QUESTION PAPER PATTERN 755

Half Yearly Examination

Subject: Foundry Technology - II
Year : 2014 – 15
Time : 2 Hrs
Marks : 60

1. Weightage to Objectives:

Objectives	K	U	A	S	Total
Percentage of Marks	30%	30%	30%	10%	100%
Marks	18	18	18	6	60

2. Weightage to form Questions:

Type of Questions	EA	SA	VSA	O	Total
Number of Questions	4 (each 7)	3 (each 4)	6 (each 2)	8 (each 1)	
Marks Allotted	28	12	12	8	60
Estimated Time	40	30	30	10	120*

* 10 minutes for paper reading

3. Weightage to Content **Marks**

Half-yearly Examination

	Marks
1. Unit – 1	23
2. Unit – 2	15
3. Unit – 3	22

4. Scheme of Sections:

Section	Type of Questions	Choice	Number of questions
A	EQ	4 out of 5	4
B	SQ	3 out of 4	3
C	VSQ	6 out of 7	6
D	OQ	8 (no choice)	8

1. Difficulty Level:

Difficult	10% of Marks
Average	50% of Marks
Easy	40% of Marks

Abbreviations Used:

K – Knowledge **U** – Understanding **A** – Application **S** – Skill

EA/EQ – Essay Answer/Question **SA/SQ** – Short Answer/Question

VSA/VSQ – Very Short Answer/Question **O/OQ** – Objective /Objective Question

Foundry Technology - I I

Class XII (Theory)

Time Allowed: 2 Hours **Max Marks: 60**

Blue Print – Half yearly Examination

Form of Questions	Objective	Very Short	Short	Essay	Total
Marks	**1**	**2**	**4**	**7**	
Unit- 1 Special Moulding and casting processes	3	2*	1	2	23
Unit II Melting and pouring practice	2	3	1*	1	15
Unit III Foundry Practice for ferrous and non-ferrous metals	3	2	2	2*	22
TOTAL	**8 (1)**	**6 (2)**	**3 (4)**	**4 (7)**	**60**

*** including choice questions**

MODEL QUESTION PAPER

Half-yearly Examination: Class – XI

Foundry Technology - II

Time: 2 Hrs **Answer All Sections** **Max. Marks: 60**

SECTION – A (Essay Questions) – 4 x 7 = 28 marks

<u>Answer Any FOUR Questions in 40 lines</u>

1. Explain process description of ceramic mould casting with neat sketch. Mention any two applications
2. State and explain the construction features of an electric arc furnace.
3. Explain the production practice of Aluminum alloy castings.
4. State the advantages, limitations and application of semi centrifugal casting process
5. Explain the moulding and casting of SG iron casting production

SECTION – B (Short Questions) – 3 x 4 = 12 marks

Answer any <u>THREE</u> Questions in 20 lines

6. What are the advantages and limitations of permanent mould casting process?
7. Mention four important criteria for selection of a melting furnace.
8. Write shore notes on castability of steels castings.
9. What is the role of nickel in stainless steel?

SECTION – C (Very Short Questions) – 6 x 2 = 12 marks

Answer any <u>SIX</u> Questions in 6 lines

10. List the applications of plaster moulding process
11. What is the basic difference between a furnace and an oven?
12. Name the steps involved in a metal melting process.
13. List the classification of steels.
14. What are the types of centrifugal casting process?
15. Mention the name of two furnaces that are heated by chemical energy
16. Can you use the same mould materials for steel casting as well as for grey cast iron? Justify.

SECTION – D (Objective Questions) – 8 x 1 = 8 marks.

17. In a _______ the molten metal is poured and allowed to solidify while the mould is revolving. *(Centrifugal Casting)*

18. During ________ process, a metal is transformed from liquid to solid phase. *(Solidification)*

19. When the molten metal is fed in the cavity of metallic mould by gravity, the method of casting is known as ________.*(Permanent mould casting method)*

20. The crystallization process consists of two major events, _______ and ________.(*Nucleation, crystal growth*.)

21. Iron ore is usually found in the form of __________.*(Oxides)*

22. The iron ore mostly used for the production of pig iron is __________.*(Haematite)*

23. In order to deliver molten metal from pouring basin to gate, a __________ is used.*(Riser)*

24. The carbon in the cast iron varies from ___________. *(1.7 - 4.5%)*

ANSWER KEYS

Half-yearly Examination: Class – XI

Foundry Technology - II

Time: 2 Hrs **Answer All Sections** **Max. Marks: 60**

SECTION – A (Essay Questions) – 4 x 7 = 28 marks

Answer Any FOUR Questions in 40 lines

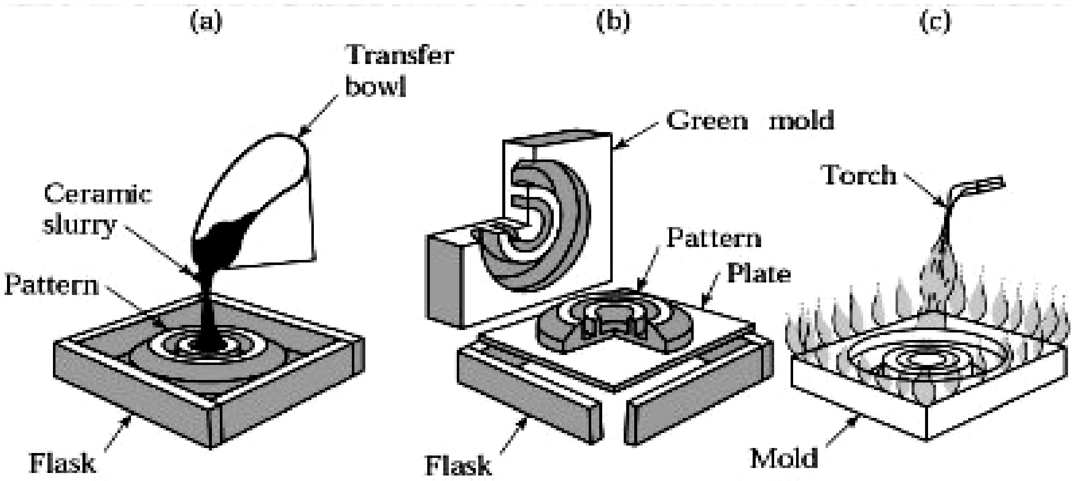
1. Explain process description of ceramic mould casting with neat sketch. Mention any two applications.

Process Description of Ceramic Mould Casting:

Step 1:
A mixture of fine grain zircon ($ZrSiO_4$), aluminum oxide, fused silica, bonding agents, and water creates ceramic slurry.

Step 2:
This slurry is poured over the casting pattern and let set. The pattern is then removed and the mould is left to dry. The mould is then fired.

Step 3:
The firing will burn off any unwanted material and make the mould hardened and rigid. The mould may also need to be baked in a furnace as well. The firing of the mould produces a network of microscopic cracks in the mould material. These cracks give the ceramic mould both good permeability and collapsibility for the casting process.



Sequence of operations in making a ceramic mould

(a) Pouring of slurry (b) stripping of green mould (c) Burn off mould

Step 4:

Once prepared, the two halves of the mould are assembled for the pouring of the casting.

Step 5:

The two halves, (cope and drag section), may be backed up with fireclay material for additional mould strength. Often in manufacturing industry the ceramic mould will be preheated prior to pouring the molten metal. The metal casting is poured, and let solidify.

