Name---------------------------

Roll no. ------------------------

Day-----------------------------

LABORATORY MANUAL
TA201A MANUFACTURING PROCESSES-I

Indian Institute of Technology, Kanpur

DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING

COURSE INSTRUCTOR	**LAB INCHARGE**	**COURSE INCHARGE**
Dr. Niraj Mohan Chawake Office: Faculty Building 412 A Ph: 2181/ nchawake@	**Mr. Anil Kumar Verma** Ph: 7978/akumarv@	**Mr. Indra Pal Singh** Ph: 7978/indraps@
Lecture	**Tuesday** **09:00 – 10 :00**	**(Venue L-20)**
Laboratory	**Monday to Friday** **(As per one of the assigned days of your section)** **02:00 pm to 05:00 pm** **Venue: Engineering Metallurgy Lab.**	

2022-2023 Sem-I

CONTENTS

TA201A: Introduction of Manufacturing Processes-I

Engineering Metallurgy Lab

*2022-2023, Semester-I, **Laboratory Schedule***

Time: **02:00 pm to 05:00 pm**

Experiment → Turn / Day & Section ↓	1st E 1	2nd E 2	3rd E 3	4th E4	5th E5	6th Lab Exam +Drawing Submission	7th P 1	8th P 2	9th P3	10th P4	11th P5	12th P6	13th Project Evaluation
Monday	6/8*	8/8	22/8	29/8	3/9@	5/9	12/9	26/9	10/10	17/10	31/10	7/11	14/11
Tuesday	2/8	16/8	20/8**	23/8	30/8	3/9***	6/9	13/9	27/9	11/10	18/10	25/10	1/11
Wednesday	3/8	10/8	17/8	24/8	31/8	7/9	14/9	28/9	12/10	19/10	26/10	2/11	9/11
Thursday	4/8	11/8	18/8	25/8	1/9	8/9	15/9	29/9	13/10	20/10	27/10	3/11	10/11
Friday	5/8	12/8	26/8	27/8#	2/9	9/9	16/9	30/9	14/10	21/10	28/10	4/11	11/11

Holiday/ Mid &End Examination	Date
Muharram	09 August, 2022 (Tue)
Independence Day	15 August,2022 (Mon)
Janmashtami	19 August, 2022 (Fri)
Mid Semester Examination	19 Sep – 24 Sep, 2022 (Mon- Sat)
Mid Semester Recess (Dussehra)	01 Oct – 09 Oct, 2022 (Sat - Sun)
Diwali	24 October,2022 (Mon)
Guru Nanak's Birthday	08 Nov, 2022 (Tue)
End Semester Examination	21 Nov – 30 Nov, 2022 (Mon- Wed)

Make-up lab on Saturday
06/08/2022@10:00 am to 01:00 pm (Monday Batch)*
20/08/2022@10:00 am to 01:00 pm (Tuesday Batch)**
27/08/2022@10:00 am to 01:00 pm (Friday Batch)#
03/09/2022@10:00 am to 01:00 pm (Monday Batch)@
03/09/2022@02:00 pm to 05:00 pm (Tuesday Batch)***

Course Staff In-Charge	Lab In-Charge	Course Instructor
Mr. Indra Pal Singh 7978/indraps@	Mr. Anil Kumar Verma 7978/akumarv@	Dr. N M Chawake 2181/nchawake@

Tutor, TAs & staff members contact:

Tutors:

Day	Tutor's	E mail	phone
Monday	Dr. Niraj Mohan Chawake	nchawake@	2181
Tuesday	Dr. Srinu Gangolu	srinu@	
Wednesday	Dr. Sudhanshu Shekhar Singh	sudhanss@	6908
Thursday	Prof. Vivek Verma	vverma@	6527
Friday	Dr. Shikhar Misra	shikharm@	2257

TAs:

