



DEPARTMENT OF MECHANICAL ENGINEERING

Haldia, PurbaMedinipur, West Bengal
HALDIA INSTITUTE OF TECHNOLOGY

PRACTICAL MANUAL

(Assessment Instrument and Instruction Items)

Course Name	Manufacturing Processes Lab
Course Code	PC –ME 492
Laboratory Name	Primary Manufacturing ProcessesLaboratory
Programme	B. Tech in Mechanical Engineering
Semester / Year	[4 th / 2 nd Year]
Academic Session	2026–27

Faculty-in-Charge & Technical Staff

Faculty-in-Charge	Mr. Satyajit Chatterjee
Co-Faculty (if any)	Mr. Sourav Sarkar
Technical Staffs	Mr. Debasis Maity
	Mr. Subhabrata Panda



Vision

To impart quality, industry-relevant teaching-learning that blends knowledge and skill to produce industry-ready mechanical engineering graduates.

Mission Statements

M1: To create qualified and proficient technocrats having contemporary skills through outcome-based and self-learning strategies.

M2: To encourage innovation-oriented and problem-based research capabilities among young engineers through higher studies, in order to nurture the progress of society.

M3: To instill strong ethical values and good professional behaviour, enabling graduates to adopt and absorb emerging changes in the engineering profession.

Program Educational Objective

Graduates of B. Tech. Mechanical Engineering program, four years after graduation will

PEO1: Specify, design, supervise, test, and evaluate engineering skills to design, develop, and implement innovative solutions, systems, and applications in Mechanical Engineering and allied industries.

PEO2: Utilize Mechanical Engineering knowledge to address real-world and societal challenges while pursuing higher studies, research, and professional development.

PEO3: Demonstrate effective individual and collaborative capabilities in multidisciplinary professional environments, with a commitment to lifelong learning and adaptability to evolving technological, industrial, and societal requirements.

Program Specific Outcomes (PSOs)

PSO1: Design, analyze and evaluate mechanical components and systems such as thermal, fluid, manufacturing, design systems and allied engineering solutions.

PSO2: Utilize and evaluate modern engineering tools, software, and techniques to model, analyze, and solve real-world mechanical engineering problems.

PSO3: Demonstrate professional and ethical responsibility, effective communication, and the ability to work in multidisciplinary teams to address societal, industrial, and environmental challenges through sustainable mechanical engineering solutions.



PC-ME 492	Category: Professional Core Courses	PCIE Marks	40
Manufacturing Processes Lab	Semester :fourth	PSEE Marks	60
L-T-P:0-0-3	Credit: 1.5	Total Marks	100
Pre-Requisites: Workshop Practice Lab, Machine Drawing Lab			
Examination (PSEE): Theory/ Drawing Assignment/ Practical/ Viva-voce/Team work/ others			

Course Content:

Experiment and instruction items are to be framed based on these units:

Unit	Content	Hours	CO
UNIT I	Pattern making: types of patterns, pattern materials, allowances (shrinkage, machining, draft, shake, distortion), parting line, core prints, carpentry tools and joints, reading the product drawing	6	CO1
UNIT II	Moulding sand testing: composition and types of moulding sand, clay content (clay washer), grain fineness number (sieve analysis), moisture content (moisture teller), compressive and shear strength, permeability number, effect of each property on casting quality	15	CO2
UNIT III	Sand mould making: mould parts (cope, drag, cheek), ramming, gating system, risers, chills, cores, venting, mould defects	3	CO3
UNIT IV	Metal casting: melting furnaces (cupola, crucible), pouring temperature, ladle handling, solidification, fettling, casting defects (porosity, cold shut, misrun, blowholes), foundry safety	6	CO4
UNIT V	Smithy and forging: hot working principles, heating range for carbon steels, forging operations (upsetting, drawing down, bending, punching), heat treatment, hardness testing, property change after forging	6	CO5
UNIT VI	Welding: welding processes (SMAW, GTAW, GMAW), electrodes and filler selection, welding parameters, joint types and preparation, weld defects, PPE and welding safety	6	CO6
Total		42	

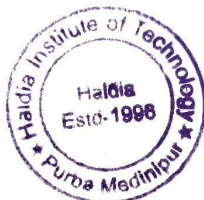
Suggested Reference Books

1. Hajra Choudhury, S.K., Hajra Choudhury, A.K., and Nirjhar Roy. Elements of Workshop Technology, Vol. I: Manufacturing Processes. Media Promoters and Publishers, Mumbai.
2. Rao, P.N. Manufacturing Technology: Foundry, Forming and Welding, Vol. 1. McGraw Hill Education, New Delhi.
3. Jain, R.K., and Gupta, S.C. Production Technology. Khanna Publishers, New Delhi.

Course Outcomes:

Upon successful completion of the course, students will be able to:

CO CODES	CO Statement	Knowledge Categories	Cognitive Level
PC-ME 492.1	Make a wooden pattern from the product drawing, applying pattern allowances, using carpentry tools, within dimensional tolerance.	P	Ap
PC-ME 492.2	Test moulding sand properties (clay content, grain fineness, moisture, strength and permeability), applying sand-testing principles, using standard foundry testing equipment, to judge its suitability for moulding.	P	An
PC-ME 492.3	Prepare a sand mould, applying gating, risering and venting knowledge, using the pattern and tested sand, to get an accurate, defect-free cavity.	P	Ap
PC-ME 492.4	Cast metal in prepared moulds, applying melting and solidification knowledge, using a furnace and ladle safely, to get a sound casting with minimal defects.	P	Ap
PC-ME 492.5	Forge carbon steel and test the change in properties, applying hot-working and heat-treatment knowledge, using a hearth, anvil and hardness tester, without cracks and within specified hardness.	P	An
PC-ME 492.6	Weld ferrous or non-ferrous metals, applying SMAW/GTAW/GMAW knowledge, using a welding machine with PPE, to get a defect-free joint of required strength.	P	Ap





ALIGNING OF COS IN [CL × KC] METRIC

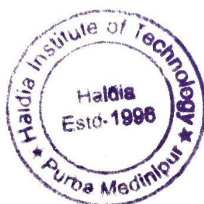
Knowledge Categories (KC)								
Cognitive Levels (CL)	Factua l	Conceptua l	Procedura l	Meta-cognitiv e	Fundamenta l Design Principles	Criteria & Specifications	Practical Constraints	Design instrumentalitie s
Remember (R)								
Understand (U)								
Apply (Ap)			CO1, CO3, CO4, CO6					
Analyze (An)			CO2, CO5					
Evaluate (E)								
Create (C)								

Assessment Pattern and Assessment Instruments for PCIE & PSEE

	PCIE								PSEE (60)	
	PCAI (40)				PCAI (40)					
Marks allotted	10	10	10	10	10	10	10	10	40	20
CO	EX1	EX 2	EX 3	VIVA I	EX 4	EX 5	EX 6	VIVA II	GR-A	GR-B (Viva)
CO1	10			10/3					40/6	20/6
CO2		10		10/3					40/6	20/6
CO3			10	10/3					40/6	20/6
CO4					10			10/3	40/6	20/6
CO5						10		10/3	40/6	20/6
CO6							10	10/3	40/6	20/6

CO-PO & CO-PSO Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
PC-ME 492.1	2	1	2	-	3	1	-	1	2	1	1	3	2	2
PC-ME 492.2	2	3	1	3	3	1	-	2	2	2	1	2	3	3
PC-ME 492.3	2	2	3	1	2	1	1	1	3	1	1	3	2	2
PC-ME 492.4	2	2	2	2	2	2	2	2	3	1	1	3	2	3
PC-ME 492.5	2	3	1	3	2	1	1	1	2	2	1	3	3	2
PC-ME 492.6	2	2	2	1	3	2	2	2	2	1	1	3	2	3
Average	2.00	2.17	1.83	2.00	2.50	1.33	1.50	1.50	2.33	1.33	1.00	2.83	2.33	2.50