Step 6:

In ceramic mould casting, like in other expendable mould processes the ceramic mould is destroyed in the removal of the metal casting.

Applications:
These casting processes are commonly used to make tooling, especially drop forging dies, but also injection moulding dies, die casting dies, glass moulds, stamping dies.

2. State and explain the different stages of tap-to-tap cycle of an electric arc furnace.

Resistance furnace is an electric furnace in which heat is developed by the passage of current through distributed resistors (heating units) mounted apart from the charge.

Arc Furnace

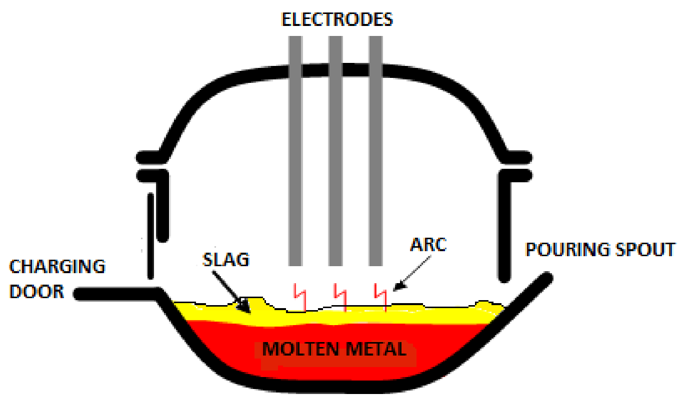
Arc furnace is an electrical furnace in which the thermal effect of an electric arc is used to melt metals. Arc furnaces are available in small units of approximately one ton capacity which are used in foundries for producing cast iron products. Industrial electric arc furnace temperatures can be raised up to 1,800 °C. In an electric arc furnace, charge material is exposed to an electric arc, and the current in the furnace terminals passes through the charged material.

Construction of Electric Arc furnace:

1. The furnace consists of a saucer-shaped hearth made of refractory material for collecting the molten metal, refractory material lining also extends to the sides and top of the furnace.

2. Two or three carbon electrodes are dipped into the furnace from the roof or the sides.

3. Doors in the side of the furnace allow removal of molten alloys (the products), removal of slag etc. The scrap metal charge is placed on the hearth and melted by the heat from an electric arc formed between the electrodes.



Schematic diagram of Electric Arc Furnace

Classification of Arc furnaces:

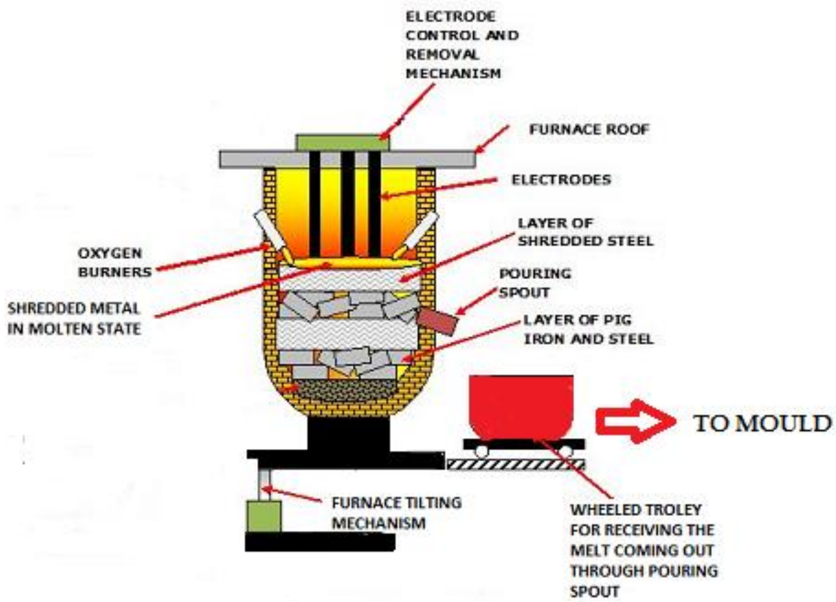
In direct arc furnaces, electric arcs are generated between electrodes and the material to be melted. In such furnaces, the electric arc comes into contact with the metal.

In indirect arc furnaces the arcs are set between electrodes which are placed at a certain distance from the materials being heated, and the heat from the arc is transmitted to them by radiation. In such furnaces the electric arc does not actually touch the metal.

Modern operations aim for a tap-to-tap time of less than 60 minutes. Some twin shell furnace operations are achieving tap-to-tap times of 35 to 40 minutes.

Direct electric-arc furnaces have a very high thermal efficiency - around 70% - and can function at as little as 450-550 kWh/tonne of metal melted.

Indirect electric arc furnaces typically achieve closer to 700-1000 kWh/tonne of steel.



Basic layout of an Electric Arc Furnace

Electric Arc Furnace Operating Cycle: Scraps melt in this type of furnace are divided into two grades:

(i) shred (this consists of scraps which have light thicknesses)

(ii) heavy melt (this consists of large slabs and beams)

3. Explain the Production practice of Aluminum alloy castings.

Aluminium Base Cast Alloys

The important engineering property of ‘specific strength’ or ‘strength-to-weight ratio’ for aluminium alloys has become quite large, which makes them very attractive materials for making components for all types of aerospace or aircraft components.

Aluminium alloy moulding and casting – special features

Moulding - Like copper alloys, aluminum alloy castings are produced in hundreds of compositions by all commercial casting processes, including *green sand, dry sand, composite mold, plaster mold, investment casting, permanent mould, , and pressure die casting.*

Gating ratio: Because the aluminium alloys can be oxidized readily if the metal stream in the mould has high flow velocity and is turbulent then there is more risk of oxidation and dross formation. So the gating system is designed in such a way that the gating ratio is non-pressurized, which means the cross sections of sprue base area: total runner cross section area: total ingate area is 1: 3 : 3 for example. Greater area of gates means that the flow velocity metal stream will slow down after the sprue and will fill the mould cavity quietly, without turbulence.

Cosworth process - This process has been developed especially to produce defect-free high quality aluminium alloy castings for aero-space applications. Aluminium alloy melts are has a strong tendency to react with air to produce films of aluminium oxide. The Cosworth process, has a special feature – the aluminium melt is not allowed to come in contact with air (oxygen) during feeding the mould. This is achieved by sealing the mould assembly and keeping it full of inert gas. The mould is placed above the melt reservoir. Molten aluminium alloy is lifted up by special electromagnetic pump to deliver the melt slowly to fill the mould from the bottom. The mould is also specially made with *zircon sand and organic binder*.

Aluminium melting and Melt treatment

Melting Furnaces: Aluminium and its alloys have relatively low melting temperature. So there are many options, depending on the amount of melt required.

a) Gas or oil-Fired Furnaces

b) Electric resistance heated Crucible Furnace for small batches

c) Coke –fired crucible furnace

d) Induction Furnace.

Melting loss, dross formation and gas absorption in melting Aluminium alloys:

Al – alloys can easily absorb harmful quantities of hydrogen gas and consequently give rise to gas or pinholes or gas porosity. It is essential to pour a clean and de-gassed melt in the moulds. Proper care is required to avoid contact of the melt with moisture. All runners, risers etc must be thoroughly dried.

