pattern can Reduces the cost of the casting.

(c) pattern Allowance

(i) Shrinkage or Contraction Allowance
(ii) Draft or Taper allowance
(iii) Machining allowance
(iv) Distortion allowance
(v) Rapping allowance.

(i) Shrinkage or Contraction Allowance

In casting process, Solidification of the molten metal takes place. All the metals or Alloys undergo decrease in volume during solidification. Certain allowances must be given on the sizes specified in the finished component drawing so that a casting.

Shrinkage allowance is an allowance added to the pattern, to compensate for the metal shrinkage that takes place while the metal solidifies.

(ii) Draft or Taper Allowance

Draft is meant the taper provided by the pattern maker on all vertical surfaces of the pattern so that pattern can be Removed from the sand without tearing away the sides of the sand mold.

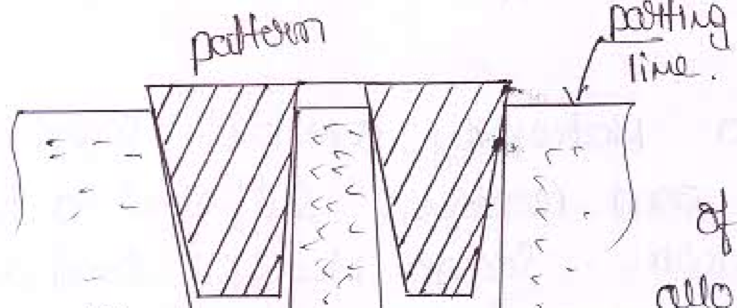


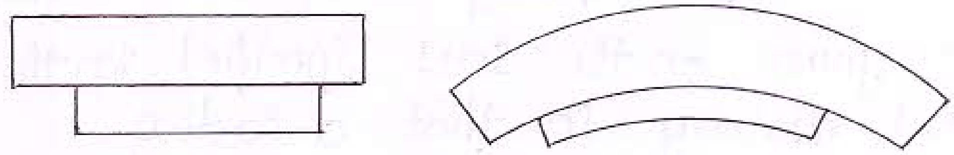
figure is an illustration of a pattern with proper draft allowance. Here, the moment pattern lifting commences, all of its surfaces are well away from the sand surface.

(iii) Machining or Finish allowance

For good surface finish, machining of casting is Required, the dimensions gets Reduces after machining. Hence the size of the pattern is made larger than the Required. For machining Extra metals are needed. This Extra metal is called machining allowances. This allowance is given in addition to shrinkage allowance.

(iv) Distortion or camber allowance

Sometimes castings get distored, during Solidification. due to their typical Shape. For Example, if the casting has the form of the letter. U, V, T or L etc --



(v) Rapping or Shaking Allowances.

To Remove the pattern from the mould cavity, pattern is Rapped with the help of draw spike so that they can be detached from the mould. But due to Excessive Rapping the size of the cavity in mould gets enlarged.

2.

(a) Ingrediends of Moulding Sand.

(i) Natural Sand.

It is a Naturally available sand. is directly used for moulding and contains Sufficient amount of clay and moisture. Some Natural sand Required 5 to 8% water for mixing before making the mould.

(ii) Synthetic Sand.

It is artificially prepared sand mixture by using proper composition of clay binder and other material as Required. This Sand has better casting properties like permeability & Refractoriness.

(iii) Special Sand

Molding sand is prepared by using Special base sands are silicon, Zircon, olivine, chromite are mixed with binders and water.

Some of the important molding sands are Explained

(i) Green sand.

The sand in its natural or moist state is called green sand. It is a mixture of silica sand with 18 to 25% of clay, having moisture content from 6to8%.

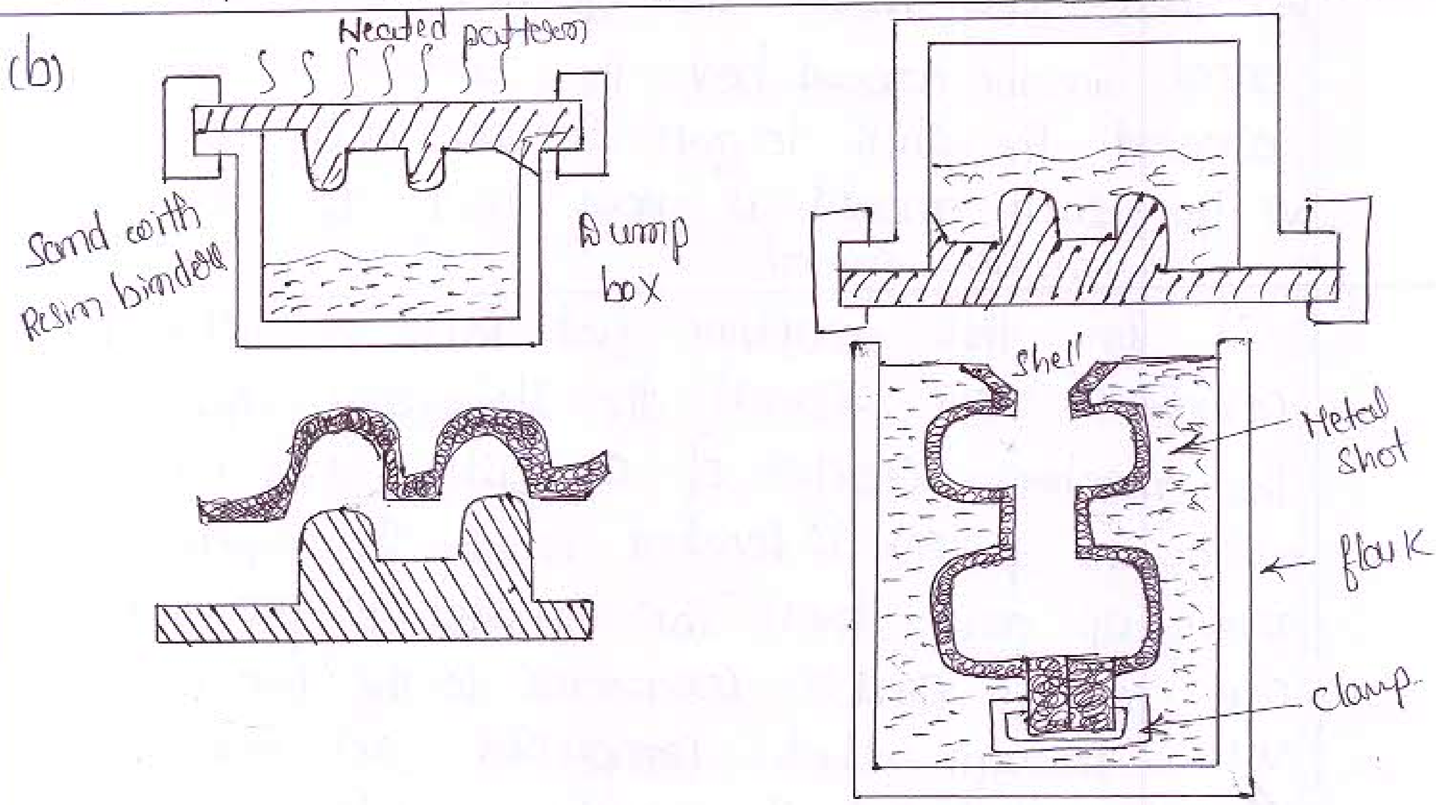
(ii) Dry sand.