Manufacturing Processes Lab (PC-ME 492)

List of Assessment Items, Instruction Items

Experiment No.	Name of the experiment	Instruction Item	CO Congruence
EX1-I	Make a wooden pattern, applying pattern allowances, from the product drawing using carpentry tools, within dimensional tolerance.	II1	CO1
EX2-I	Determine clay content of moulding sand, applying clay-washing principle, using a clay washer, within the specified clay percentage.	II2	CO2
EX2-II	Determine grain fineness of moulding sand, applying sieve analysis, using a sieve shaker, to match the required finish and permeability.		
EX2-III	Measure moisture content of moulding sand, applying knowledge of its effect on strength, using a moisture teller, within about 2-5%.		
EX2-IV	Determine compressive and shear strength of moulding sand, applying bonding principles, on rammed specimens using a strength tester, to resist mould failure.		
EX2-V	Determine permeability of moulding sand, applying knowledge of gas venting, using a permeability meter, to avoid blowholes and pinholes.		
EX3-I	Prepare a sand mould, applying gating, risering and venting knowledge, using the pattern and tested sand, to get an accurate, defect-free cavity.	II3	CO3
EX4-I	Cast metal in prepared moulds, applying melting and solidification knowledge, using a furnace and ladle safely, to get a sound casting with minimal defects.	II4	CO4
EX5-I	Forge carbon steel and test property changes, applying hot-working and heat-treatment knowledge, using a hearth, anvil and hardness tester, without cracks and within specified hardness.	II5	CO5
EX6-I	Weld ferrous or non-ferrous metals, applying SMAW/GTAW/GMAW knowledge, using a welding machine with Personal Protective Equipment (PPE), to get a defect-free joint of required strength.	II6	CO6



INSTRUCTION ITEM-1(II-1)

EX1	Make a wooden pattern, applying pattern allowances, from the product drawing using carpentry tools, within dimensional tolerance.	II1	CO1
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Theory:

The pattern is the principal tool during the casting process. It is the replica of the object to be made by the casting process, with some modifications. The main modifications are the addition of pattern allowances, and the provision of core prints. If the casting is to be hollow, additional patterns called cores are used to create these cavities in the finished product. The quality of the casting produced depends upon the material of the pattern, its design, and construction. The costs of the pattern and the related equipment are reflected in the cost of the casting. The use of an expensive pattern is justified when the quantity of castings required is substantial. The most commonly used patterns in foundry are as follows

- Single Piece Pattern
- Split Pattern or Two Piece Pattern
- Multi piece Pattern
- Gated Pattern
- Cope and Drag Pattern
- Match Plate Pattern
- Loose piece Pattern
- Follow Board Pattern
- Sweep Pattern
- Skeleton Pattern

Functions of the Pattern:

- A pattern prepares a mold cavity for the purpose of making a casting.
- A pattern may contain projections known as core prints if the casting requires a core and need to be made hollow.
- Runner, gates, and risers used for feeding molten metal in the mold cavity may form a part of the pattern.
- Patterns properly made and having finished and smooth surfaces reduce casting defects.
- A properly constructed pattern minimizes the overall cost of the castings.

Pattern Material:

Patterns may be constructed from the following materials. Each material has its own advantages, limitations, and field of application. Some materials used for making patterns are: wood, metals and alloys, plastic, plaster of Paris, plastic and rubbers, wax, and resins. To be suitable for use, the pattern material should be:

1. Easily worked, shaped and joined
2. Light in weight
3. Strong, hard and durable
4. Resistant to wear and abrasion
5. Resistant to corrosion, and to chemical reactions
6. Dimensionally stable and unaffected by variations in temperature and humidity
7. Available at low cost

The usual pattern materials are wood, metal, and plastics. The most commonly used pattern material is wood, since it is readily available and of low weight. Also, it can be easily shaped and is relatively cheap. The main disadvantage of wood is its absorption of moisture, which can cause distortion and dimensional changes. Hence, proper seasoning and upkeep of wood is almost a pre-requisite for large-scale use of wood as a pattern material.

Pattern Allowances:

Pattern allowance is a vital feature as it affects the dimensional characteristics of the casting. Thus, when the pattern is produced, certain allowances must be given on the sizes specified in the finished component drawing so that a casting with the particular specification can be made. The selection of correct allowances greatly helps to reduce machining costs and avoid rejections. The allowances usually considered on patterns and core boxes are as follows:

1. Shrinkage or contraction allowance
2. Draft or taper allowance
3. Machining or finish allowance
4. Distortion or camber allowance
5. Rapping allowance



1. Shrinkage or Contraction Allowance

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

- 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; riser, 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. The rate of contraction with temperature is dependent on the material.

2. Draft or taper allowance

It is the taper provided on vertical surfaces of a pattern to facilitate its removal from the mould without excessive rapping or breakage of cavity edges. The amount of taper varies with the type of pattern. The taper on the inner surfaces should be greater than on the outside surface. The amount of taper varies from 0.5° to 1.5° . It may be reduced to less than 0.5° for larger castings. The wooden patterns require more taper than metal patterns because of the greater frictional resistance.

3. Machining Allowance

It provides for sufficient excess metal on all cast surfaces that require machining. The required machine allowance depends on following factors:

- The size and shape of casting
- The metal to be casted.
- Casting surface roughness and surface defect.
- Method of machining to be employed.
- The degree of finish required on the machined portion.

4. Distortion allowance:

This allowance is provided on the pattern to compensate for possible distortion of the casting because of the unequal cooling rates of different sections of the casting and uneven internal stresses. Such an allowance depends on the judgment and experience of the pattern maker, who understands the shrinkage characteristics of the metal.

5. Rapping and Shaking Allowances:

This allowance is provided in the pattern to compensate for the rapping of mould because the pattern is to be rapped before removing it from mould. As a result of this the size of the mould cavity increases a negative allowance is provided in the pattern to compensate the same. In small and medium size casting, this allowance can be neglected. But in large casting this allowance is considered by making the pattern slightly smaller than the casting.

List of Equipment used:

Machine Tool	Wood Turning Lathe	Wood Planner	Bench Drill		
Cutting Tool	File	Hacksaw	Hand Drill	Chisel	Circular Saw
Miscellaneous Tool	Marking Gauge	Scriber	Hammer or Mallet	Planner	Outside & Inside Caliper

Product Detail:

The following figure displays the part of a machine made up of aluminum for which the pattern is to be manufactured. All dimensions are in millimeter

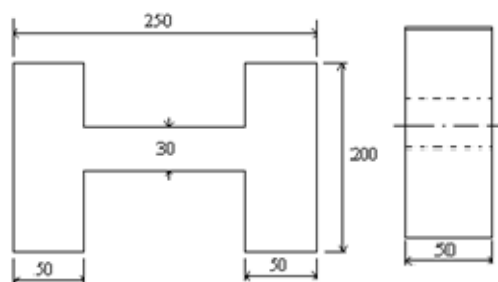


Figure: Casting to be manufactured.



Procedure:

Step 1 – Study the drawing: Carefully study the front and side views. Identify the overall dimensions, side-member width, central web thickness and pattern depth. Confirm any dimension not shown clearly.

Step 2 – Select and inspect the wood: Select well-seasoned, straight-grained wood free from knots, cracks, excessive moisture and warping.

Step 3 – Prepare the wooden blank: Prepare a rectangular blank slightly larger than the required final size. For the dimensions shown, the basic envelope is approximately 250 mm × 200 mm × 50 mm before allowing for machining/finishing.

Step 4 – Plane the blank: Plane the faces to obtain flat surfaces and approximately perpendicular edges. Check the faces using a try square.

Step 5 – Mark the front profile: On the 250 mm × 200 mm face, mark the overall outline. Mark the two 50 mm side members and the upper and lower recessed portions according to the drawing. Mark the 30 mm central web dimension.