Dross formation is the formation of aluminium oxide and other oxides which collect on the surface of molten metal. It is a typical problem of aluminium melting, causing surface and internal defects in castings. Dross formation and gas absorption depends on the type of melting unit. Electric resistance furnaces and induction furnaces produce the cleanest melt, lowest risk of dross formation and gas (hydrogen) absorption.

Fluxing means adding suitable agents,

(i) to react with the dross so that it can float up

(ii) to prevent reaction of the melt of aluminium with atmosphere by acting as a barrier

(iii) to absorb impurities in the melt. This is also called *Cover flux*. All aluminium alloys, in general, are melted under flux cover of halide salts. These fluxes contain salt mixtures that are *liquid at normal aluminum melting temperatures*.

Typical fluxes are:

a) 47.5% sodium chloride, 47.5% potassium chloride, and 5% sodium aluminum fluoride

b) 45% KCl, 45 % NaCl and 10 % NaF. Other cover flux combinations include aluminium and zinc chlorides.

Flushing or degassing is the step to remove dissolved gas, mainly hydrogen, by causing bubbling of another harmless gas or gas mixture through the melt. Neutral or inert gas like argon (Ar) can be passed through the melt, but this gas is costly. Use of N_2, and / or Cl_2 gas is common. Cl_2 gas is reactive and some aluminium is lost as aluminium chloride, but is very effective as a degasser.

4. State the types of centrifugal casting process and write advantages, limitations and applications of each process

There are three types of centrifugal casting:

(i) True centrifugal casting
(ii) Semi-centrifugal casting
(iii) Centrifuge centrifugal casting.

True centrifugal casting:

Advantages:

- Dense and fine grained metal castings are produced by true centrifugal casting
- Clean metal casting is obtained as lighter impurities such as sand, slag, oxides and gas float quickly towards the centre of rotation from where they can be easily machined out.
- No requirement of central core to produce pipe.
- Gating system is not required, this increases yield of the casting as high as 100% in some cases.
- Quality castings with good dimensional accuracy can be produced with this process.
- True centrifugal casting is a manufacturing process that is capable of very high rates of productivity.

Limitations:

- This process is limited to certain shape
- High equipment cost
- Skilled manpower required for operation and maintenance

Applications:

- Cast iron pipes, alloy steel pipes.
- Bearings for electric motors and machinery.
- Liners for I.C. engines.

Semi-centrifugal casting:

Advantages:

- It ensures purity and density at the extremities of a casting such as wheel or pulley.
- Poor structure and impurities can be machined out from the central wheel.

Limitations:

- Limitation over the shape of the casting.
- Lower yield compare to true centrifugal casting.

Applications:

- Manufacturing of Cast pulleys and wheels, shaped castings with cores

Centrifuge centrifugal casting:

Advantages:

- Denser component can be produced compare to other traditional process.
- Impurities free castings are produced by this method.
- Large numbers of castings are produced using a single mould or multiple moulds.

Disadvantages:

- Only small size of castings can be made.
- Lower yield compare to two other centrifugal casting.

Applications:

- Valve bodies and bonnets, plugs, yokes, brackets and a wide variety of various industrial castings.

5. Explain the moulding and casting of SG iron casting production

Production Technique of Spheroidal Graphite Iron:

The moulding practice is similar to that of grey iron with the exception that allowance has to be made for slightly different shrinkage characteristics of nodular iron. Some modification to the gating system is also necessary because of the dross forming tendency of nodular iron. The pattern shrinkage is 13 mm per meter with substantially pearlitic matrix and on annealing to completely ferritic structure, the pattern shrinkage is recommended to about 4 mm per meter.

Patterns for Green sand moulding:

- Small scale production: a simple wood pattern on a follow board will do.
- Medium scale production: A match plate pattern
- Mass scale production: cope and drag pattern
- Pattern shrinkage allowance 2.5 to 4 mm per 300 mm

Gating and feeding system:

A good gating and feeding system should be,

- Fills mold cavity rapidly but without turbulence
- Prevents introduction of air and mold gases into the metal stream
- Stops slag, dross or sand tec., from entering the mold along with the molten metal
- Aids in promoting progressive solidification of the castings
- Maintain a high casting yield
- Gating and feeding practice is less critical for grey iron than for other metals, because during solidification graphite precipitates and the expansion of graphite balances solidification shrinkage of gray iron
- Gates for gray iron castings are about 50 to 80% smaller than those required for comparable bronze, aluminium or steel castings
- Gates should be designed such that they will break off cleanly and would not require (much) grinding, sawing or chipping

Two types of gating systems:

Unpressurized Gating System:

- A non pressurized system with a restriction near the base of the sprue.

	Sprue	:	Runner	:	All gates
Cross-sectional area	1	:	4	:	3

- A non-pressure gating system helps displacing non-metallic inclusions into the runner extension, floating slag and minimizing spurting of the metal from the gate into the mold cavity.

Pressurized Gating System:

- A pressurized system restricts the rate of metal flow into the mold cavity and provides an opportunity for the slag to float at the top of the sprue or in the pouring basin.

	Sprue	:	Runner	:	All gates
Cross-sectional area	10	:	9	:	8

- Gates should be located in such a way that directional solidification is promoted
- Risers should be placed at regions of the casting last to solidity.

Moulding Practice

For the production of cast iron castings, several moulding processes such as green sand moulding, dry sand moulding, shell moulding, CO_2 process moulding, High pressure sand moulding and permanent moulds are used, but the greatest tonnage of castings is produced by green sand moulding.

Characteristics of Moulding sand mixtures:

- High green compressive and shear strength
- Sufficient clay to absorb expansion
- Sufficient moisture to activate clay
- Sufficient permeability
- Mould hardness

Cores: Different types of cores used for making cavities etc. in gray castings are Oil sand cores

- Hot box core
- CO_2 Core
- Cold set core

Melting Practice:

- Induction furnace to be used for melting to control the chemical composition.
- Owing to the requirements of composition control of base iron, melting of charge material for the production of S.G. iron is generally carried out in electric induction melting furnaces.
- Basic lined direct arc furnaces can give base iron of very low sulphur content but are not commonly used.

- Basic lined or lineless hot blast cupolas with basic slag practice may be used for the production of S.G. Iron, since the sulphur content can be reduced to the desired level and sufficiently high carbon in the melt can be obtained.

- The molten cast iron of suitable chemical composition is then treated with magnesium (some times with cerium), to obtain nodular form after inoculation with multi component ferrosilicon.

- After magnesium treatment, only a small quantity of residual magnesium is left in the metal. For getting the proper spheroidization, it is necessary to control the physical and chemical conditions of the base iron.

- Graphite nodules can be obtained by a large number of processes and techniques which can be broadly classified into following two categories:

- Processes which use magnesium master alloys.
- Processes which use pure magnesium

Heat Treatment:

The cost of normalizing or annealing is usually 10 to 25 pct. of the total cost and therefore, efforts should be made to produce every single type or grade of ductile iron without any heat treatment. As cast delivery presents the most significant saving potential in the overall economy of S.G. iron castings.

Applications:

The automotive, agriculture implement industries and pipe and pipe fittings are major uses of ductile iron castings. It has been estimated that automotive applications such as crank shaft, rocker arms, spacer blocks, spindles, cam shafts, connecting rods account for approximately 55 percent of the total ductile iron castings production.