Day	Roll No.	Name	Mobile no.	Email
Monday	21106033	V S S Manoj Kumar Gunnabhaktula	9030665844	mkumarg21@
	18106261	Ajay Singh	8810647604	ajaysgh@
Tuesday	21206261	Md Irfan Ali		irfanali21@
	21106029	Satyam Kumar Shukla	7292882136/9918405672	skshukla21@
Wednesday	21106031	Swastika Paul	9933744971	swastikap21@
	21106028	Satabhisha Ghosh	8336857136/8777474679	sghosh21@
Thursday	21106287	Kunal Kishore	9113366358	kunalk21@
	21106288	Rajneesh Pandey	7000123327	rajneeshp21@
Friday	18106268	Kaushal Rajenaprasad Shakya	8446774162	kashakya@
	21106280	Shubham Prabhudayal Jaiswal	7588779816	shubhampj21@
Following two TAs will be used for attendance and other jobs related to the course.				
	21106286	Divanshu Kumar (Theory)	8008950284	divanshuk21@
	20106271	Murli Manohar (Theory)	9149973498	murlimhr20@
	18206267	Sandeep Kumar Sahni	7392848010	ssahni@

Staff members:

S No.	Staff 's	E mail		Phone
1.	Mr. Anil Kumar Verma	akumarv@iitk.ac.in	9450729498	7978
2.	Mr. Indra Pal Singh	indraps@iitk.ac.in	9452961465	7978/7865
3.	Mr. Nripen Deka	dnripen@iitk.ac.in	8303306481	7978
4.	Mr. Rakesh Kumar	kumarr@iitk.ac.in	9415479184	7978/7375
5.	Mr. Gaurav Mishra	mgaurav@iitk.ac.in	7985496928	7978
6.	Mr. Bharat Raj Singh	brsingh@iitk.ac.in	9795955448	7978
7.	Mr. Anurag Prasad	anuragp@iitk.ac.in	7379797330	7978/6277
8.	Mr. Pappu	--	7388827052	7978

General Information
Grading policy:

- Theory (40% weightage of the total): Mid Semester Exam (2 hours): 40%, End Semester Exam (3 hours): 60%
- Laboratory (60% weightage of the total): Weekly lab quiz: 10%, Weekly Job: 10%, Lab Exam: 20%, Project Report: 10%, Project evaluation: 50%
- There will be a total of 13 lectures starting from 02 August 2022
- Anyone attending 12 lectures or more will awarded 5% extra marks to theory component (unless scored 100%)
- Those attending all the labs will earn 5% extra marks in the lab component.
- No make-up lab will be provided for cultural/ sports activities or casual leaves.
- If you attend less than 10 labs, you will be deregistered from the course or will be awarded 'F' if last of deregistration is over.
- All the lab turns from E1 to E6 is mandatory. The only exception is medical emergency which must be approved by SUGC.
- Only SUGC approved medical cases will be given a makeup lab and any other kind of absence will automatically result in deregistration from the course.
- Absence from project turns (P1-P6) will invite a penalty of 10 marks in the project assuming that project is of 60 Marks (will be prorated appropriately).

Safety:

- To avoid injury, the student must take the permission of the laboratory staff before handling any machine. Careless handling of machines may result in serious injury.
- Students must ensure that their work areas are clean and dry to avoid slipping.
- A leather apron and leather hand gloves will be issued to each student during Welding and Brazing exercises. Students not wearing the apron will not be permitted to work in the laboratory.
- At the end of each experiment, students must clear off all tools and materials from the work area.
- During Sheet Metal forming wearing cotton hand gloves must be compulsory.
- Students must come to the laboratory wearing (i) Trousers, (ii) Full-sleeve tops and (iii) Closed shoes.
- Project report must be submitted by 6th turn. Any group not submitting the project report by this time will be deregistered from the course.

Rules:

- Follow the lab timing (2:00pm – 5:00pm). There will be two attendances: Initial attendance (at sharp 2 PM) to be taken by TAs at the beginning of the lab session and final one consists of filling the job submission form.
- **Mobile phone is strictly prohibited during the lab. Any violators will be expelled from that lab turn.**
- Students arriving late would be sent back (compulsorily after 2.05pm)
- **Half pants, loosely hanging garments, slippers and sandals are not allowed**.
- Students should tie their hair properly with no loose or long hanging hair
- Before commencement of the experiment, there will be a 5-minute lab-quiz on questions related to previous lab.
- Every student should obtain a copy of Manufacturing Processes Laboratory manual from **Copy Point (Shop-C).** You are required to bring your lab manual every day. Lab manual will also be available online.