The sand in its dried state is called dry sand. Here dextrin is used up to 2% with clay and water to prepare sand mixture. Hence prepared green sand has been dried or backed in suitable oven after the making mould.

(iii) Loam sand.

Loam is mixture of sand and clay with water to a thin plastic paste. Loam sand constist higher percentage of clay as much as 20-30% and 18% water

(b)



Shell Moulding

It is a Special type of Sand casting process and also known as coring process. In this process, Sand mixture consists of washed and dried fine Sand, 3-4% thermo-Setting binder like urea or phenol - formaldehyde Resin.

Steps involved in operation

(i) The prepared Sand mixture is taken in damp box. the metal pattern is heated upto 175° to 350°c in an oven, which facilitates easy Removal of the Shell from the pattern. Then pattern is placed on top of a damp box.

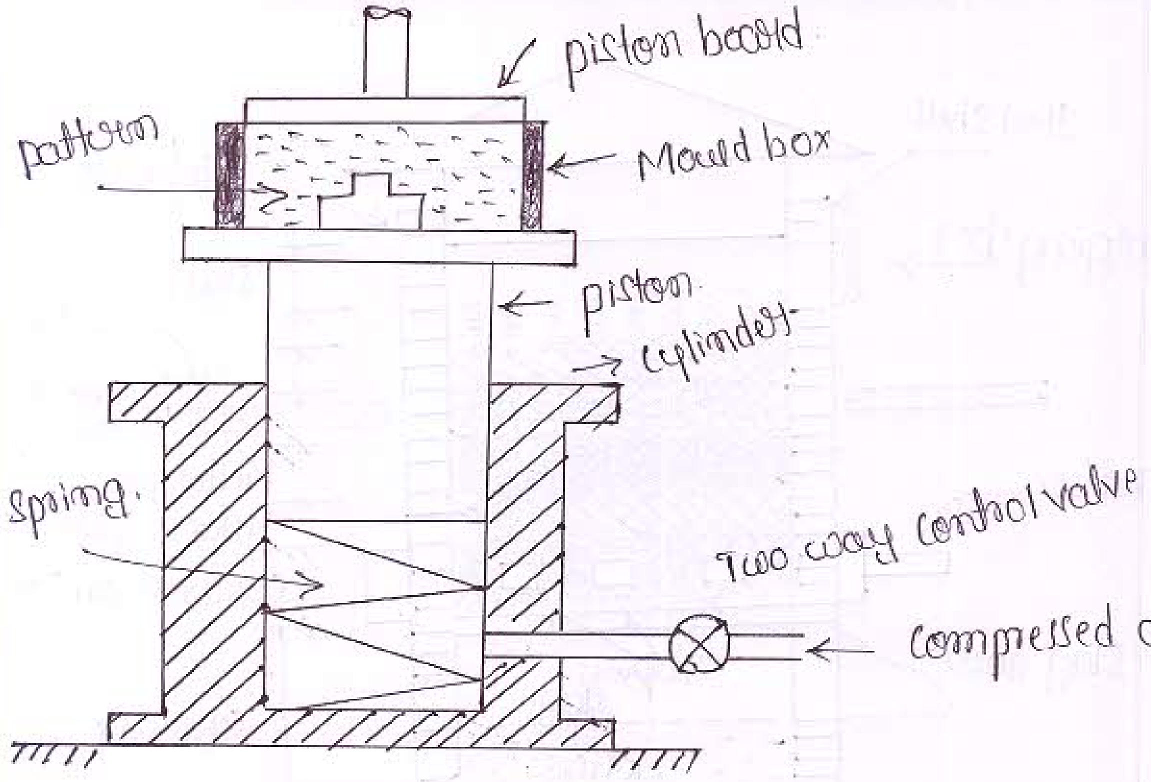
(ii) A dump box along with pattern is inverted for short time. The Sand mix is damped on the heated metal pattern in 30 Sec. the shell of 6mm to 18mm thick is formed and is depends on the pattern temperature.

(iii) Now pattern along with shell is cured in an oven at 300°c for 1 to 3 minutes to make the Shell strong.

(iv) Then two halves are joined with clamps and are placed in the mould box. The backing sand is Rammed around the shell to give Support in a flask.

(v) The shell mould is now Ready to Receive the molten metal.

(C) In this machine flat table is lifted by the compressed air against the stationary squeezing head. The machine consist of a piston and cylinder mechanism. The piston is located inside the cylinder that can move up and down. The cylinder is provided with only one passage and is connected to the two way controlling valve. though which compressed air enters the cylinder or it escapes out. The pattern plate and mould box are clamped to the flat table and the table along with mould box are mounted on a piston.



A stationary head is fixed over the mould box will squeeze the sand when the piston moves upward. the machine is firmly fixed on concrete base. Schematic arrangement of Jolting machine.

Module-02

3.