SECTION – B (Short Questions) – 3 x 4 = 12 marks
Answer any <u>THREE</u> Questions in 20 lines

25. What are the advantages and limitations of permanent mould casting process?

Advantages:

- Good mechanical properties
- Higher production rates than sand casting, but much slower than die casting.
- High dimensional accuracy and very good surface finish
- Reduced machining
- Cast-in inserts
- Reduced porosity and inclusions

- Permanent mould castings can be CNC machined, powder coated, anodized and heat treated
- Thin section can be cast

Limitations:

- The casting design must be simple enough and with sufficient draft so that the ejection from the mould is feasible.
- Limited to low melting point metals
- Trimming is required
- High tooling and equipment cost
- Limited die life
- Long lead time to start production after getting the order, because machining to make the dies from a drawing , using a strong die alloy takes a long time.

26. Mention four important criteria for selection of a melting furnace.

- Melting efficiency
- Pollution problems and control measures to be taken
- Kind of metal or alloy to be melt
- Cost of installation of the furnace
- Capacity of the furnace
- Quantity of metal to be melt and Quantity of finished product

27. Write shore notes on castability of steels castings.

Castability of steel castings

The common principles of gating and risering are applicable for steel castings also. It should be noted that proper feeding of castings depend on

- the design of runner, gates and risers
- proper location of ingates and risers
- temperature and fluidity of the melt
- shrinkage of the casting

a) Fluidity - Steel melt has moderate fluidity and fluidity decreases rapidly with temperature. Alloy steels have lower fluidity than plain steels, high – Cr steels have lower fluidity than other steels. Higher the carbon level, lower is the melting point and higher is the fluidity.

b) Shrinkage - Since volume shrinkage of steel castings in general is significant, adequate riser volume and proper riser location is critical.

28. What is the role of nickel in stainless steel.

- ❖ Stainless steels may have 18-30 % Cr and up to about 10 % Ni. Most cast stainless steels are of course considerably more complex alloy.
- ❖ Nickel is an essential element in non-magnetic varieties of austenitic stainless steels. Presence of nickel imparts ductility of stainless steel.
- ❖ It is mainly used to improve properties in 1-5 % concentration, by a combination of strength and toughness, in conjunction with other strengthening elements like Cr. Mo. It strengthens and toughens.
- ❖ It is extremely useful in increasing impact strength. At high concentrations, nickel imparts resistance against attack by mineral acids.

SECTION – C (Very Short Questions) – 6 x 2 = 12 marks
Answer any SIX Questions in 6 lines

1. List the applications of plaster moulding process

Applications

- Metals cast by this process are mainly yellow brass, manganese and aluminium bronzes, aluminium and magnesium alloys.
- Typical products made in plaster moulds are propeller, core boxes, handles, aluminium pistons, pump and impeller parts, locks, small housings etc.

2. What is the basic difference between a furnace and an oven?

A furnace is a refractory lined chamber in which temperatures as high as 1800 ^{0}C can be attained with a view to melt a charged materials	Equipment for lower temperatures is called oven.
Furnaces are used in industry for melting purposes. They vary in sizes (capacity), types of fuel used and types of charge to be melted	Oven can be used for preheating purpose and it can not melt any metals.

3. Name the steps involved in a metal melting process.

Step 1: Preparing the metal and loading
Step 2: Melting of metal
Step 3: Refining and treating molten metal
Step 4: Holding molten metal
Step 5: Tapping molten metal
Step 6: Transporting molten metal

4. List the classification of steels.

A) Plain carbon steels

i) Low carbon steels (< 0.20% C)

ii) Medium carbon (0.20 to 0.50% C)

iii) High carbon steels (> 0.50% C)

B) Low alloy steel

C) High alloy steel

High alloy steels for specific applications – a) application at high temperature b) for wear and abrasion resistance and c) for elevated temperature applications.

5. What are the types of centrifugal casting process?

- ❖ True centrifugal casting
- ❖ Semi-centrifugal casting
- ❖ Centrifuge centrifugal casting.

6. Mention the name of two furnaces that are heated by chemical energy

- ❖ Reverberatory Furnace
- ❖ Crucible Furnace
- ❖ Rotary Furnace

7. Can you use the same mould materials for steel casting as well as for grey cast iron. Justify.

- ❖ If the mould is CO2 or No Bake or Furan process we can use the same mould materials to steel casting. But the gating and risering should be changed.

- ❖ If the mould is Green Sand process we can not use that mould to steel casting process.

SECTION – D (Objective Questions) – 8 x 1 = 8 marks.

1. In a ________ the molten metal is poured and allowed to solidify while the mould is revolving. *(Centrifugal Casting)*

2. During _________ process, a metal is transformed from liquid to solid phase. *(Solidification)*

3. When the molten metal is fed in the cavity of metallic mould by gravity, the method of casting is known as _________.*(Permanent mould casting method)*

4. The crystallization process consists of two major events, ________ and _________.(*Nucleation, crystal growth*.)

5. Iron ore is usually found in the form of __________.*(Oxides)*

6. The iron ore mostly used for the production of pig iron is __________.*(Haematite)*

7. In order to deliver molten metal from pouring basin to gate, a __________ is used.*(Riser)*

8. The carbon in the cast iron varies from ___________. *(1.7 - 4.5%)*

QUESTION PAPER PATTERN

Annual Examination

Subject: Foundry Technology - II
Year : 2014 – 15
Time : 2 Hrs
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6. Weightage to Content **Marks**

Annual Examination

2. Unit – 1 15 Marks
3. Unit – 2 10 Marks
4. Unit – 3 15 Marks
5. Unit – 4 10 Marks
6. Unit – 5 10 Marks

5. Scheme of Sections:

Section	**Type of Questions**	**Choice**	**Number of questions**
A	EQ	4 out of 5	4
B	SQ	3 out of 4	3

C	VSQ	6 out of 7	6
D	OQ	8 (no choice)	8

7. **Difficulty Level:**

Difficult	10% of Marks
Average	50% of Marks
Easy	40% of Marks

Abbreviations Used:

K – Knowledge **U** – Understanding **A** – Application **S** – Skill

EA/EQ – Essay Answer/Question **SA/SQ** – Short Answer/Question

VSA/VSQ – Very Short Answer/Question **O/OQ** – Objective /Objective Question

Foundry Technology - II

Class XII (Theory)

Time Allowed: 2 Hours **Max Marks: 60**

Blue Print - Annual Examination

Form of Questions	Objective	Very Short	Short	Essay	Total
Marks	**1**	**2**	**4**	**7**	
Unit- 1 Special Moulding and casting processes	2	1	1	1	15
Unit II Melting and pouring practice	1	2*	1*	1	10
Unit III Foundry Practice for ferrous and non-ferrous metals	2	1	1	1	15
Unit IV Cast metals Technology	2	2	1	1*	10
Unit V Testing and Quality Assurance in Foundry	1	1	0	1	10
TOTAL	**8**	**6(1)**	**3 (1)**	**4 (1)**	**60**

*** including choice questions**

MODEL QUESTION PAPER

Annual Examination: Class – XII

Foundry Technology - II

Time: 2 Hrs **Answer All Sections** **Max. Marks: 60**

SECTION – A (Essay Questions) – 4 x 7 = 28 marks

Answer Any FOUR Questions in 40 lines

1. Explain process description of ceramic mould casting with neat sketch. Mention any two applications
2. State and explain the construction features of an electric arc furnace with neat diagram.
3. Explain the production practice of Aluminum alloy castings.
4. Explain various types of steel castings with applications.
5. Describe the use of radiographic testing for casting inspection

SECTION – B (Short Questions) – 3 x 4 = 12 marks

Answer any THREE Questions in 20 lines

6. What are the advantages and limitations of permanent mould casting process?
7. Mention four important criteria for selection of a melting furnace.
8. Write shore notes on castability of steels castings.
9. Difference between low carbon steels and medium carbon steels.