Step 6 – Transfer the depth: Use a marking gauge to transfer the 50 mm pattern depth from the side view to the blank.

Step 7 – Rough cutting: Make saw cuts along the waste boundaries. Remove the major unwanted portions carefully, keeping sufficient material for final chiselling and planing.

Step 8 – Chiselling and shaping: Remove the remaining waste wood using suitable chisels and a mallet. Work gradually up to the marked lines.

Step 9 – Form the central web and side members: Maintain the specified 30 mm central web and 50 mm side-member widths. Check dimensions repeatedly with a steel rule or vernier caliper.

Step 10 – Provide draft: Provide a small draft on surfaces parallel to the direction of pattern withdrawal. Draft facilitates removal of the pattern from the sand mould without damaging the mould cavity.

Step 11 – Provide allowances: If the drawing dimensions represent final casting dimensions, provide appropriate shrinkage and machining allowances. Rapping allowance should be considered where applicable.

Step 12 – Finish the pattern: Plane and sand all accessible surfaces. Remove sharp unwanted projections, tool marks and loose fibres.

Step 13 – Seal and paint: Apply wood sealer/primer and suitable pattern paint. Allow adequate drying before handling.

Step 14 – Final inspection: Verify all specified dimensions, profile accuracy, squareness, symmetry, draft and surface finish before the pattern is used for moulding.

The pattern of a final product is though having a resemblance with latter one but due to the several reasons a number of allowances are linked with the former one. The lists of concerned allowances are displayed below for various materials.

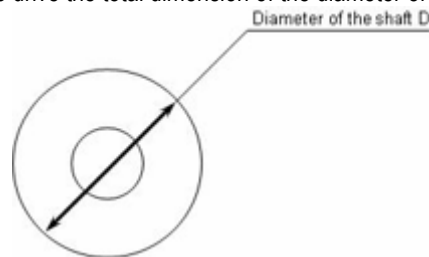


Table: Contraction Allowance for Different Metals.

Serial No.	Metals/Alloys	Contraction Allowance mm/meter
1	Grey cast iron	7 to 10.5
2	White cast iron	21
3	Malleable iron	15
4	Steel	21
5	Copper	16
6	Brass	16
7	Bronze	10.5 to 21
8	Zinc	24
9	Lead	24
10	Aluminum	16
11	Magnesium	18

Note: The contraction of metals/alloys is always volumetric, but the contraction allowances are always expressed in linear measures.

The following figure displays the way to drive the total dimension of the diameter of the shaft.



$$A = B + (C + D + E + F) \text{ [For outside diameter]}$$

$$A = B + (C + D + E - F) \text{ [For inside diameter]}$$

A – Outside diameter of pattern

D – Draft allowance

E – Distortion allowance

B - Outside diameter of product

C – Shrinkage allowance

F – Machining allowance

Precaution:

- Planing of timber should be done carefully
- During Sawing and chiseling operation work should be held properly by G-cramp.
- Use of ball peen hammer should be limited so as to prevent the damage of work.

Conclusions:

F.A.Q:

1. What is the difference between marking gauge and mortise gauge?
2. Which tool is used to draw a line perpendicular to a reference edge?
3. Why the Saw teeth are alternately bent?
4. Which chisel is useful to produce mortise and tenon joint?
5. What is the use of oilstone?



INSTRUCTION ITEM-1(II-2)

EX2-I	Determine clay content of moulding sand, applying clay-washing principle, using a clay washer, within the specified clay percentage.	II2-1	CO2
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Theory:

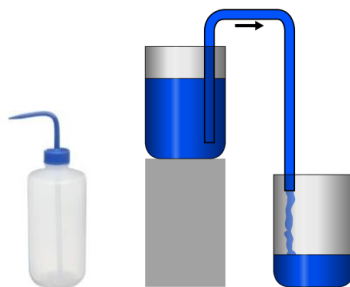
The basic principle of this experiment is attributed to difference in weight of original sand (W1) and weight of clay free sand (W2).

Therefore, % of clay content can be computed as $\{(W1-W2)/W1\} \times 100$

Equipment: Consists of stirrer, beaker, siphon, timer unit, 53 micron sieve pan, wash bottle.



Stirrer with beaker, sieve pan



Wash bottle

Siphoning

Materials: Testing sand, Caustic soda solution

Procedure:

- Dry the sand for one hour at $105 \pm 5^\circ\text{C}$.
- Then allow it to stand in a desiccator for cooling, and weigh 50 g of sample accurately, put into the beaker, add 475cc of 20 to 25°C distilled water and 25cc of Caustic soda solution (with 30 g of caustic soda dissolved into 970 cc of water). If the distilled water is not available, ordinary water can be used.
- Place the stirrer slowly on the beaker, and stir sufficiently for about 10 minutes.
- Take out the beaker, and pour water in it, to wash the sand adhering to the wall into the beaker, up to about 15 cm depth in total.
- Stir it sufficiently, and allow it to stand for about 10 minutes and allow supernatant water to flow through siphon bringing the level down to 2.5 cm.
- Add 20 to 25°C distilled water again up to 15 cm depth, and stir sufficiently, and allow it to stand for about 10 minutes.
- Again allow the supernatant water to flow out by the siphon until the height from the bottom becomes 2.5 cm. Then, add water again up to 15 cm depth, stir it sufficiently and allow it to stand for 5-10 minutes.
- Repeat the same operation until the discharged water becomes clear.
- Filter the sand particles remaining in the beaker, using about 9 cm filter paper in a Buchner funnel, and move the sand along with filter paper to a large wash glass.
- Dry it perfectly at $105 \pm 5^\circ\text{C}$ and cool.
- Double the difference between the weight of washed sand particles and the weight of original sample is the percent of clay content.

Precautions:

- It is desirable that test should be conducted twice or more for the same sample, and that the mathematical mean value of test results within deviation $\pm 5\%$ should be taken as the result of the test.



- The motor speed can be adjusted steplessly between 600 and 3,000 rpm, and therefore when it is desired to shorten the time or to change stirring eddy current, the speed can be adjusted arbitrarily (standard speed is 1,500 rpm for 50 Hz, and 1,800 rpm for 60 Hz).
- Siphoning should be done carefully so that specimen do not come out of the beaker.

Conclusion:

- F.A.Q:**
1. What is the use of caustic soda?
 2. Why sand grains settle faster than clay particles?
 3. On which principle siphoning works?
 4. What should be the normal range of clay percentage in making sand mould for ferrous casting?
 5. What will happen about permeability and green compression strength if clay content is more?



INSTRUCTION ITEM-1(II-2)

EX2-II	Determine grain fineness of moulding sand, applying sieve analysis, using a sieve shaker, to match the required finish and permeability.	II2-2	CO2
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Theory:

The physical properties of molding sand are widely influenced by its shape and size. It is therefore imperative to know the shape and size of molding sand. Grain size of sand is designated by a number called “grain fineness number” a quantitative indication of grain distribution. The test for fineness is conducted by screening sand grains by means of set of standard sieves that are graded and numbered according to the fineness of their mesh.

The sand retained on each of the sieve expressed as a percentage of the total mass. To calculate the grain fineness number each sieve has been given a weight age factor. The amount retained on each sieve is multiplied by the respective weightage factor or multiplying factor, summed up, and then divided by the total mass of the sample, which gives the grain fineness number.

The Grain Fineness Number (GFN) can be expressed as

$GFN = \frac{\sum M_i f_i}{\sum f_i}$ where $\sum M_i$ = Multiplying factor of corresponding sieve

f_i = Retained amount of sand in each sieve after shaking

Equipment: Digital weighing machine and Sieve shaker.



Material Required: Clay free Silica sand, riddle.