(a) Cupola zones

⇒ Combustion or Oxidizing zone

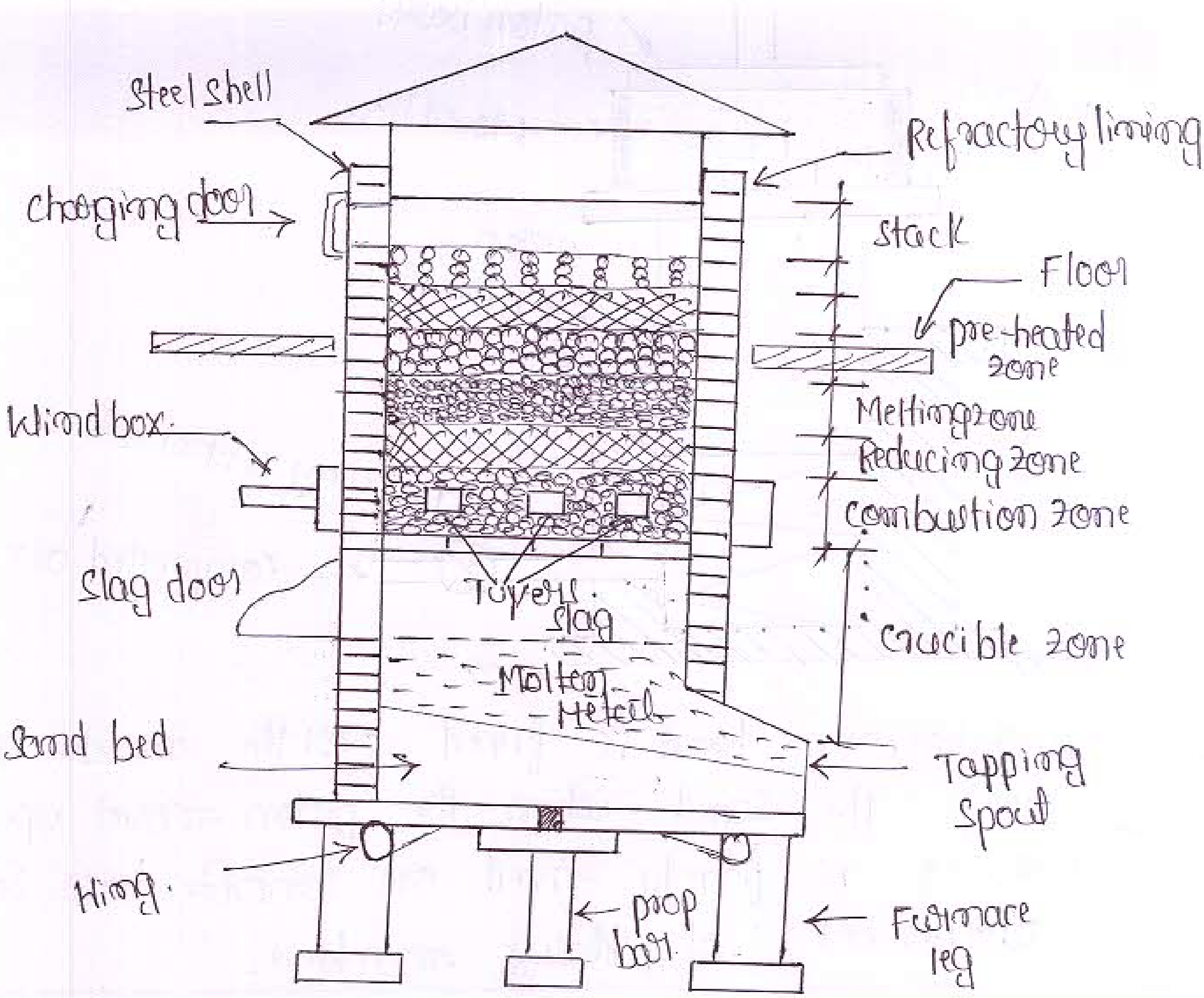
⇒ Reducing zone

⇒ Melting zone

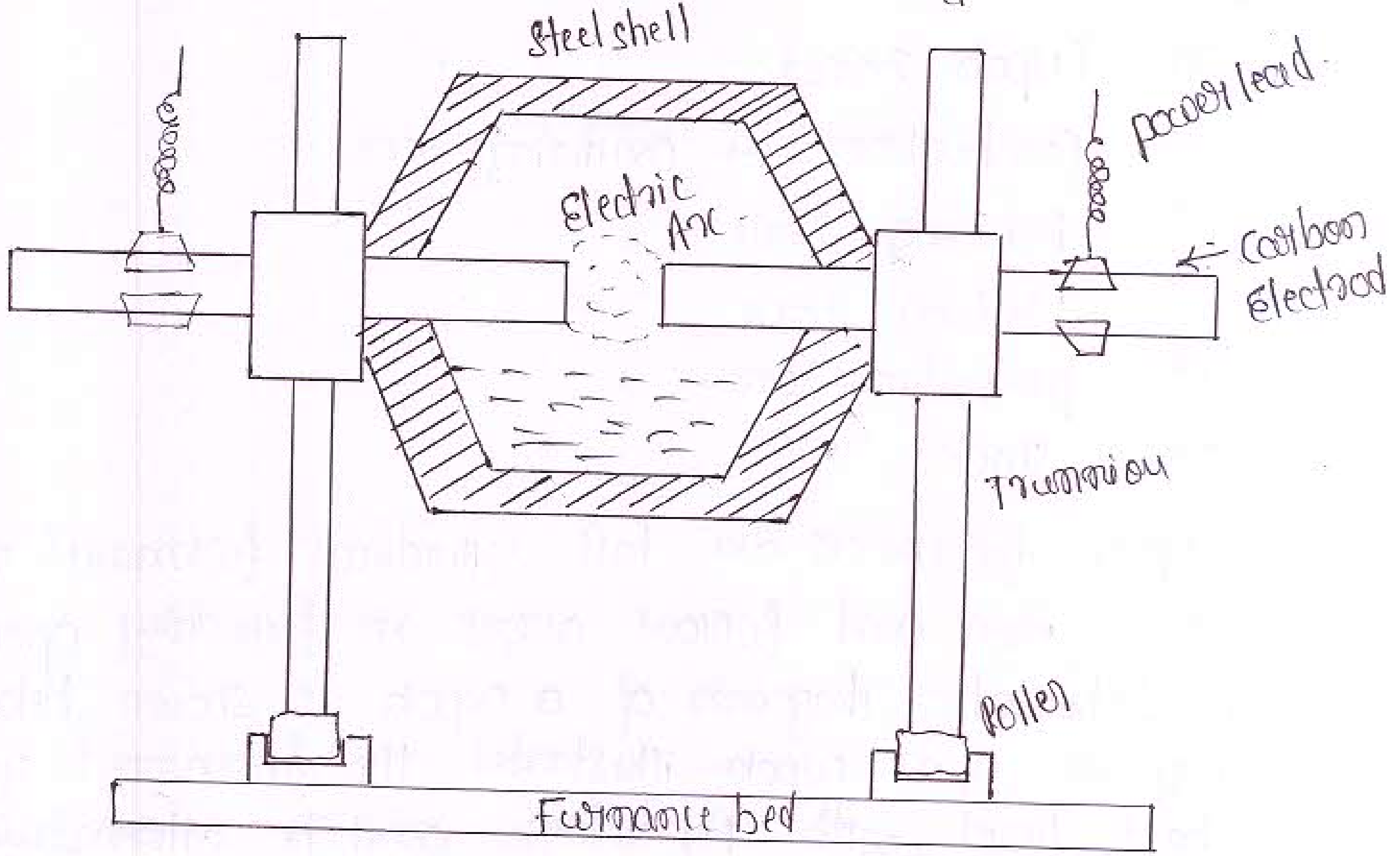
⇒ preheating zone

⇒ Stack.