Suggested Reading Materials:

- **Preferred:** Fundamentals of Modern Manufacturing: Materials, Processes and Systems, Mikell P. Groover
- Fundamental of Manufacturing, G. K. Lal & S. K. Choudhury
- Materials & Processes in Manufacturing, E. P. DeGarmo, J. T. Black and Kohser.
- Manufacturing Engineering & Technology, S. Kalpakjian
- E. P. Degarmo: Materials & Processes in Manufacturing, Macmillan.

Lab turns distribution:

S No.	Lab Turn	Experiments	Staff members
1	E-1	Moulding and Casting	Mr. Anurag Prasad / I P Singh,
2	E-2	Sheet Metal Forming	Mr. Rakesh Kumar
3	E-3	Welding Process	Mr. Gaurav Mishra
4	E-4	Brazing	Mr. Bharat Raj Singh/ Mr. Anil kumar verma
5	E-5	Object Fabrication	Mr. Nripen Deka
6	LE-6	Lab Exam	Respective staff (as per experiment)
7	P-1	Project	Staff supervisor
8	P-2	Project	Staff supervisor
9	P-3	Project	Staff supervisor
10	P-4	Project	Staff supervisor
11	P-5	Project	Staff supervisor
12	P-6	Project	Staff supervisor
13	P-7	Project Evaluation	Tutors with respective staff

Rotation of experimental turns:

Group -1	Group-2	Group-3	Group-4	Group-5
E-1	E-2	E-3	E-4	E-5
E-2	E-3	E-4	E-5	E-1
E-3	E-4	E-5	E-1	E-2
E-4	E-5	E-1	E-2	E-3
E-5	E-1	E-2	E-3	E-4

Project schedule:

2nd Turn	Project group formation
3rd Turn	Bring a minimum of three project ideas along with the rough sketch. One project idea will be finalized on this turn.
4th Turn	Discussion on a finalized project with proper drawing as per engineering norms, including parts drawing (with numbering and materials)
5th Turn	A final discussion on drawing and process (bring complete report)
6th Turn	Final drawing submission.
7th - 12th Turns	Projects
13th Turn	Project Evaluation

Outline of project report:

S. No.	Description	Page no.
1	Project name	1
2	Tutor name	
3	Staff supervisor	
4	Section:	
5	S No. / Roll no. / Name / Signature’s	
6	Contents	2
7	Certificate about plagiarism (format to be obtained from the lab or course website.	3
8	Acknowledgement	4
9	Introduction	5
10	Motivation	6
11	Group member work distribution	7
12	Materials List	8
13	Isometric Drawing with numbering	9
14	Part Drawing (mm, page no.)	10 xyz

Point to be used in the project:

- Which part will be made from which process?
- You would learn basic of manufacturing techniques in this lab for example metal forming, casting and welding and brazing. Out of these, you must involve minimum three techniques in your project.
- Proper drawing should be made and submitted in consultation with tutor and lab staff.
- The part drawing should be made with appropriate dimensions.
- You have to make isometric and part drawing with appropriate dimensions on A-4sheet.

Project size:

- Size of the project: 40 cm × 40 cm × 40 cm (to be strictly followed) and total weight for casting objects should not exceed 500g (Aluminum) per project as per required. Oversize/overweight projects will invite penalty in the project evaluation.
- Total project weight should not exceed 5 Kg.
- External colour/paint should not be used.
- Do not polish/grind cast component used in your project.

About the project

1. Plan your project carefully. Do not make it unnecessarily complicated. The project has to be entirely your work. Laboratory staff (Technical guide) will provide only the guidelines. They will not make any part of your project.
2. Your tutor, lab in-charge and the technical staff will advise you on the design of your project.
3. There will be no extra lab turn for project.
4. The project groups will be formed and informed to you by the end of the second lab turn.
5. You should come with at least three ideas with the rough sketch on the third lab turn for the discussion and to be frozen one idea.
6. On the fourth and fifth lab turns you should come with all necessary information such as drawing; manufacturing process for each part etc. The drawing should be as per the engineering norms.
7. The copy of the final project drawing with material list and process plan (complete report) must be submitted on the sixth lab turn. You should select materials from the list only. (The list will be displayed on lab notice board).
8. The exact responsibilities of each group member should be specified.
9. Two best projects will be chosen from each day. There will be one overall best project award out of all the shortlisted projects. The certificates will be given to the students (winners) in a common gathering after project evolution.
10. Size of the project: 40 cm. x 40cm. x 40cm. (**to be followed strictly**) and total weight for casting objects (cast iron) should not exceed 1.5 kg and 1kg of aluminium per project. The oversized and over-weighted project will be imposed with negative marking.
11. Do not grind the aluminium parts of the project.
12. At least three operations are to be incorporated in the project. (Welding process, molding & casting and metal forming process)
13. Moving parts in your project will be given extra credit during evaluation.
14. External colour/paint cannot be used. Polishing/grinding of the cast component used will not allow.