Procedure:

- Arrange set of sieves having the pan at bottom and coarsest sieve on top.
- Take 100 gms of dried and clay free sample on the top sieve. Put the lid and keep entire sieve set on shaking mechanism. Slide the clamping device on two side flexible bars and clamp the set of sieves with the help of knurled screws. Set the timer for 10 minutes and switch on the instrument. Remove the clamping device on completion of shaking.
- Take weights of the sand retained in each sieve including pan.
- Put your results in the following table and compute GFN of the sand sample



Sr. No	Sieve opening No(μm)	Weight in gms on sieve(f_i)	Multiplying factor(M_i)	Product= $M_i \times f_i$
1	1700		5	
2	850		10	
3	600		20	
4	425		30	
5	300		40	
6	212		50	
7	150		70	
8	106		100	
9	75		145	
10	53		200	
11	Sieve		300	

Precautions:

- Ensure that the equipment is completely free from dust, dirt and other foreign particles.
- Use soft brush for cleaning.
- Do not turn timer knob in anti-clockwise direction.
- Before tightening the clamping device, ensure that sieves fit exactly into each other.

Conclusion:

F. A. Q:

1. What does AFS Grain Fineness Number represent? And why is it important?
2. Which properties are being affected by size distribution?
3. What should be done if the sand is wet and full of clay?
4. What should be the size of grains in case of non-ferrous casting and ferrous casting?
5. In which unit mesh size is measured? Is there any relation of it with G.F.N?

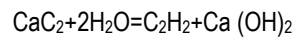


INSTRUCTION ITEM-1(II-2)

EX2-III	Measure moisture content of moulding sand, applying knowledge of its effect on strength, using a moisture teller, within about 2-5%.	II2-3	CO2
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Theory:

The moisture teller utilizes calcium carbide to measure the moisture content. A measured amount of calcium carbide in a container along with a separate cap consisting of measured quantity of moulding sand is kept in the moisture teller. The apparatus is then shaken vigorously such that the following reaction takes place:



The acetylene coming out will be collected in the space above the sand raising the pressure. The intensity of this pressure is proportional to the acetylene generated which in turn proportional to the moisture content in the sand. The pressure gauge is calibrated suitably so as to give direct reading of moisture content in the sand.

Equipment:

Rapid moisture teller: The apparatus consists of simple accurate beam balance, a scoop for measuring absorbent, a metallic pressure vessel and steel balls for mixing the sample and absorbent.

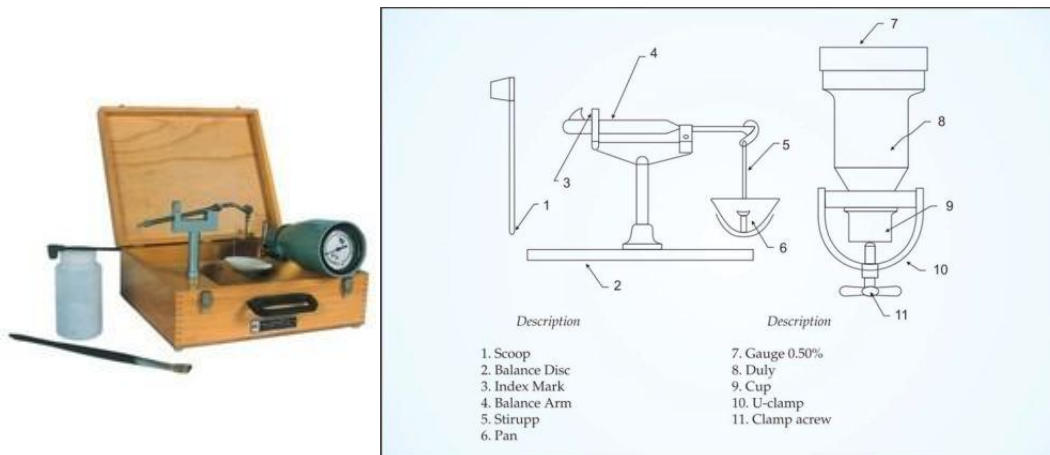


Figure: Rapid moisture teller

Material Required: Fine grained sand.

Procedure:

- The apparatus required for the test includes one metallic pressure vessel with clamp for sealing cup and a gauge calibrated in percentage water. One counterpoint balance, a scoop for measuring calcium carbide and three steel balls of 12.5 mm diameter and one steel ball of 25 mm diameter.
- Set up the balance and place the sample in the pan till the mark on the balance arm mass lines up with the index mark.
- Unclamp the clamping screw to move the U-clamp off the cup. Lift off the cup. Clean the cup and the body.
- Hold the body horizontally and gently deposit one level scoopful of calcium carbide halfway inside the chamber. Then lay the chamber down without disturbing the calcium carbide charge and transfer the soil weighed out as above from the pan to the cup.
- Holding cup and chamber approximately horizontal bring them together, without disturbing sample or calcium carbide, bring the U clamp round and clamp the cup tightly into place.
- With the gauge downwards, shake the moisture meter up and down vigorously for 5 seconds, then quickly turn it so that the gauge is upwards, give a tap to the body of the moisture meter to ensure that all the contents fall into the cup.
- Hold the rapid moisture meter downward, again shake for 5 seconds, then turn it with gauge upwards and tap. Hold for one minute. Repeat this for a third time. Once more invert the rapid moisture meter and shake up and



down to cool the gas. Turn the rapid moisture meter with the gauge upwards, and dial horizontal held at chest height when the needle comes to rest, take the reading. The readings on the meter are the percentages of water on the wet mass basis.

- Alternatively, the three smaller steel balls can be placed in the cup along with the soil and the larger one in the body along with the absorbent and seal up the unit as usual. Hold the rapid moisture meter vertical so that the material in the cup falls into the body. Now holding the unit horizontally, rotate it for 10 seconds so that the balls are rolled round the inside circumference of the body. Rest for 20 seconds. Repeat the rotation – rest cycle until the gauge reading is constant (usually this takes 4 to 8 min). Note the reading as usual.
- Finally release the pressure slowly (away from the operator) by opening the clamp screw and taking the cup out, empty the contents and clean the instrument with a brush.
- Calculate the water content (W) on the dry mass from the water content (M) obtained on the wet mass basis as the reading on the rapid moisture meter, as follows:

$$W = [M/(100-M)]*100$$

Where,

W = percent water content of the dry mass

M = percent water content of the wet mass

Precautions:

1. Clean the instruments with a soft dry brush after use.
2. Do not expose sand sample to atmosphere.
3. Do not expose the absorbent compound to atmosphere.

Conclusion:

- F. A. Q:**
1. Why moisture content test is necessary?
 2. What is the conventional method of determining the moisture of the sample?
 3. What is the difference between wet basis and dry basis moisture percentage?
 4. Is there any difference in the reading obtained from moisture teller method and conventional method? Justify your answer.
 5. What is the chemical reaction occurs within the pressure vessel used?
 6. What is the function of steel balls used?



INSTRUCTION ITEM-1(II-2)

EX2-IV	Determine compressive and shear strength of moulding sand, applying bonding principles, on rammed specimens using a strength tester, to resist mould failure.	II2-4	CO2
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Theory:

The physical properties of moulding sand widely vary with its ingredients. Compressive and shear strength of moulding sand solely depends on the relative amount of different ingredients. The main ingredients of moulding sand are sand, clay and moisture with some coal dust and adhesive material for better performance. Before making of any mould it is necessary to check the compressive and shear strength of the moulding sand, because sand having insufficient strength produce lot of casting defects.

Both the strength are determined by universal strength testing machine. The machine consists of various arrangements to determine compressive, shear, tensile strength and deformation of foundry sand. In each case, a specimen having standard size and shape is ruptured by subjecting respective stresses. The fracture stresses indicate respective strength values. The machine contains a scale to read the strength values directly.

Equipment:

Universal testing machine: The Universal Sand Strength Testing Machine consists of three major parts; frame, pendulum weight and pusher arm. The pusher arm is motivated by means of a small handwheel, which, through a gearbox, rotates a pinion engaged in a rack on the quadrant. The pendulum weight swings on a ball bearing and can be moved by the pusher arm, via test specimen, from a vertical position, with a consequent increase of a load on the testspecimen. A magnetic bar is moved up the calibrated scale by the pendulum weight and indicates the point at which the specimen collapses.