SECTION – C (Very Short Questions) – 6 x 2 = 12 marks

Answer any SIX Questions in 6 lines

10. List the applications of plaster moulding process
11. What is the basic difference between a furnace and an oven?
12. Name the steps involved in a metal melting process.
13. List the classification of steels
14. Outline briefly any four characteristics of metals.
15. State the compositions and application of Grey cast iron.
16. What is hot fettling process?

SECTION – D (Objective Questions) – 8 x 1 = 8 marks.

17. In a _______ the molten metal is poured and allowed to solidify while the mould is revolving.*(Centrifugal Casting)*
18. When the molten metal is fed in the cavity of metallic mould by gravity, the method of casting is known as ________.*(Permanent mould casting method)*
19. The crystallization process consists of two major events, _______ and ________.(*Nucleation, crystal growth*.)
20. Iron ore is usually found in the form of __________.*(Oxides)*
21. The iron ore mostly used for the production of pig iron is __________.*(Haematite)*
22. The percentage of carbon in pig iron is _________.*(1-5%)*
23. Cast iron is manufactured in __________.*(Cupola Furnace)*
24. _________ tests locate the casting defects present in the interior of the castings .*(NDT)*

ANSWER KEYS

Annual Examination: Class – XII

Foundry Technology - II

Time: 2 Hrs **Answer All Sections** **Max. Marks: 60**

SECTION – A (Essay Questions) – 4 x 7 = 28 marks

Answer Any FOUR Questions in 40 lines

1. Explain process description of ceramic mould casting with neat sketch. Mention any two applications

Process Description of Ceramic Mould Casting:

Step 1:

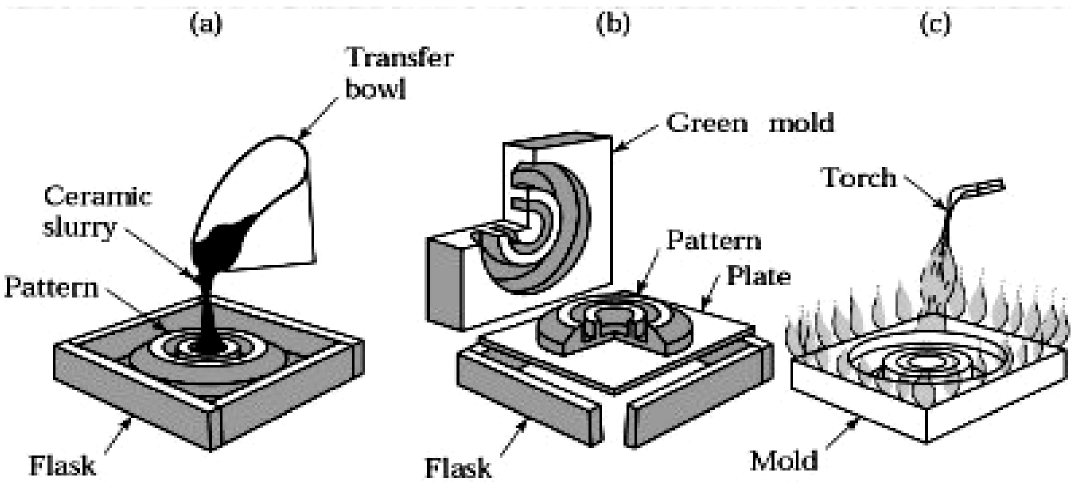
A mixture of fine grain zircon ($ZrSiO_4$), aluminum oxide, fused silica, bonding agents, and water creates ceramic slurry.

Step 2:

This slurry is poured over the casting pattern and let set. The pattern is then removed and the mould is left to dry. The mould is then fired.

Step 3:

The firing will burn off any unwanted material and make the mould hardened and rigid. The mould may also need to be baked in a furnace as well. The firing of the mould produces a network of microscopic cracks in the mould material. These cracks give the ceramic mould both good permeability and collapsibility for the casting process.



(a) Pouring of slurry (b) stripping of green mould (c) Burn off mould

Step 4:

Once prepared, the two halves of the mould are assembled for the pouring of the casting.

Step 5:

The two halves, (cope and drag section), may be backed up with fireclay material for additional mould strength. Often in manufacturing industry the ceramic mould will be preheated prior to pouring the molten metal. The metal casting is poured, and let solidify.

Step 6:

In ceramic mould casting, like in other expendable mould processes the ceramic mould is destroyed in the removal of the metal casting.

Applications:

These casting processes are commonly used to make tooling, especially drop forging dies, but also injection moulding dies, die casting dies, glass moulds, stamping dies.

2. State and explain the different stages of tap-to-tap cycle of an electric arc furnace.

Resistance furnace is an electric furnace in which heat is developed by the passage of current through distributed resistors (heating units) mounted apart from the charge.

Arc Furnace

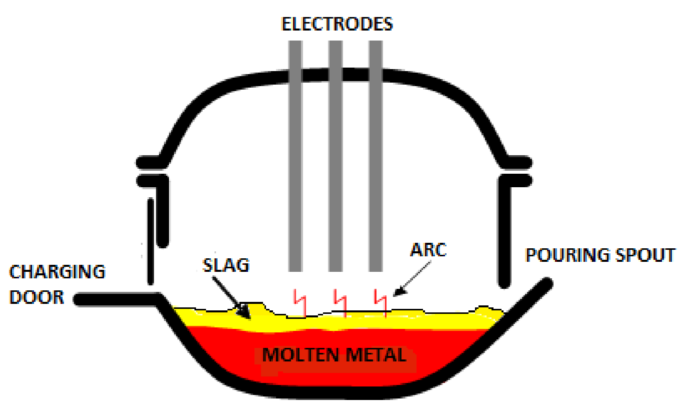
Arc furnace is an electrical furnace in which the thermal effect of an electric arc is used to melt metals. Arc furnaces are available in small units of approximately one ton capacity which are used in foundries for producing cast iron products. Industrial electric arc furnace temperatures can be raised up to 1,800 °C. In an electric arc furnace, charge material is exposed to an electric arc, and the current in the furnace terminals passes through the charged material.

Construction of Electric Arc furnace:

1. The furnace consists of a saucer-shaped hearth made of refractory material for collecting the molten metal, refractory material lining also extends to the sides and top of the furnace.

2. Two or three carbon electrodes are dipped into the furnace from the roof or the sides.

3. Doors in the side of the furnace allow removal of molten alloys (the products), removal of slag etc. The scrap metal charge is placed on the hearth and melted by the heat from an electric arc formed between the electrodes.