In case of any doubt regarding the above, please contact Mr. Anil Kumar Verma & Mr. Indra Pal Singh.

Projects materials list of TA201P			
S. No.	Descriptions	Size	Approx. Rate
1	Mild Steel Flat	25 mm x 3 mm	Rs.65/kg
2	Mild Steel Flat	25 mm x 5 mm	Rs.63/kg
3	Mild Steel Round Rod	25 mm dia	Rs.65/kg
4	Mild Steel Round Rod	10 mm dia	Rs.68/kg
5	Mild Steel Round Rod	8 mm dia	Rs.68/kg
6	Mild Steel Round Rod	6 mm dia	Rs.70/kg
7	Mild Steel Round Rod	5 mm dia	Rs.70/kg
8	Mild Steel Round Rod	4 mm dia	Rs.70/kg
9	Mild Steel Round Rod	3 mm dia	Rs.80/kg
10	Mild Steel Square Rod	10 mm x 10 mm	Rs.63/kg
11	Mild Steel Square Rod	6mm x 6 mm	Rs.65/kg
12	Mild Steel Round Pipe	1 inch dia	Rs 450/20 ft length pipe
13	Mild Steel Round Pipe	3/4 inch dia	Rs 425/20 ft length pipe
14	Mild Steel Round Pipe	10 mm dia	Rs 300/20 ft length pipe
15	Mild Steel Square Pipe	25 mm x 25 mm	Rs 450/20 ft length pipe
16	Mild Steel Square Pipe	15 mm x 15 mm	Rs 300/20 ft length pipe
17	Mild Steel Angle	25 mm x 25 mm	Rs 450/20 ft length pipe
18	Mild Steel Discs	20-50 mm dia x 10 mm thick	Avg ~ Rs 20-25/disc
19	Galvanized Iron Sheet	3 ft x 8 ft x 0.35 mm	Rs 756/sheet
20	Galvanized Iron Sheet	3 ft x 8 ft x 0.5 mm	Rs 820/sheet
21	Mild Steel Sheet	4 ft x 8 ft x 0.5 mm	Rs 945/sheet
22	Mild Steel Sheet	4 ft x 8 ft x 0.7 mm	Rs 1058/sheet
23	Mild Steel Sheet	4 ft x 8 ft x 1.0 mm	Rs 1278/sheet
24	Mild Steel Sheet	4 ft x 8 ft x 2.0 mm	Rs 3090/sheet
25	Thermocol	1000 cm x 500 cm x 12 mm	Rs 30/sheet
26	Thermocol	1000 cm x 500 cm x 24 mm	Rs 65/sheet
27	Thermocol	1000 cm x 500 cm x 36 mm	Rs 110/sheet
28	Thermocol	1000 cm x 500 cm x 48 mm	Rs 160/sheet
29	Thermocol	1000 cm x 500 cm x 74 mm	Rs 220/sheet
30	Fevicol	small size tube	Rs 5/tube
31	Sandpaper for thermocol	(9X11 inch), No. 80	Rs 7/sheet
32	Nut-Bolt Mild steel Washer	all sizes	Avg ~ Rs 10/piece
33	Thin Galvanized Wire	1 mm and 2 mm dia	Rs 20/ meter
34	Aluminium for melting	ingots	Rs 380/kg

INTRODUCTION TO CASTING PROCESSES

Background

Casting is one of the oldest and one of the most popular processes of converting materials into final useful shapes. The casting process is primarily used for shaping metallic materials; although it can be adopted for shaping other materials such as ceramic, polymeric and glassy materials. In casting, a solid is melted, treated to the proper temperature and then poured into a cavity called mould, whose shape is similar to final desired shape in which molten metal spreads completely before solidification starts. Simple as well as complex shapes can be made from any metal that can be melted. The resulting product can have virtually any configuration the designer desires.