Compression and Shear heads
Sand Rammer and specimen tube

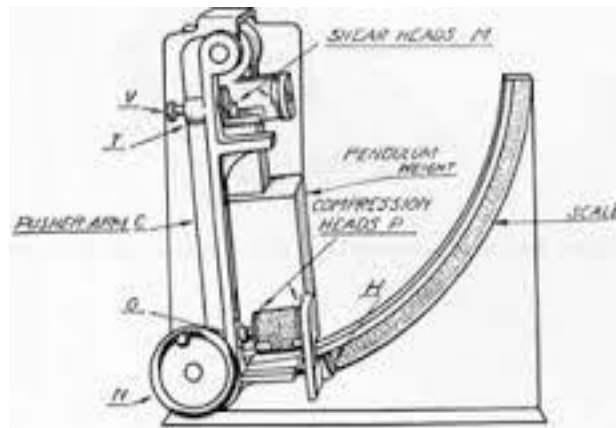


Figure: Universal Molding Sand Strength Testing Machine

Materials: Moulding sand, water.

Procedure:

- Remove the bolt located at left side of the machine.
- Keep the instrument on plane and sturdy table.
- Ensure the pendulum is swinging freely.
- ensure the front edge of pusher plate should coincide with "O" on the scale and the magnetic rider is resting against pusher plate.
- For testing green strength respective pads are inserted in bottom location and for dry strength in top location.



- Standard specimens (50mm diameter × 50mm length) are placed in between pads so that plane surface of the specimen touches against pad.
- Rotate the wheel in clockwise direction uniformly until the specimen breaks.
- Read the scale to determine corresponding strength
- Express the observed readings in kPa.
- To determine the variation of compressive strength with moisture content do the same for a no of specimen having only changed amount moisture content.

Precautions:

- If there is a gap in between the specimen and compressive pads, rotate the adjusting screw for removing gap
- Immediately after the breaking of the specimen, the pendulum with the pusher plate drops slightly down whereas the maximum effective compression strength is indicated on the scale by lower edge of the magnetic rider.

Conclusion:

- F.A.Q:**
1. What should be the normal range of green compression and shear strength of moulding sand?
 2. Why green shear strength is less than green compression strength?
 3. In what type of casting green shear strength is important?
 4. Why the sand specimen fails on rotation of the pendulum of the machine?
 5. What amount of compressive and shear forces are applied on the specimen when it fails?
 6. What modification of the machine is needed to increase the capacity of the machine?
 7. In case of measuring dry compression and shear strength where should the specimen be located?



INSTRUCTION ITEM-1(II-2)

EX2-V	Determine permeability of moulding sand, applying knowledge of gas venting, using a permeability meter, to avoid blowholes and pinholes.	II2-5	CO2
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Theory:

Permeability is the property of the moulding sand by virtue of which entrapped gases in the molten metal and moisture present or generated in the moulds can escape when the molten metal is poured in the mould and the rate of flow air passing through a standard specimen under a standard pressure is termed as permeability number.

It depends on the following factors:

- Shape and size of sand grains
- Moisture Content
- Clay Content
- Degree of ramming of sand

Principle: Permeability of sand sample is tested by a device known as permeability meter .It utilizes an arrangement to allow the exit of a controlled amount of air through the sand sample at a definite pressure difference. The corresponding time taken by the air in passing through the same is recoded separately. The standard permeability test is to measure time taken by a 2000 cub cm of air at a pressure typically of 10g/sq cm to pass through a standard sand specimen confined in a specimen tube. The standard specimen size is 50.8 mm in diameter and a length of 50.8 mm. Then the permeability number P is obtained by,

$$P = (V \times H) / (p \times A \times t)$$

Where, P= Permeability number
V= Volume of the air passing through the specimen in c.c
H=Height of specimen in cm
P=air pressure in kg/cm²
A= area of cross-section of the specimen incm²
T=time in minutes, taken by the air to pass

Specimen preparation: Since the permeability of sand is dependant to a great extent on degree of ramming, it is necessary that the specimen be prepared under standard condition. To get reproducible ramming conditions, a laboratory sand rammer is used along with a specimen tube. The measured amount of sand is filled in the specimen tube and a fixed weight of 6.35 to 7.25 kg is allowed to fall on the sand three times. To produce this size(50.8 mm height) of specimen usually sand of 145 to 175 gm would be required.

Equipment: 1. Specimen tube (metallic) 2. Rammer 3. Permeability meter.



Figure: Permeability Tester

Material Required: Silica sand, bentonite clay, water, coal dust, soda ash, potash,



Procedure:

- Screw proper orifice with washer on the rubber-sealing.
- Take the specimen tube with rammed specimen and place it inverted over the rubber-sealing.
- Check initial water level at “zero” mark in the manometer tube.
- Put the valve at “D” position and slowly lift the air tank to the top position.
- Then put the valve on “P” position. After a little while the water level in the manometer tube will rise to the maximum height and gets stabilized for some time.
- Take this manometer reading and note the corresponding permeability number from the chart affixed.
- Finally, put the valve on “D” position. The air tank automatically comes down releasing the entrapped air and the manometer shows zero.
- Repeat the above procedure as required.

Precautions:

- Pull the air tank slowly to bring it to its original position keeping the valve on “D” position to avoid water entering the air tube.
- For removal of the water completely from manometer use zero adjustment screw.
- Ensure positive sealing of the specimen tube on rubber-sealing boss.
- Select proper orifice and screw or unscrew it by hand pressure only.

Conclusion:

F. A. Q:

1. How will the specimen holder and tube assembly be leak proof?
2. What will be the effect on the permeability if the specimen is over rammed?
3. How will you ensure that the volume of air is 2000 cc?
4. What will happen if the amount of water poured is more than the required?
5. What should you do if the initial water level in the manometer is not at zero mark?



INSTRUCTION ITEM-1(II-3)

EX3	Prepare a sand mould, applying gating, risering and venting knowledge, using the pattern and tested sand, to get an accurate, defect-free cavity.	II3	CO3
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Theory:

Moulding involves packing and ramming of moulding sand around a pattern inside a mould box, withdrawing the pattern to make the mould cavity, setting cores (for hollow castings) in the mould cavity, and finishing and casting the mould.

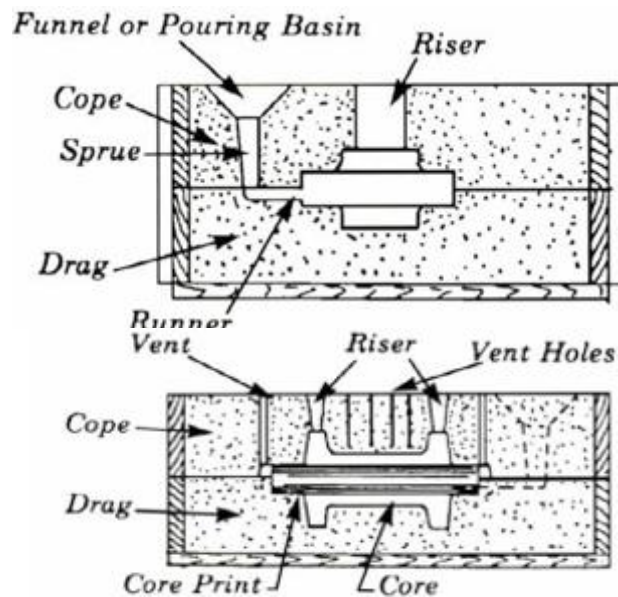


Figure: Schematic diagram of sand mould.