Schematic diagram of Electric Arc Furnace

Classification of Arc furnaces:

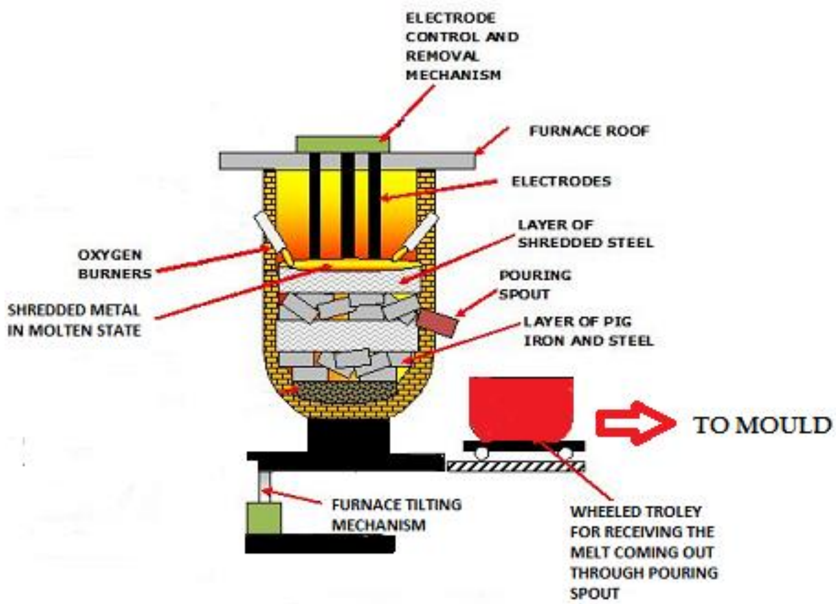
In direct arc furnaces, electric arcs are generated between electrodes and the material to be melted. In such furnaces, the electric arc comes into contact with the metal.

In indirect arc furnaces the arcs are set between electrodes which are placed at a certain distance from the materials being heated, and the heat from the arc is transmitted to them by radiation. In such furnaces the electric arc does not actually touch the metal.

Modern operations aim for a tap-to-tap time of less than 60 minutes. Some twin shell furnace operations are achieving tap-to-tap times of 35 to 40 minutes.

Direct electric-arc furnaces have a very high thermal efficiency - around 70% - and can function at as little as 450-550 kWh/tonne of metal melted.

Indirect electric arc furnaces typically achieve closer to 700-1000 kWh/tonne of steel.



Basic layout of an Electric Arc Furnace

Electric Arc Furnace Operating Cycle: Scraps melt in this type of furnace are divided into two grades:

(i) Shred (this consists of scraps which have light thicknesses)

(ii) Heavy melt (this consists of large slabs and beams)

3. Explain the Production practice of Aluminum alloy castings.

Aluminium Base Cast Alloys

The important engineering property of ‘specific strength’ or ‘strength-to-weight ratio’ for aluminium alloys has become quite large, which makes them very attractive materials for making components for all types of aerospace or aircraft components.

Aluminium alloy moulding and casting – special features

Moulding - Like copper alloys, aluminum alloy castings are produced in hundreds of compositions by all commercial casting processes, including *green sand, dry sand, composite mold, plaster mold, investment casting, permanent mould, , and pressure die casting.*

Gating ratio: Because the aluminium alloys can be oxidized readily if the metal stream in the mould has high flow velocity and is turbulent then there is more risk of oxidation and dross formation. So the gating system is designed in such a way that the gating ratio is non-pressurized, which means the cross sections of sprue base area: total runner cross section area : total ingate area is 1: 3 : 3 for example. Greater area of gates means that the flow velocity metal stream will slow down after the sprue and will fill the mould cavity quietly, without turbulence.

Cosworth process - This process has been developed especially to produce defect-free high quality aluminium alloy castings for aero-space applications. Aluminium alloy melts are has a strong tendency to react with air to produce films of aluminium oxide. The Cosworth process, has a special feature – the aluminium melt is not allowed to come in contact with air (oxygen) during feeding the mould. This is achieved by sealing the mould assembly and keeping it full of inert gas. The mould is placed above the melt reservoir. Molten aluminium alloy is lifted up by special electromagnetic pump to deliver the melt slowly to fill the mould from the bottom. The mould is also specially made with *zircon sand and organic binder*.

Aluminium melting and Melt treatment

Melting Furnaces: Aluminium and its alloys have relatively low melting temperature. So there are many options, depending on the amount of melt required.

a) Gas or oil-Fired Furnaces

b) Electric resistance heated Crucible Furnace for small batches

c) Coke –fired crucible furnace

d) Induction Furnace.

Melting loss, dross formation and gas absorption in melting Aluminium alloys:

Al – alloys can easily absorb harmful quantities of hydrogen gas and consequently give rise to gas or pinholes or gas porosity. It is essential to pour a clean and de-gassed melt in the moulds. Proper care is required to avoid contact of the melt with moisture. All runners, risers etc must be thoroughly dried.

Dross formation is the formation of aluminium oxide and other oxides which collect on the surface of molten metal. It is a typical problem of aluminium melting, causing surface and internal defects in castings. Dross formation and gas absorption depends on the type of melting unit. Electric resistance furnaces and induction furnaces produce the cleanest melt, lowest risk of dross formation and gas (hydrogen) absorption.

Fluxing means adding suitable agents,

(i) to react with the dross so that it can float up

(ii) to prevent reaction of the melt of aluminium with atmosphere by acting as a barrier

(iii) to absorb impurities in the melt. This is also called *Cover flux*. All aluminium alloys, in general, are melted under flux cover of halide salts. These fluxes contain salt mixtures that are *liquid at normal aluminum melting temperatures*.

Typical fluxes are:

a) 47.5% sodium chloride, 47.5% potassium chloride, and 5% sodium aluminum fluoride

b) 45% KCl, 45 % NaCl and 10 % NaF. Other cover flux combinations include aluminium and zinc chlorides.

Flushing or degassing is the step to remove dissolved gas, mainly hydrogen, by causing bubbling of another harmless gas or gas mixture through the melt. Neutral or inert gas like argon (Ar) can be passed through the melt, but this gas is costly. Use of N_2, and / or Cl_2 gas is common. Cl_2 gas is reactive and some aluminium is lost as aluminium chloride, but is very effective as a degasser.

4. Explain various types of steel castings with applications.

A. Plain carbon steels -

i) Low carbon steels (< 0.20% C)

ii) Medium carbon (0.20 to 0.50% C)

iii) High carbon steels (> 0.50% C)

Such steels served useful purpose earlier, but for many versatile applications, these are one replaced by alloy steels, requiring smaller section thickness, hence less weight.

B. Low alloy steels

C. High alloy steels

Low carbon steels are 'annealed' after casting. Annealing heat treatment involves heating the castings to a moderate temperature and holding there for sufficient time to make the casting tougher, as ductility is increased and chemical composition becomes more homogeneous.

Strength in carbon steel comes from,

(i) carbon level – higher carbon, higher strength

(ii) Mn and Si in correct proportion – they remain dissolved in iron and provides strength; they also favour the formation of very hard and strong 'martensite' phase while cooling the casting from high temperature above 900 ^{0}C.

Applications: These castings of moderate strength and appreciable ductility and toughness are quite economical and used in electrical machinery, as structural components where the expected load is limited – as in transport equipment, textile machinery, etc.