Cupola furnaces are tall. cylindrical furnaces used to melt iron and ferrous alloys in foundary operations. A Schematic diagram of a cupola is shown below. This diagram of a cupola illustrates the furnace's cylindrical shaft lined with Refractory and the alternating layers of coke and metal scrap. The molten metal flows out of a spout at the bottom of the cupola.



(b) Indirect Arc Electric melting Furnace



Construction

(i) This furnance consists of a Horizantal Steel Shell lined with Refractory fire bricks. The furnance shell is mounted on trunnions and Rollers and can be tilted through 180° facilitates to easy Removal of molten metal to the ladle.

(ii) Two carbon electrodes are mounted along the Horizantal axis and these Electrodes can be Removed Horizantally in and out so as to maintain desired Arc distance between them as shown in fig.

Working

(i) The ingots and shell scrap are charged into the furnac throught the charging door and door is closed.

(ii) The power supply is turned on. an arc is generated by strucking the tips of the both the electrodes each other

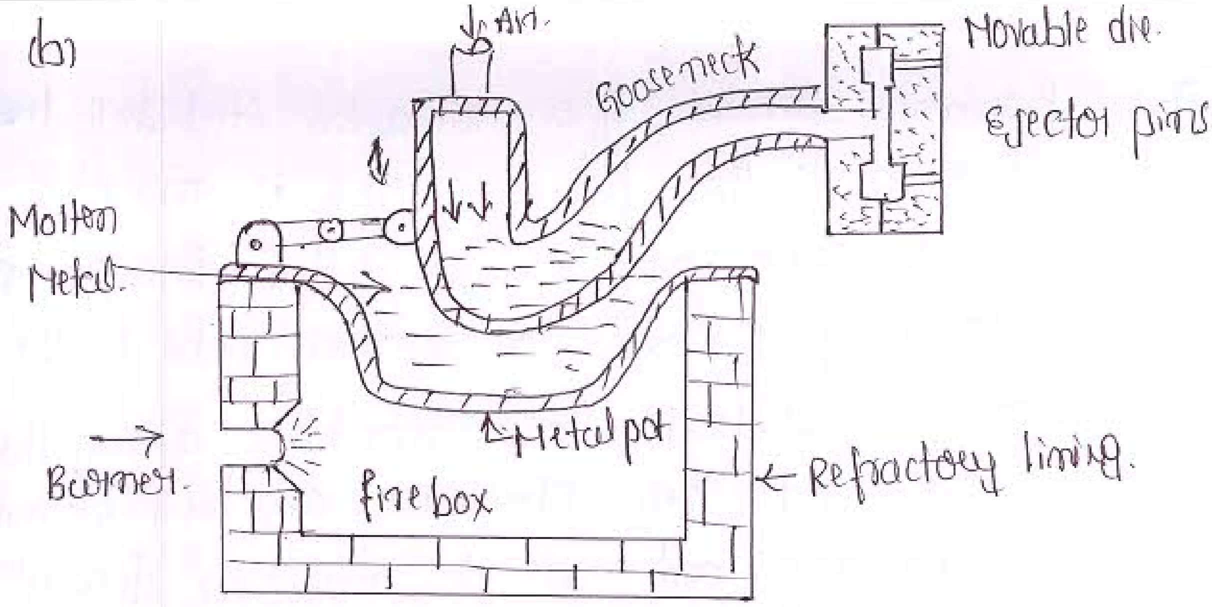
(iii) The heat is generated due to Arcing between Electrodes, Arcing temp of 3000°c is generated which is transferred to the metal charge.

(iv) The metal below the electrodes starts melting. gradually it melts Remaining metal in the furnance As the charge starts melting. the flux Reacts to form slag containing all the impurities.

(4).
(a)

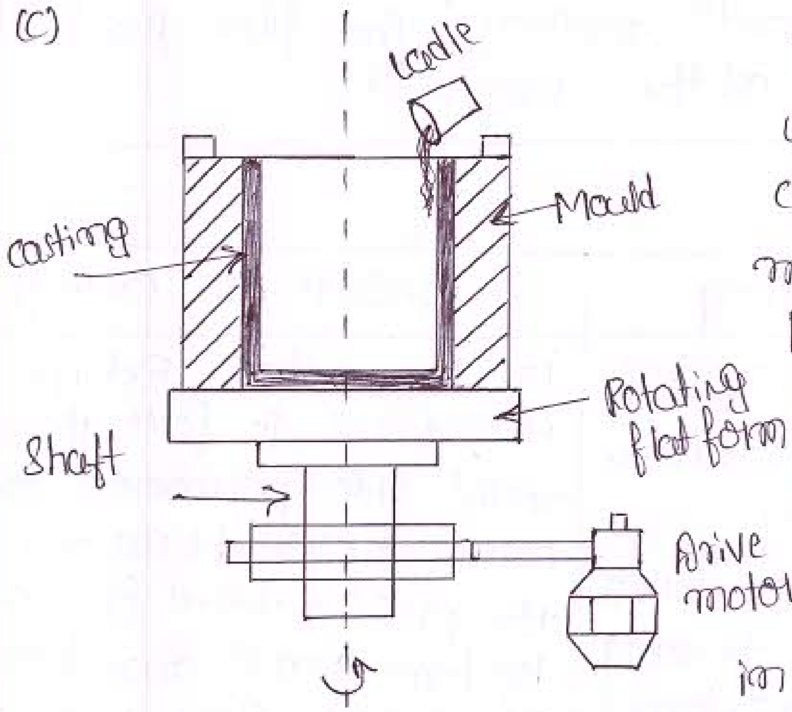
Gravity die casting	pressure die casting.
In this moulds are madeup of metals. are permanent & can be used Repeatedly. In this casting method. molten metal is poured into the mold under gravity. only no External pressure is Applied to force.	In this method. External pressure is Required to force the molten metal into permanent mold is caued pressure die casting. In this the pressure varies from 20 to 2000 kgf/cm^2 and is maintained till solidification stage is Reached.

(b)



In hot chamber die casting method, the goose neck melting pot is included within the machine and is operated by a lifting mechanism. Initially goose neck is immersed in the molten metal and is filled by gravity. Then it is raised as too bring the nozzle in contact with die casting and is locked in that position. compressed air is then supplied from the top of the neck to force the molten metal into the mould and pressure is maintained till solidification. when solidification is complete. goose neck is lowered down to eject the casting with the help of ejector pins.