Molding Flask or Molding Box:

It is a rigid frame in which moulding sand is rammed to form a mould. These boxes do not have bottom and top. Boxes are made of steel, cast iron or aluminum alloys. Two boxes are required for a complete mould for a casting. Top box is called 'cope box' and the bottom box, 'drag box'. In the box, handles are provided for lifting. Lugs are cast with boxes. The lugs of one box will have projecting pins which enter the holes in the lugs of the other box. When the mould is made, the boxes are separated and the pattern is removed. Now, when the boxes are reassembled for pouring metals, the pins enter the holes in the lugs ensuring proper assembly as before.

Raw Materials

The principal ingredient of a moulding sand is silica sand, SiO_2 . Clay and water are other ingredients. Clay is a binder. It imparts plasticity to the moulding sand the moist state and strength when dried.

Classification of moulding sands according to the clay contents are as follows

Types of Sand	Clay Content (%)
Silica Sand	Up to 2
Lean Sand	2-10
Moderately Strong Sand	10-20
Extra Strong Sand (Loam Sand)	Up to 50

Additives

such as wood flour, coal dust, graphite, peat and other inorganic matter are added to the moulding sand to impart special properties and to enhance other properties. Upon contact with the molten metal, additives burn and produce gasses which form a gas "jacket". This prevents interaction between the metal and the mould material.

Coal dust (sea coal) used in moulding sands for cast iron for improving the surface finish and for the ease of cleaning the castings.

Cereal is ground corn flour. Used for increasing the green or dry strength or collapsibility. Wood flour helps to improve collapsibility.



Types of Moulding Sand:

Classification according to availability:

1. Natural sand: In some regions, this sand is available in a mixed condition along with clay. The sand has adequate properties required of moulding sand and hence, can be directly used after minor processing.
2. Synthetic sand: Synthetic sand is prepared by blending binder – free silica sand with clay and additives.

Classification based on moulding process:

1. Green sand: Sand in its natural and moist state.
2. Dry sand: For making large castings, the mould is dried and the sand is called dry sand.
3. Loam sand: Loam sand has high clay content (50%) employed for loam moulding of large castings.

Classification according to application:

1. Facing sand: Facing sand is used directly next to pattern surface so that it comes into contact with the molten metal when the molten metal is poured. Since it is subjected to severest conditions, it must possess high strength and refractoriness. It is made of silica sand and clay, with no addition of used sand.
2. Backing sand: Used to back – up the facing sand and to fill the whole volume of the moulding box. Used sand is usually used as backing sand.
3. System sand: System sand is used for making the entire mould, in machine moulding. Since the whole mould is of system sand, its properties must be higher than those of backing sand.
4. Parting sand: Parting sand is nothing but clean clay – free silica sand. It is used to prevent the green sand from sticking to the pattern and also to ensure clinging – free separation of cope and drag.
5. Core sand: A core is subjected to extremely severe conditions due to the surrounding of molten metal from all sides. Since the metal is all around the core, gases can escape only through core prints. Hence the core should have very high permeability and this can be achieved by mixing the core sand with core oil, resins and other binding materials.

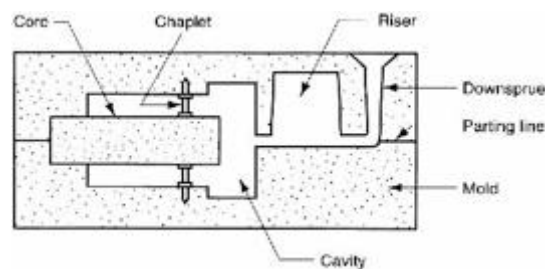


Figure: Possible chaplet design and casting with core.

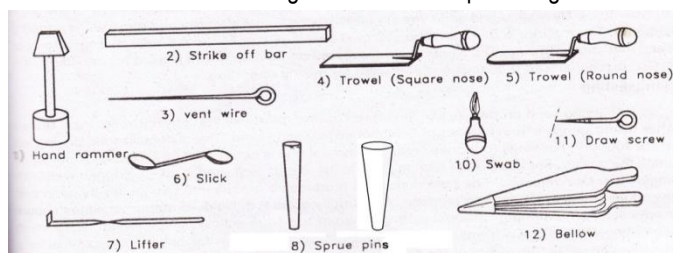


Figure: Moulding tools



Figure: Moulding flasks

Cores and Core Boxes:

A core is a preformed baked sand or green sand aggregate inserted in a mold to shape the interior part of a casting which cannot be shaped by the pattern. A core box is a wood or metal structure, the cavity of which has the shape of the desired core which is made therein. A core box, like a pattern is made by the pattern maker. Cores run from extremely simple to extremely complicated. A core could be a simple round cylinder form needed to core a hole through a hub of a wheel or bushing or it could be a very complicated core used to core out the water cooling channels in a cast iron engine block along with the inside of the cylinders. Dry sand cores are for the most part made of sharp, clay-free, dry silica sand mixed with a binder and baked until cured; the binder cements the sand together. When the mold is poured the core holds together long



enough for the metal to solidify, then the binder is finely cooked, from the heat of the casting, until its bonding power is lost or burned out. If the core mix is correct for the job, it can be readily removed from the castings interior by simply pouring it out as burnt core sand. This characteristic of a core mix is called its collapsibility. The size and pouring temperature of a casting determines how well and how long the core will stay together. A core for a light aluminum casting must collapse much more readily than a core used in steel, because of the different time, weight and heats involved.

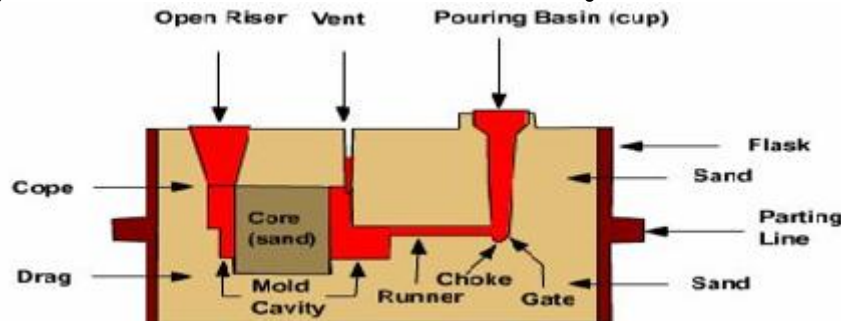


Figure: Mould section showing some casting terms

Casting Defects:

Defects may occur due to one or more of the following reasons:

- Fault in design of casting pattern.
- Fault in design on mold and core.
- Fault in design of gating system and riser.
- Improper choice of moulding sand.
- Improper metal composition.
- Inadequate melting temperature and rate of pouring.

Classification of casting defects

Surface Defect	Internal Defect	Visible defects
Blow	Blow holes	Wash
Scar	Porosity	Rat tail
Blister	Pin holes	Swell
Drop	Inclusions	Misrun
Scab	Dross	Cold shut
Penetration		Hot tear
Buckle		Shrinkage/Shift

Procedure:

- 1. The pattern is shown in Figure 10. The pattern is placed face downwards on a board and the bottom moulding box is placed round it in an inverted position as shown in figure.
- 2. The pattern is first covered with the mixture of facing sand and coal dust and then the box is filled up with used sand (backing sand) and well rammed using wooden rammer. The excess sand from the box is struck off using a strike – off bar.
- Now, the box, still resting on the board is turned over and the board is removed. The upper surface (which is rested on the board earlier) is leveled and smoothed with a trowel. A thin layer of parting sand (burnt sand or dust scraped from castings) is now sprinkled to avoid the adhering of sand in top box to that in the bottom box, so that the halves on the mould can be easily separated for removing the pattern.
- Next, the top box, facing sand is first thrown in and finally filling is completed with old sand. Now, gate and riser patterns are inserted and the sand is rammed well. Next, the gate and riser patterns are withdrawn, and the top box is lifted off and laid upside down on the floor or on the table.
- The pattern (still in the bottom box) is lightly “rapped” and lifted out using a draw spike. The impression of the pattern is now touched up using smoothing tools in case of any injury to the mould cavity. The sides of the cavity are dusted with fine plumbago to give a good surface to the casting.
- Channels (runners) are cut on the bottom mould (cope) to lead the metal from the pouring gate to the mould cavity and the top box is placed in position on the bottom box. Now the mould is ready for pouring.