Medium carbon steels, with carbon level of 0.2 to 0.5 %.

i) In addition, one advantage is that, a suitable combination of % carbon and % Mn can develop resonably high strength by a simple treatmenmt of heating to about 950 ^{0}C in a heat treatment furnace and then, taking the castings out of the furnace and cooling in air. This treatment is 'normalising'.

ii) If more ductility is required at the expense of strength, the castings are to be heated again at moderate tempearture (300-500 ^{0}C). This treatment, called stress relief.

iii) Annealing, should be followed for castings of complex shapes with thin and thick sections. In medium carbon steels, presence of relatively high level of manganese (1-1.5% Mn) increases the range of strength after normalising treatment.

Aplications: In transport sector, in equipmen for metal forming and cutting machinery, in earthmoving and agricultural machinery etc. Valve casings, pump covers, impellers, strong pipe manifolds, dies for plastic moulding etc are made from steel castings of medium carbon steel.

Low alloy steels:

Addition of small percentages of alloying elements, keping the carbon level low (< 0.4). Desirable combination of strength and ductility can be obtained, along with the ability to sustain fluctuating load for a long time, durability etc.

Such combination of properties cannot be obtained from plain carbon steels. In addition, since carbon level is low, weldability is excellent.

Low- alloy steel castings can possess tensile strengths in the range 500- 2000 MPa (70 to 200 ksi). The tensile and yield strengths of low alloy steels, in general, can be 40 to 50 % higher than those of plain carbon steels with the same carbon content.

HIGH-ALLOY STEELS

The more prominent members of high alloy steels are (1) The family of wear resistant high manganese steels and (2) High Chromium alloys – mainly stainless steels.

Austenitic High Manganese Steels (Hadfield steel)

The original austenitic manganese steel, containing about 1.2% C and 12% Mn, was invented by Sir Robert Hadfield in 1882. Hadfield`s steel was unique in that it combined high toughness and ductility with high work-hardening capacity.

The special metallurgical feature of this type of steel is its ability to work hardens**.** The "Hadfield" grade has an original hardness of approximately 220 BHN.

With continued impact and /or compression, it will surface harden to over 550 BHN. It should be noted that only the outer skin surface hardens. The material underneath remains highly ductile and tough.

Applications:

1. Austenitic high manganese steel is used extensively primarily in the fields of rock crushers, grinding mills, dredge buckets, power shovel buckets and teeth, cement kiln components etc..

2. Other applications include hammers in hammer mill crushers and grates for automobile recycling and military applications such as tank track pads.

5. Describe the use of radiographic testing for casting inspection

Radiographic Testing

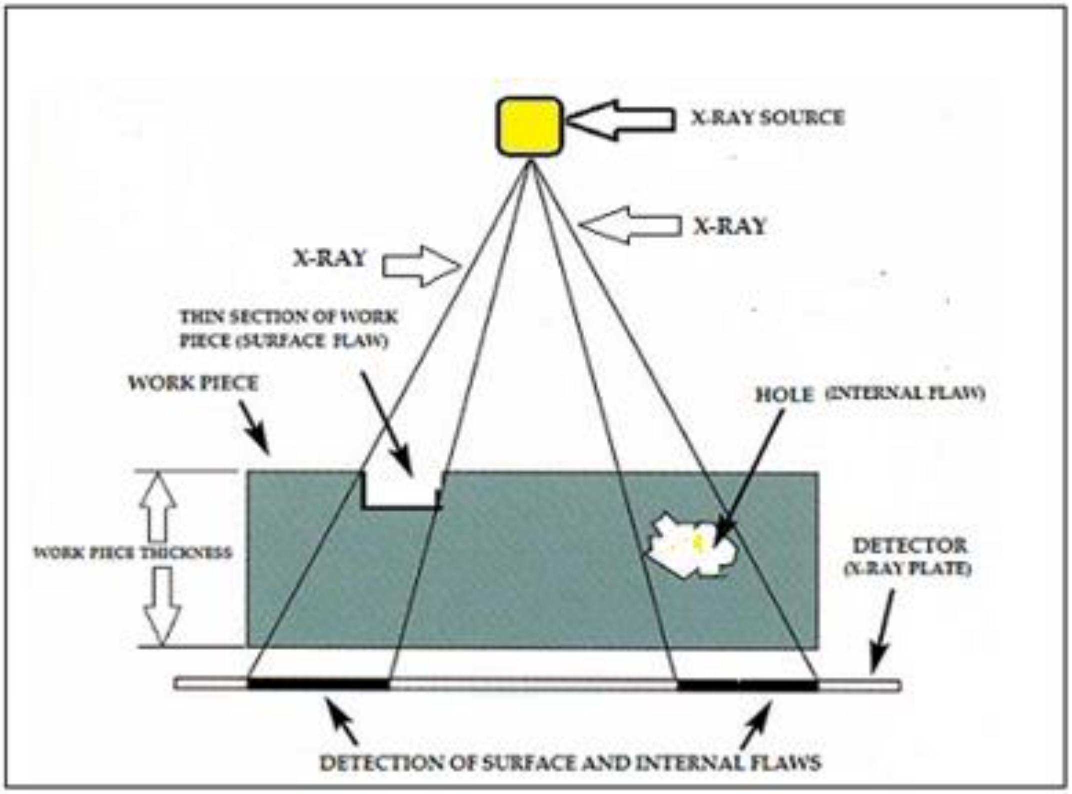
The NDT procedures stated so far are helpful to detect surface flaws. But blow holes, cracks, shrinkage etc. may remain inside the work piece. In order to detect such internal defects, radiographic testing is used.

Working procedure:

1. The work piece is placed between the radiation source and detector.

2. Amount of radiation depends upon the thickness and density if the work piece. The density and thickness of in the blow hole or cracked area is different from those of surrounding area of the work piece.

3. As a result, amount of radiation needed for these areas are different from the other area. This variation in radiation produces an image of the blow hole or crack on the detector. This helps in finding the actual location of the blow hole or crack.



Radiographic Testing

SECTION – B (Short Questions) – 3 x 4 = 12 marks
Answer any <u>THREE</u> Questions in 20 lines

1. What are the advantages and limitations of permanent mould casting process?

Advantages:

- Good mechanical properties
- Higher production rates than sand casting, but much slower than die casting.
- High dimensional accuracy and very good surface finish
- Reduced machining
- Cast-in inserts
- Reduced porosity and inclusions
- Permanent mould castings can be CNC machined, powder coated, anodized and heat treated
- Thin section can be cast

Limitations:

- The casting design must be simple enough and with sufficient draft so that the ejection from the mould is feasible.
- Limited to low melting point metals
- Trimming is required
- High tooling and equipment cost
- Limited die life
- Long lead time to start production after getting the order, because machining to make the dies from a drawing , using a strong die alloy takes a long time.

2. Mention four important criteria for selection of a melting furnace.

- Melting efficiency
- Pollution problems and control measures to be taken
- Kind of metal or alloy to be melt
- Cost of installation of the furnace
- Capacity of the furnace
- Quantity of metal to be melt and Quantity of finished product

3. Write shore notes on Castability of steels castings.

Castability of **steel castings**

The common principles of gating and risering are applicable for steel castings also. It should be noted that proper feeding of castings depend on

- the design of runner, gates and risers
- proper location of ingates and risers
- temperature and fluidity of the melt
- shrinkage of the casting

a) Fluidity - Steel melt has moderate fluidity and fluidity decreases rapidly with temperature. Alloy steels have lower fluidity than plain steels, high – Cr steels have lower fluidity than other steels. Higher the carbon level, lower is the melting point and higher is the fluidity.

b) Shrinkage - Since volume shrinkage of steel castings in general is significant, adequate riser volume and proper riser location is critical.