(C)



True centrifugal casting is used to produce hollow cylindrical castings without making use of cores like pipes, liners and symmetric hollow body. Hexagonal, square, Round etc. contours on the outside and cylindrical inside can be easily produced in castings.

Module : 08

5.
(a) Solidification is the process where liquid metal transforms into solid upon cooling. Transformation from liquid to solid metal is accomplished by a shrinkage in the volume.

(b) Solidification in pure metal takes place in two stages

(i) Nucleation of minute crystal

(ii) Growth of these crystals into grains

Nucleation : Molten Metal posseses high Energy and atoms have high mobility. As the liquid metal cools the atoms gradually loose its Energy and Reestablish the atomic bond b/w atoms. therefore Small cluster of atoms formed at several places in the molten metal and are known as Nuclei. It is the number of nuclei formed during the stage of nucleation which decides the final grain structure.

Crystal Growth : This is the stage where molten metal continues to solidify around the Nuclei which are already formed. The Nuclei and the metal Solidifying around them continiously Release latent heat which it had Aquired during melting. This heat is Absorbed by the Surrounding molten metal and therefore for solidification to continue more and more heat to be Extracted.

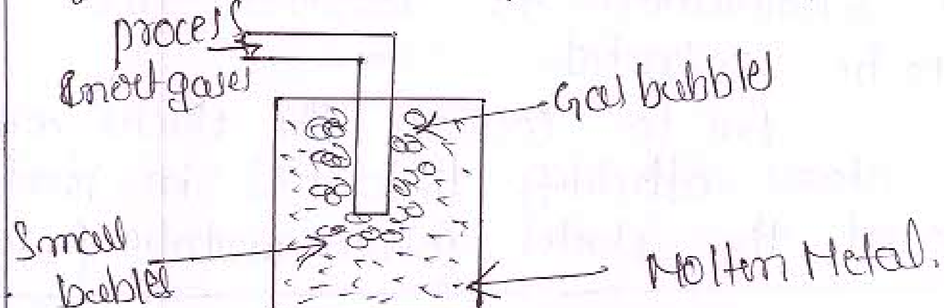
Due to cooling the Nuclei will grow Rapidly with atoms attaching themselves in identical layers around the Nuclei forms dendritic formation

(c) Degasification is the process of Removal of gas from molten metals or alloys.
Degasification may be carried out in different ways:

(i) Use of flux: Fluxes are employed to Remove the gases from the molten metal. Degasification by using flux is suitable only for non-ferrous Metals. The Surface of molten metal is covered with fluxes and gas dissolution can be prevented mixture of chloride with or without fluorides are used as fluxes.

(ii) Flux Washing process: In this process, gases from the molten metal is Removed by dissolution of fluxes. Here molten metal is subjected to the agitation with flux and ensure proper dissolution of flux within molten metal. the dissolved flux material Removes the gases from metal.

(iii) Degassing using Inert gases: Dissolved gases from the molten metal can be Removed by using inert gases. Inert gases introduced into the molten metal under pressure. Results formation of large numbers of Small bubbles within the molten metal. These bubbles creates low pressure Region into which the dissolved gases gets diffuses. Bubbles along with dissolved gases floats to the top are also Removed during the process.



(iv) Vaccum Degassing : The gases from the molten metal can also be Removal by vaccum degassing method.

The amount of gas dissolved in the molten Metal is a function of partial pressure of the Surrounding atmosphere

i.e $S \propto \sqrt{P}$

Gases from the molten metal can be Removed by Reducing surrounded atmospheric pressure.

6.

(a) casting defects

(i) porosity.

causes of porosity

⇒ High coring temperature
⇒ Less flux used
⇒ Gas desired in metal charge

Remedies

⇒ Maintain proper pouring temperature
⇒ Increase flux proportions.

(ii) Metal penetration

causes

⇒ use of large grain size
⇒ soft Ramming of Mould
⇒ pouring temp of Metal too high

Remedies

⇒ use sand having finer gain sand.
⇒ provide Hard Ramming
⇒ Maintain proper pouring temperature

(iii) Mis Run

when the Metal is unable to fill the mould cavity completly and thus leaving unfilled portion called Miss Run which occurs due to Insufficient fluidity of the molten Metal.

(b) Advantages of Aluminium castings

⇒ A wide Range of mechanical properties. Strength, Hardness, and other properties may be greatly altered by alloying and /or heat treatment.

⇒ Architectural and decorative value.

⇒ Corrosion Resistance

⇒ Nontoxicity

⇒ Electrical Conductivity.

⇒ Easy of Machining

⇒ Lower casting shipping costs per piece.

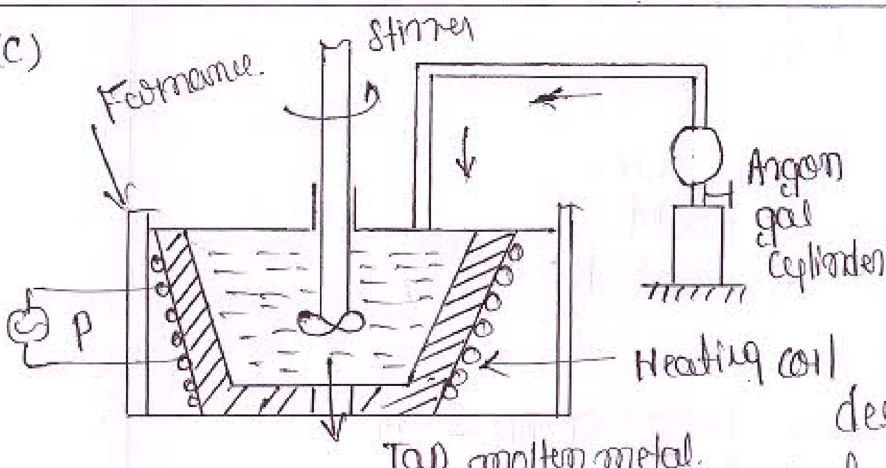
Limitations of Aluminium castings

⇒ Lack of Resistance to abrasion and wear

⇒ Absence of Aluminium alloys which can develop the combination of high tensile strength, toughness obtainable in ferrous alloys.

⇒ Lack of Resistance of severe corrosion to the degree offered by numerous copper- and nickel-base alloys and stainless steels.