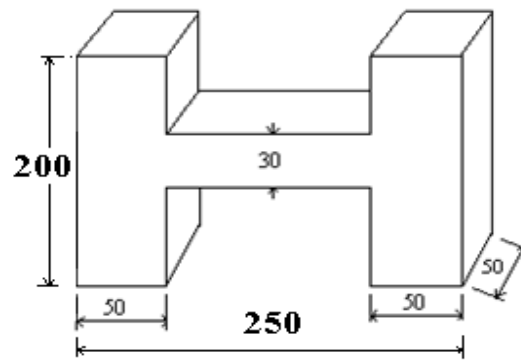


Figure: Machine part is to be manufactured by sand casting process.

Precaution:

- During mixing of Sand and clay hard particles should be removed otherwise mould may get damaged.
- Ramming should be done within limit. Too much ramming may lead to poor permeability.
- Moulding flasks should be handled carefully.

Conclusion:

F.A.Q:

1. What are the moulding tools used in making the mould?
2. What do you mean by post casting operations? What this operation is named?
3. What is the function of riser?
4. Why venting of the mould is needed?
5. What type of pattern is needed in making cylindrical casting and why?



INSTRUCTION ITEM-1(II-4)

EX4	Cast metal in prepared moulds, applying melting and solidification knowledge, using a furnace and ladle safely, to get a sound casting with minimal defects.	II4	CO4
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Theory: The casting process is the oldest, most versatile, and the most flexible process for forming metals. Basically, it consists of introducing molten metal into a cavity or mold of desired form and allowing the metal to solidify. There is practically no limit to the size, shape, and alloy of the casting that may be made. Castings regularly produced range from tiny dental inlay of rare metals to complicated steel castings exceeding 2000 ton in weight. Almost any article may be cast with proper technique. In sand casting, a mold is produced by shaping a suitable refractory material to form a cavity of desired shape, such that a liquid metal can be introduced into this cavity. The mold cavity has to retain its shape until the molten metal has solidified and the casting is separated from the mold. There are also some other types of casting processes: e.g. permanent mold casting, die casting, plaster casting, investment casting, squeeze / semi solid casting, slush casting, shot casting etc.

Equipment: Moulding tools, moulding board, moulding flasks, wooden pattern, crucible, furnace, ladle.



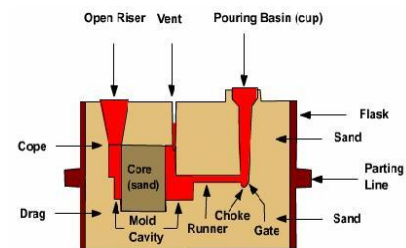
Figure: Furnace



Ladle



Bench Grinder



Mould section showing some casting terms

Materials: Molding Sand, Aluminum metal.

Procedure:

- After the preparation of sand mold, melt aluminum metal or any available aluminum alloy in a muffle furnace.
- When the metal is liquid enough to pour into the mold, put off the fire and hold the crucible with the help of a holder or ladder.
- Place some weight on the mold and pour the molten metal into the mold through the spruce or pouring basin.
- Continue pouring until the molten metal comes out of risers of the mold.
- Allow the metal to solidify in the sand mold for some time.
- When the metal in the mold is solidified, break the sand mold with the help of breakers to remove the required metal casting.
- Finally, the casting is machined to get the finished shape.

Precautions:

- Handle the moulding flasks carefully so that sand mould does not damage.
- Care should be taken at the time of placing the crucible so that heating elements do not damage.
- Remove the crucible from the furnace carefully.
- Pour the metal gently into the cavity.

Conclusion:

F.A.Q:

1. What are the moulding tools used in making the mould?
2. What do you mean by post casting operations? What this operation is named?
3. What is the function of riser?
4. Why venting of the mould is needed?
5. What type of pattern is needed in making cylindrical casting and why?



INSTRUCTION ITEM-1(II-5)

EX5	Forge carbon steel and test property changes, applying hot-working and heat-treatment knowledge, using a hearth, anvil and hardness tester, without cracks and within specified hardness.	II5	CO5
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Theory:

Forging is the term for shaping metal by using localized compressive forces. Cold forging is done at room temperature or near room temperature. Hot forging is done at a high temperature, which makes metal easier to shape and less likely to fracture. Warm forging is done at intermediate temperature between room temperature and hot forging temperatures.

Hot forging (Hot working)

Hot forging is defined as working a metal above its recrystallization temperature. The main advantage of hot forging is that as the metal is deformed the strain-hardening effects are negated by the recrystallization process.

Cold forging (Cold working)

Cold forging is defined as working a metal below its recrystallization temperature, but usually around room temperature. If the temperature is above 0.3 times the melting temperature (on an absolute scale) then it qualifies as warm forging.

Blacksmith

Blacksmithing is the art of shaping heated iron and steel with hand tools such as hammers or with forging machines. A Blacksmith is the person who does this work either by hand or with help of machines. "Black" comes from the color of the metal after being heated and cooled. "Smith" comes from the word, "smite" or "to strike". Therefore the blacksmith is one who strikes black metal.

Drawing:

Drawing lengthens the metal by reducing one or both of the other two dimensions. As the depth is reduced, the width narrowed, or both the piece is lengthened or "drawn out". As an example of drawing, a smith making a chisel might flatten a square bar of steel, lengthening the metal, reducing its depth but keeping its width consistent. Drawing does not have to be uniform. A taper can result as in making a wedge or the woodworking chisel blade. If tapered in two dimensions a point results.

Upsetting:

Upsetting is the process of making metal thicker in one dimension through shortening in the other. One form is by heating the end of a rod and then hammering on it as one would drive a nail: the rod gets shorter, and the hot part widens. An alternative to hammering on the hot end would be to place the hot end on the anvil and hammer on the cold end.

Equipments used: Hearth furnace, Hand hammer, anvil, tongs, etc.



Figure 1 Tools used for manual forging.

Procedure:

- A piece of MS rod is taken of length 230mm.
- The rod is heated at about 900°C in a hearth furnace. It takes near about 1 hr. for raising the temperature.
- The red hot rod is taken out from the furnace by the help of tongs. The rod is taken to the anvil for giving it a proper shape. Hand hammer is used to forge the red hot rod into a chisel shape.



- For giving this shape the rod heated for the second time.
- Again it taken out from the furnace and give the final shape as chisel edge. The heated chisel is kept in a flow of air for cooling.
- After it is cooled Hardness is tested where hot working is done, no working is done and where cold work is done.

Material	Condition of metal worked	Property tested



Figure 2. Some forged products

Precaution:

- Heated rod should be carefully taken out from the furnace.
- During forging care should be taken during removal of scales from hot metal
- Hot metal should be held firmly by tong.

Conclusion:

Frequently asked questions during Interviews:

1. What is forging processes?
2. What are the main advantage and disadvantage of forging processes?
3. What are Drawing and Fullering Process?
4. Compare Smith forging, drop forging, press forging and upset forging. Mention three points for each.
5. What advantages does press forging have over drop forging? Why are pure metals more easily cold worked than alloys?



INSTRUCTION ITEM-1(II-6)

EX6	Weld ferrous or non-ferrous metals, applying SMAW/GTAW/GMAW knowledge, using a welding machine with Personal Protective Equipment (PPE), to get a defect-free joint of required strength.	II6	CO6
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Theory:

Manual metal arc welding (MMAW), also known as Shielded metal arc welding (SMAW) or informally as stick welding, is a manual arc welding process that uses a consumable electrode coated in flux to lay the weld. An electric current, in the form of either alternating current or direct current from a welding power supply, is used to form an electric arc between the electrode and the metals to be joined. As the weld is laid, the flux coating of the electrode disintegrates, giving off vapors that serve as a shielding gas and providing a layer of slag, both of which protect the weld area from atmospheric contamination.