4. Difference between low carbon steels and medium carbon steels.

Low carbon steels (< 0.20% C) are 'annealed' after casting. Annealing heat treatment involves	**Medium carbon steels,** with carbon level of 0.2 to 0.5 %. In addition to a suitable

heating the castings to a moderate temperature and holding there for sufficient time to make the casting tougher, as ductility is increased and chemical composition becomes more homogeneous.	combination of % carbon and % Mn can develop reasonably high strength by a simple treatmenmt of heating to about 950 ^{0}C in a heat treatment furnace and then, taking the castings out of the furnace and cooling in air. This treatment is 'normalising'.
Strength in carbon steel comes from (i) carbon level – higher carbon, higher strength (ii) Mn and Si in correct proportion – they remain dissolved in iron and provides strength; they also favour the formation of very hard and strong 'martensite' phase while cooling the casting from high temperature above 900 ^{0}C	If more ductility is required at the expense of strength, the castings are to be heated again at moderate tempearture (300-500 ^{0}C). This treatment, called "stress relief". Annealing, should be followed for castings of complex shapes with thin and thick sections. In medium carbon steels, presence of relatively high level of manganese (1-1.5% Mn) increases the range of strength after normalising treatment.
Applications: These castings of moderate strength and appreciable ductility and toughness are quite economical and used in electrical machinery, as structural components where the expected load is limited – as in transport equipment, textile machinery	*Applications*: In transport sector, in equipmen for metal forming and cutting machinery, in earthmoving and agricultural machinery etc. Valve casings, pump covers, impellers, strong pipe manifolds, dies for plastic moulding etc are made from steel castings of medium carbon steel

SECTION – C (Very Short Questions) – 6 x 2 = 12 marks
Answer any <u>SIX</u> Questions in 6 lines

25. List the applications of plaster moulding process

Applications

- Metals cast by this process are mainly yellow brass, manganese and aluminium bronzes, aluminium and magnesium alloys.
- Typical products made in plaster moulds are propeller, core boxes, handles, aluminium pistons, pump and impeller parts, locks, small housings etc.

26. What is the basic difference between a furnace and an oven?

A furnace is a refractory lined chamber in which temperatures as high as 1800 ^{0}C can be attained with a view to melt a charged materials	Equipment for lower temperatures is called oven.
Furnaces are used in industry for melting	Oven can be used for preheating purpose

purposes. They vary in sizes (capacity), types of fuel used and types of charge to be melted	and it can not melt any metals.

27. Name the steps involved in a metal melting process.

Step 1: Preparing the metal and loading
Step 2: Melting of metal
Step 3: Refining and treating molten metal
Step 4: Holding molten metal
Step 5: Tapping molten metal
Step 6: Transporting molten metal

28. List the classification of steels

A) Plain carbon steels
- i) Low carbon steels (< 0.20% C)
- ii) Medium carbon (0.20 to 0.50% C)
- iii) High carbon steels (> 0.50% C)

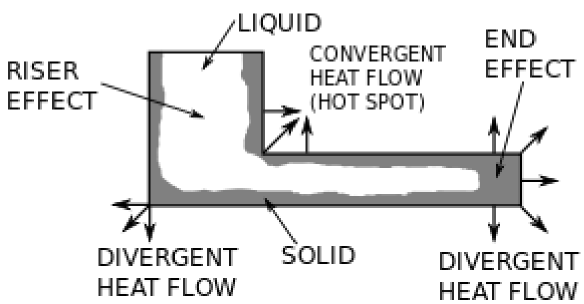
B) Low alloy steel
C) High alloy steel

High alloy steels for specific applications – a) application at high temperature b) for wear and abrasion resistance and c) for elevated temperature applications.

29. Outline briefly any four characteristics of metals.

Metals have useful properties including strength, ductility, high melting points, thermal and electrical conductivity, and toughness. A few of the common characteristics of metals are presented below.

- Ability to alloy
- Ability to deform easily (malleability / ductility)
- Electrical Conductivity
- Crystalline nature
- Heat treatable
- Fluidity



- Most metals and alloys shrink as the material changes from a liquid state to a solid state. Therefore, if liquid material is not available to compensate for this shrinkage a *shrinkage defect* forms. When progressive solidification dominates over directional solidification a shrinkage defect will form.
- The geometrical shape of the mold cavity has direct effect on progressive and directional solidification.
- At the end of tunnel type geometries divergent heat flow occurs, which causes that area of the casting to cool faster than surrounding areas; this is called an *end effect*.
- Large cavities do not cool as quickly as surrounding areas because there is less heat flow; this is called a *riser effect*. Also note that corners can create divergent or convergent (also known as *hot spots*) heat flow areas.
- In order to induce directional solidification chills, risers, insulating sleeves, control of pouring rate, and pouring temperature can be utilized.

30. State the compositions and application of Austempered ductile iron.

Composition of Ductile Iron for Austempered Ductile Iron is:

Alloying Element	C	Si	Mn	Cu	Ni	Mo
% of Composition	3.5-3.7	2.5-2.7	0.25-0.40	0.05-0.8	0.01-0.8	If required, 0.25

Applications:

- ✓ Ductile iron is finding increasing applications in automobile parts e.g. crankshafts, piston rings and cylinder liners. The use of ductile iron in these applications provides increased strength and permits weight savings.
- ✓ In agricultural and earth-moving application, brackets, sprockets wheels and track components of improved strength are made of ductile iron.
- ✓ General engineering applications include hydraulic cylinders, mandrels, machine frames, switch gears, rolling mill rolls, tunnel segments, bar stock, street furniture and railway rail-clip supports.

31. What is hot fettling process?

Hot Fettling Processes

- ❖ These methods have the particular advantage of avoiding dust generation and are adopted for ferrous alloys. Hot fettling processes include powder washing process, air-carbon are process and plasma torches.
- ❖ In the first method, iron powder is dispersed through a specially designed torch into an oxyacetylene flame, which is played across the surface of the casting to remove excess metal.
- ❖ In the air-carbon are process, an arc is applied to obtain local melting of excess metal which is blown away by a stream of compressed air as in the cutting process.

- Plasma torches can be used for cutting as well as removal of metal.

SECTION – D (Objective Questions) – 8 x 1 = 8 marks.

1. In a _______ the molten metal is poured and allowed to solidify while the mould is revolving.*(Centrifugal Casting)*

2. When the molten metal is fed in the cavity of metallic mould by gravity, the method of casting is known as ________.*(Permanent mould casting method)*

3. The crystallization process consists of two major events, _______ and ________.(*Nucleation*, *crystal growth*.)

4. Iron ore is usually found in the form of __________.*(Oxides)*

5. The iron ore mostly used for the production of pig iron is __________.*(Haematite)*

6. The percentage of carbon in pig iron is _________.*(1-5%)*

7. Cast iron is manufactured in __________.*(Cupola Furnace)*

8. _________ tests locate the casting defects present in the interior of the castings .*(NDT).*