(c)



In the stir casting process, the alloy matrix say aluminium, is melted at a controlled temperature and the desired quantity of Reinforcement material is added to the molten alloy. Argon is usually used as the gas carried gas to assist injection of the Reinforcements in clean form. The molten alloy is stirred continuously to create a vortex to force the slighty lighter particles into the melt. Stirring again to disperse the Reinforcement particles as uniformly as possible in a short time.

Module : 04

7.

(a) Welding processes are classified based on the basic principles employed as;

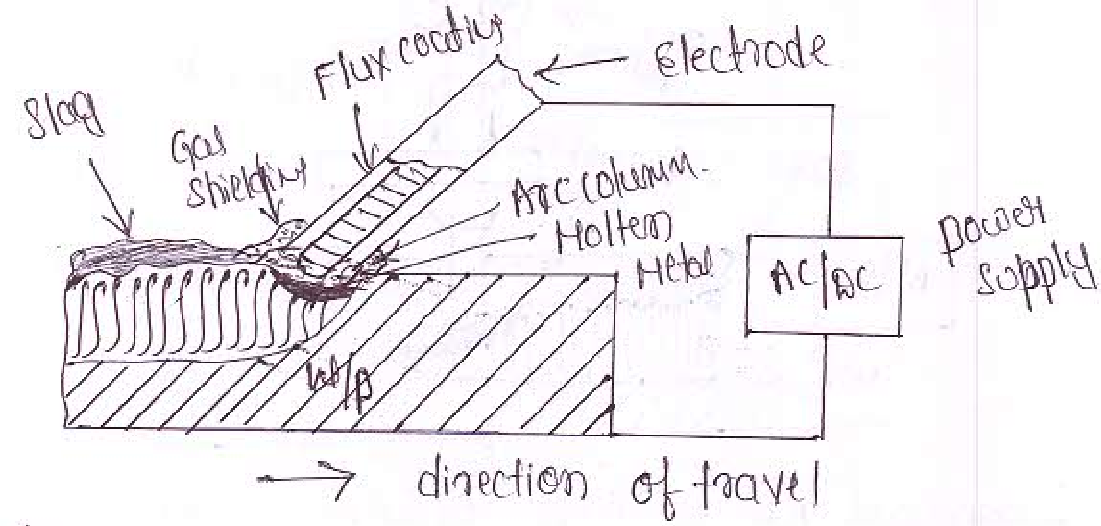
⇒ plastic welding: The parts to be joined are heated only up to the plastic state and then fused together by applying the external pressure

Ex: Forge welding, Resistance welding etc --

⇒ Fusion welding: The joint is made by melting the parts at the interface so that after solidification. the components are fused of joined together.

Ex: Arc welding, gas welding etc --

(b)



principle

(i) At first the job is cleaned and all types of contaminates like grease, oil, dirt, scale and paint are removed. The surfaces of the electrodes are also made very clean.

(ii) During operation the bare metal end of the welding stick is clamped in an electrode holder connected to the positive pole of power source and negative pole is connected to the workpiece.

(iii) Welding commences as an arc is struck between a tip of a consumable electrode and the workpiece Region

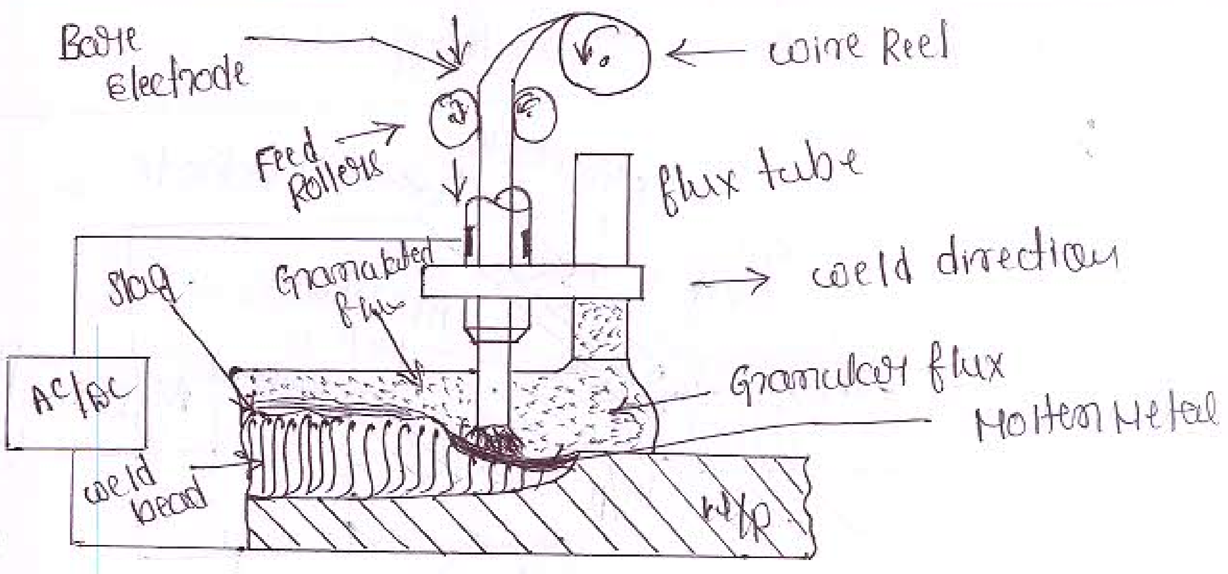
Where welding is needed.

(iv) An Arcing temperature is of the order 3000° to 5000°C is generated. Due to this high heat both Electrodes and workpiece tip melts simultaneously.

(V) Flux melts with the core wire and covers the surface of the molten metal and the weld pool, Excluding oxygen and nitrogen to come in their Contact.

(vi) Simultaneously the Electrode is moved along the length of the workpiece to complete the joint, then after the arc is Extinguished by increasing the gap between workpiece and the Electrode.

(C)



Submerged Arc welding or SAW is one of the most occurring arc welding processes. It needs a bare consumable metallic electrode which may be solid or tubular. The electrode should be used in a continuous approach. It should be fed continuously.

The main features of this welding is that, the arc and weld pool formed. are protected from environment contamination by the Application of blanket of granular flux. Thus this welding technique is known by the name "Submerged Arc welding". when temperatures Rises, molten flux becomes Conductive and this creates a path for electrons to flow between Electrode & workpiece.

8.

(a) principle of Resistance welding.

Resistance welding processes are pressure welding processes in which heat is generated by, when heavy current is passed for short time through a material; it offers Resistance to flow of current resulting in heating of the material. The heat generated is used to join the workpieces. These processes differ from other welding processes in the Respect that no fluxes are used, filler metal Rarely used.