Most of the metals and alloys can be welded by one type of welding process or the other. However, some are easier to weld than others. To compare this ease in welding term 'weldability' is often used. The weldability may be defined as property of a metal which indicates the ease with which it can be welded with other similar or dissimilar metals. Elements of welding process used with common welding joints such as base metal, fusion zone, weld face, root face, root opening toe and root are depicted in Figure.

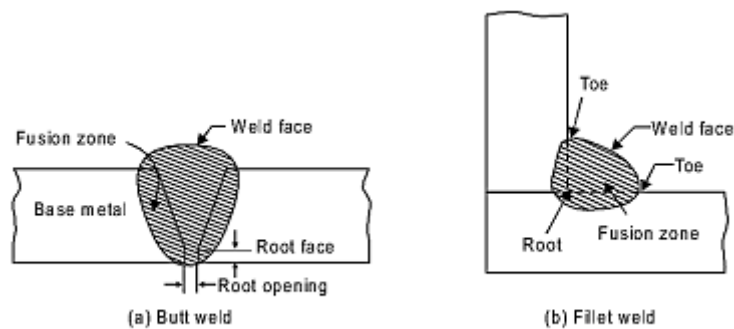


Fig. Terminological elements of welding process

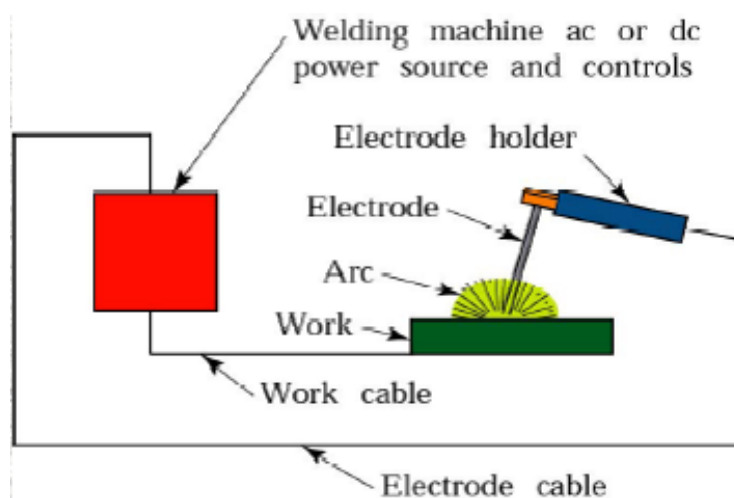


Figure: WELDING SETUP

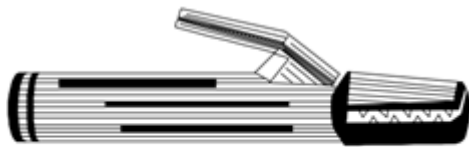


Fig. Electrode holder

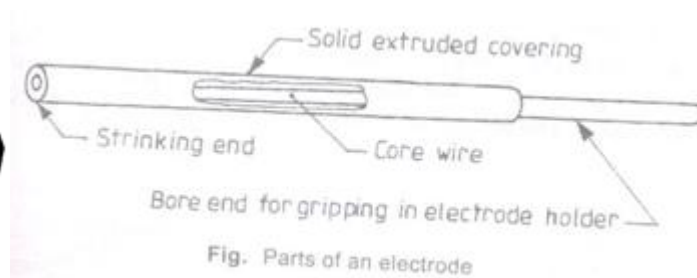


Fig. Parts of an electrode



Fig. Earth clamp

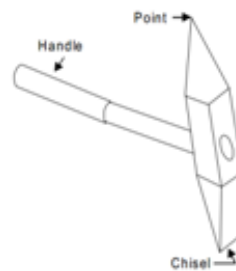


Fig. Chipping and hammer

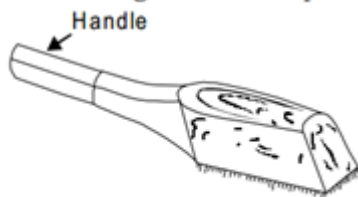


Fig. Wire brush

Safety Recommendations for ARC Welding

The beginner in the field of arc welding must go through and become familiar with these general safety recommendations which are given as under.

- The body or the frame of the welding machine shall be efficiently earthed. Pipe lines containing gases or inflammable liquids or conduits carrying electrical conductors shall not be used for a ground return circuit. All earth connections shall be mechanically strong and electrically adequate for the required current.
- Welding arc in addition to being very hot is a source of infra-red and ultra-violet light also; consequently the operator must use either helmet or a hand-shield fitted with a special filter glass to protect eyes.
- Excess ultra-violet light can cause an effect similar to sunburn on the skin of the welder.
- The welder's body and clothing are protected from radiation and burns caused by sparks and flying globules of molten metal with the help of the following:
 - Gloves protect the hands of a welder.
 - Leather or asbestos apron is very useful to protect welder's clothes and his trunk and thighs while seated he is doing welding.
 - For overhead welding, some form of protection for the head is required.
 - Leather skull cap or peaked cap will do the needful.
 - Leather jackets and leather leggings are also available as clothes for body protection.
- Welding equipment shall be inspected periodically and maintained in safe working order at all times.
- Arc welding machines should be of suitable quality.
- All parts of welding set shall be suitably enclosed and protected to meet the usual service conditions.

Welding joints

Some common welding joints are shown in Figure. Welding joints are of generally of two major kinds namely lap joint and butt joint. The main types are described as under.



1. Lap weld joint 2. Butt weld joint 3. Tee Fillet Weld 4. Edge joint 5. Corner joint



Material Required:

Mild steel plate of size 50X30X5 mm – 2 No's

Welding Electrodes: M.S electrodes 3.15 mm X450 mm

Welding Equipment/ Tools:

1. Air cooled transformer Voltage-80 to 100 V 3 phase supply, amps up to 400.
2. Electrode holder
3. Electrode cable and Earthing cable
4. Ground or Earthing clamp
5. Tongs
6. Wire Brush
7. Chipping hammer
8. Welding table (metallic)

Safety equipments required:

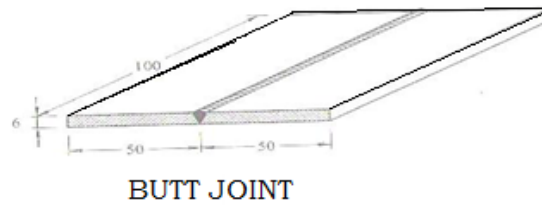
1. Face shield
2. Leather Apron
3. Leather Hand Gloves

Sequence of operations:

1. Tacking
2. Welding
3. Cooling
4. Chipping
5. Cleaning

Procedure:

- The given M.S pieces are thoroughly cleaned of rust and scale.
- The two pieces are positioned on the welding table such that, they are separated slightly for better penetration of the weld.
- The electrode is fitted in the electrode holder and the welding current is set to be a proper value.
- The ground clamp is fastened to the welding table.
- Wearing the apron and using the face shield, the arc is struck and holding the two pieces together; first run of the weld is done to fill the root gap.
- Second run of the weld is done with proper weaving and with uniform movement. During the process of welding, the electrode is kept at 150 to 250 mm from vertical and in the direction of welding.
- The scale formation on the welds is removed by using the chipping hammer.
- Filing is done to remove any spatter around the weld.



Conclusion:

The single V-butt joint is thus made, using the tools and equipment as mentioned above.

F.A.Q:

1. Which tool is used to clean the surface of the workpiece?
2. What is the source of deposition of metal?
3. What is the criteria of two metals to be welded?
4. What is the role of shielding gas formed around the weld zone?
5. What power source has to be used in case of non-consumable electrode?
6. Why chipping hammer is used?