The heat generated during Resistance welding is given by following Expression.

$$H \alpha I^2RT$$

where

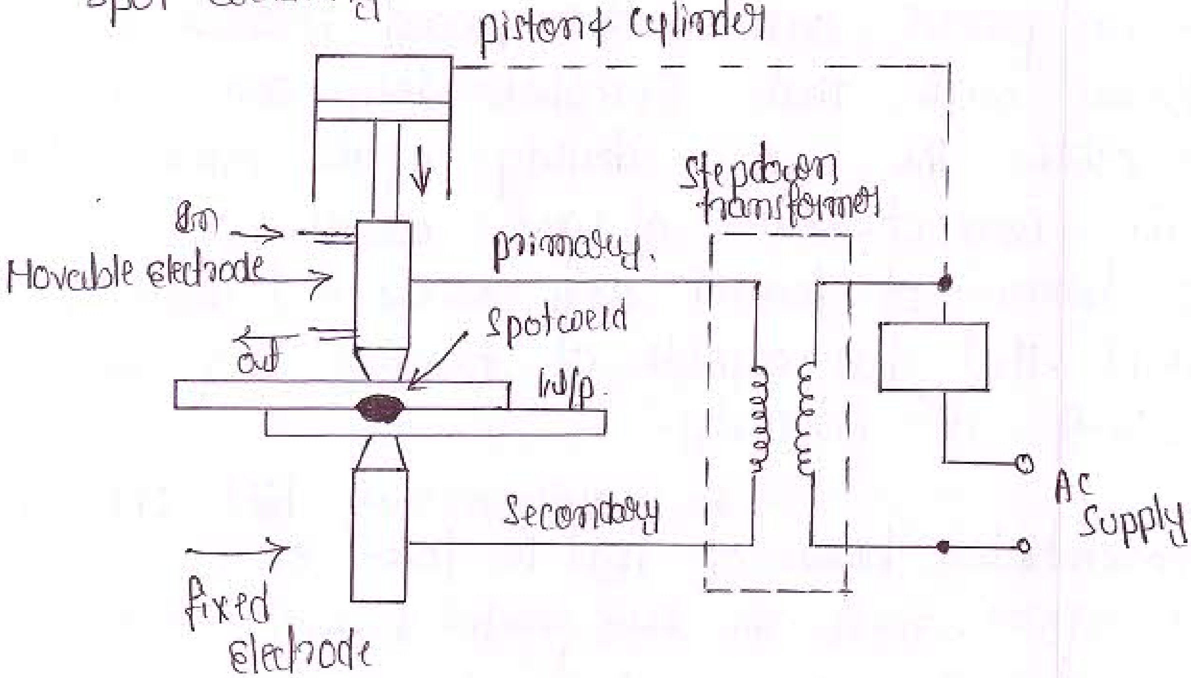
H ⇒ is heat generated

I ⇒ is current in amperes

R ⇒ is Resistance of area being welded

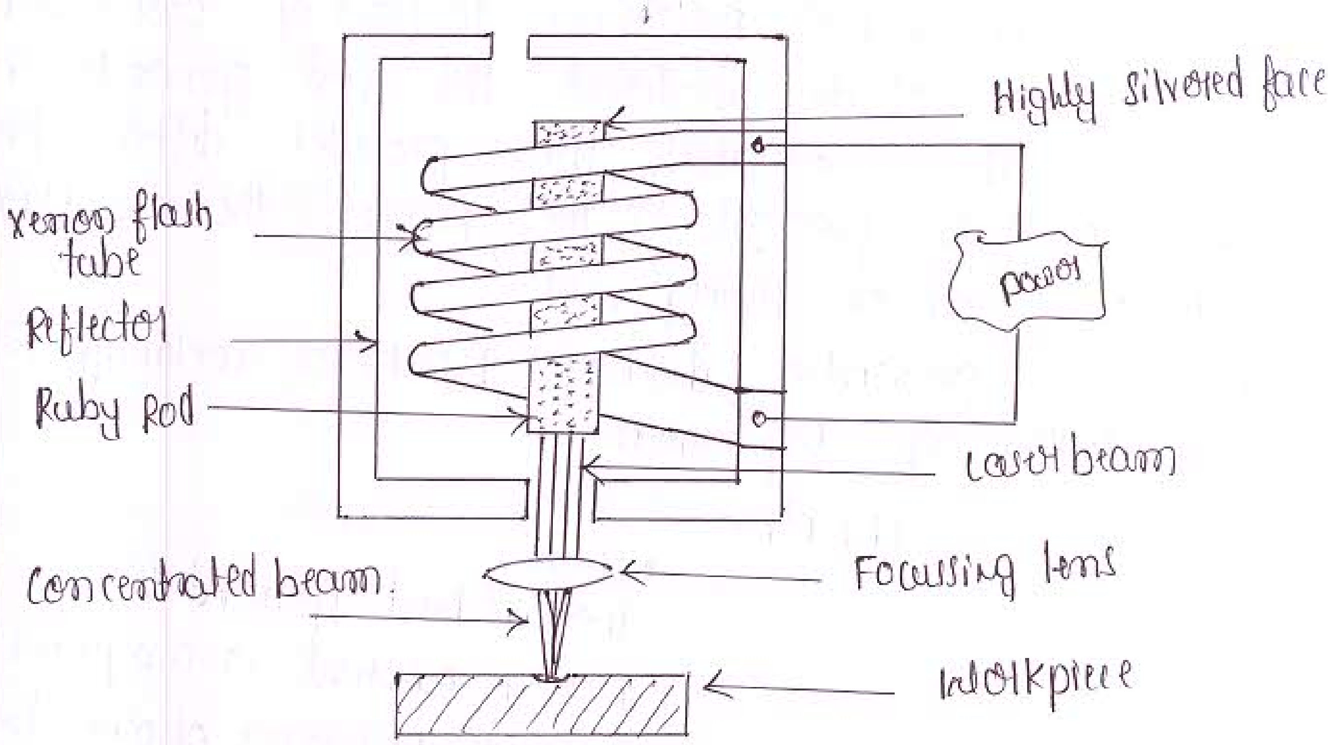
T ⇒ is time for the flow of current.

(b) Spot welding.



Resistance spot welding is a Resistance welding process in which fusion of two or more overlapping sheets of Metal are held b/w electrodes through which welding current is supplied for a definite time and also force is exerted on work pieces. The Resistance to this current flow by weld metal causes the fusion at weld Region and forms a joint at localized point called spot weld.

(ii) Laser welding



The LASER stands for "Light Amplification by stimulated Emission of Radiation". Laser welding is a high Energy beam process and in this Regard is similar to electron beam with that exception they are unlike one another. The Energy density of the laser is achieved by the concentration of light waves not electrons. Laser is a beam of focused and concentrated monochromatic light that has capable of travelling long distance without losing its intensity.

In laser welding heat obtained from the concentrated beam of light to focus on a small area on the workpiece, melt the base metal & cause welding action at the joint. The process of welding is illustrated in above figure.

(c) Thermit welding.

It is a fusion welding process that makes use of intense heat generated by Exothermic chemical Reaction of the thermit mixture.

Thermit is a non-Explosive mixture consists primarily of finely divided aluminum and iron oxide in the Ratio of about 1:3 by weight. other metal oxides that can be used in place of iron oxide include oxides of copper. Nickel. chromium or Maganese but iron oxide Thermit is the most commonly used.

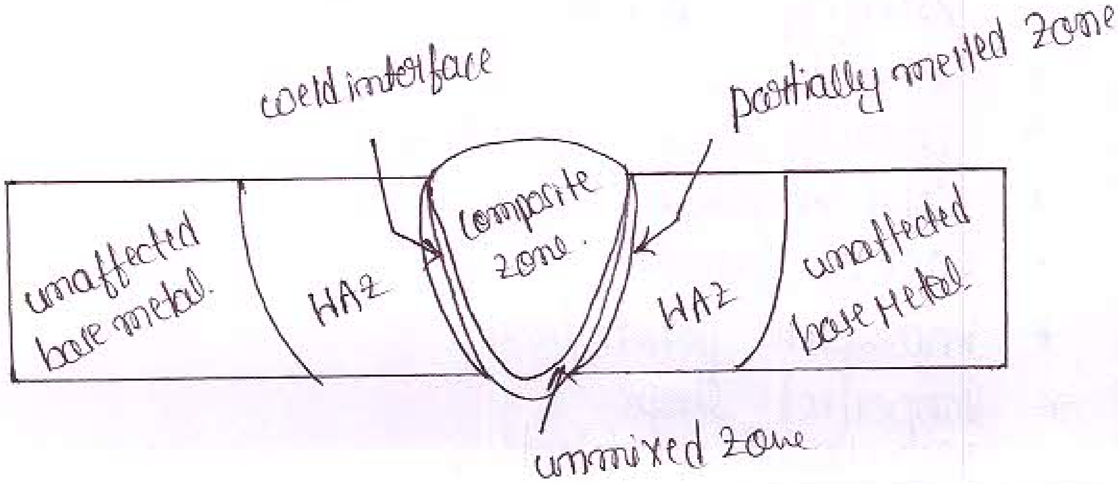
The thermit mixture is kept in a Refractory lined crusible and the mixture is ignited with a highly inflammable powder consisting of Barium peroxide, an ignition temperature of 1150°c is attained which initiates the main thermit Reaction.

$$8Al + 3Fe_3O_4 \Rightarrow 9Fe + 4Al_2O_3 \text{ (slag)} + \text{Heat}.$$

Slag being very light floats over the thermit steel there by protecting the metal from atmospheric gases. Apart from the basic ingredients of the thermit mixture other materials may be added to produce a desired thermit melt for any Specific Application.

Module : 05

9.
(a) Formation of different weld zones



(i) Fusion zone: is the centre zone, can be characterized as a mixture of completely molten base metal with molten metal of filler Rod and it is termed the weld bead. Fusion welding is similar to casting process wherein under high welding temperature base metal Reaches the molten metal. forms the pool of molten metal and on solidification it becomes a strong joint.

(ii) Weld interface zone: which is also Referred to as mushy zone. is a narrow zone consting of partially melted base material which has not got an oppotunity for mixing. This zone Separates the fusion zone & Heat affected zone

(iii) Heat affected zone: is the Region next to weld interface zone & surround the fusion zone. this zone is not the fused zone but Experiences an Elevated temperature that is well below the solidus temperature while high enough that can change the microstructure of the material. The amount of change in microstructure in HAZ depends on the amount of heat input.

(iv) unaffected base metal zone: is the last zone and it is surrounding the HAZ is likely to be in a state of high Residual stress, due to the shrinkage in the fusion zone.

(b) Welding defects

* cracks
* porosity
* Solid inclusion
* Lack of fusion
* incomplete penetration
* Imperfect shape
* Miscellaneous defects.

Methods of to detect the welding defects

⇒ Visual Examinations

⇒ Radiography testing
  * Gamma-ray
  * X-Ray

⇒ Magnetic testing

⇒ Ultrasonic inspection

⇒ penetrant Examinations

⇒ Stethoscopic test

⇒ Eddy-current Inspection.

10.

(a)

Soldering	Brazing.
* It is a method of joining two or more thin workpiece of similar or dissimilar metal or an alloy by using a filler material * filler metal have the melting temperature lower than 450°C. * Filler metal called as solder.	* It is the process of joining two or more similar or dissimilar metal pieces is done with the help of filler metal * The filler metal have the melting point more than 450°C * Filler metal called as spelter.

(b) principle and working.

In this process, acetylene is mixed with oxygen in correct proportions in the welding torch and ignited. The flame Resulting at the tip of the torch is sufficiently hot to melt and join parent metal.

The oxy-acetylene flame Reaches a temperature of about 3300°C and thus can melt most of the ferrous and non-ferrous metals in common use. A filler metal Rod or welding Rod is generally.

It consists of two sets of large cylinders in which one cylinder consist oxygen at high pressure and other contains acetylene gas. welding torch device is used to mix both oxygen and acetylene gases at Required proportion and it. will burn the mixture at the tip as shown in figure. The pressure at which both gases supplied to the torch are controlled by the pressure Regulators.

(c) Methods used for Inspection of casting & welding.

(i) Ultrasonic Testing Method : Ultrasonic Testing uses high frequency Sound waves to conduct Examinations & make measurements. Besides its wide use in Engg Applications such as flaw detection, dimensional measurements material characterization, etc --

(ii) X-Ray Radiography Inspection Method :

Radiography is one of the most important and widely used methods for detecting internal defects for both ferrous and nonferrous metals and other materials.

(iii) Eddy current Inspection : Eddy current Inspection is one of several of NDT methods that use the principal of "electromagnetism" to detect flaws in conductive materials.

Eddy current test method can detect very small cracks in or near the surfaces of the material.

(iv) <u>Holographic Inspection:</u>

Holographic Inspection method can be used for non destructive testing of materials. Holography is coined by Gabor using Greek words. it means whole information.

In HNDT techniques, the test sample is interferometrically compared with the sample after it has been stressed. A flaw can be detected if by stressing the object it creates an anomalous deformation of the surface around the flaw.