Casting products range in size from a fraction of centimeter and fraction of kilogram to over 10 meters and many tons. Moreover, casting has marked advantages in the production of complex shapes, of parts having hollow sections or internal cavities, of parts that contain irregular curved surfaces and of parts made from metals which are difficult to machine.

Several casting processes have been developed to suit economic production of cast products with desired mechanical properties, dimensional accuracy, surface finish etc. The various processes differ primarily in mould material (whether sand, metal or other material) and pouring method (gravity, pressure or vacuum). All the processes share the requirement that the material solidifies in a manner that would avoid potential defects such as shrinkage voids, gas porosity and trapped inclusions. The casting process involves three necessary steps, i.e. mould making, melting and pouring of melt into the mould cavity, and removal and finishing of casting after complete solidification. One of the significant classifications of casting is based on whether the mould is used again or it is prepared fresh every time. Sand casting is an example of an expendable mould process or where the mould is broken after every casting to remove the component. In this lab, students will practice this particular process by making the mould and then pouring the liquid metal into the mould to form a final component.

SAND CASTING PROCESSES

Sand is one of the cheaper, moderately refractory materials and hence is commonly used for making moulds. Sand contains grains of silica (SiO_2) along with a few impurities. For mould making, sand is mixed with a binder material such as clay, molasses, oil, resin etc.

Green Sand Moulding

In the green sand moulding process, clay (a silicate material) along with water (to activate clay) is used as a binder. The mould-making mainly consists of preparing a cavity having the same shape as the part to be cast. There are many ways to obtain such a cavity or mould, and in this demonstration, you will learn to make it using a wooden ‘pattern’, metal ‘flasks’ and ‘green-sand’ as the mould material.

A pattern is a reusable form having approximately the same shape and size as the part to be cast. A pattern can be made out of wood, metal or plastic; wood is the most common material. Green sand refers to an intimate mixture of sand (usually river sand), bentonite clay (3-7% by weight of sand, to provide bonding or adhesion between sand grains), and water (3-6% by weight of sand, necessary to activate the bonding action of the clay).

Mixing the above ingredients in a sand muller provides the intimate mixing action. In practice, a significant part of this sand mixture consists of ‘return sand’, i.e. the reusable portion of the sand left after the solidified metal casting has been removed from the mould. Moulding flasks are rectangular frames with open ends, which serve as containers in which the mould is prepared. Usually, a pair of flasks are used; the upper flask is referred to as ‘Cope’ and the lower one as ‘Drag’. A riddle is a relatively coarse sieve which is used to break the lumps in the green sand and its aeration.

Sometimes the casting itself must have a hole or cavity in or on it. In that case, the liquid metal must be prevented from filling certain portions of the mould. A ‘core’ is used to block off portions of the mould from being filled by the liquid metal. A core is normally made using sand with a suitable binder like molasses. The core is prepared by filling the core-box with core sand to get the desired shape and the baking this sand core in an oven at a suitable temperature. During mould making, a suitable ‘gating system’ and a riser’ is also provided. The gating system is the network of channels used to deliver the molten metal from outside the mould into the mould cavity. Various components of the gating system are pouring cup, sprue, runners and gates. Riser or feeder head is a small cavity attached to the casting cavity, and the liquid metal of the riser serves to compensate the shrinkage in the casting during solidification and ideally should be last to freeze. Fig. 1 below shows the various parts of a typical sand mould. Several hand tools, such as rammer, trowel, sprue pin, draw spike, slick, vent wire, gate cutter, strike-off bar etc. are used as aids in making a mould.

Melting and Pouring of Metals

Next important step is the melting of metal. A melting process must be capable of providing molten metal not only at the proper temperature, greater than melting point, but also in the desired quantity, with acceptable quality, and within a reasonable cost. In order to transfer the metal from the furnace into the moulds, some pouring device, or ladle, must be used. The primary considerations are to maintain the metal at the proper temperature for pouring and to ensure that only quality metal will get into the moulds (without slag or oxide). The operations involved in the melting of metal in oil-fired furnace/induction furnace and pouring of liquid metal into the mould cavity will be shown during the demonstration.

Removal and Finishing of Castings

After complete solidification, the castings are removed from the mould. Most castings require some cleaning and finishing operations, such as removal of cores, removal of gates and risers, removal of fins and flash, cleaning of surfaces, etc.

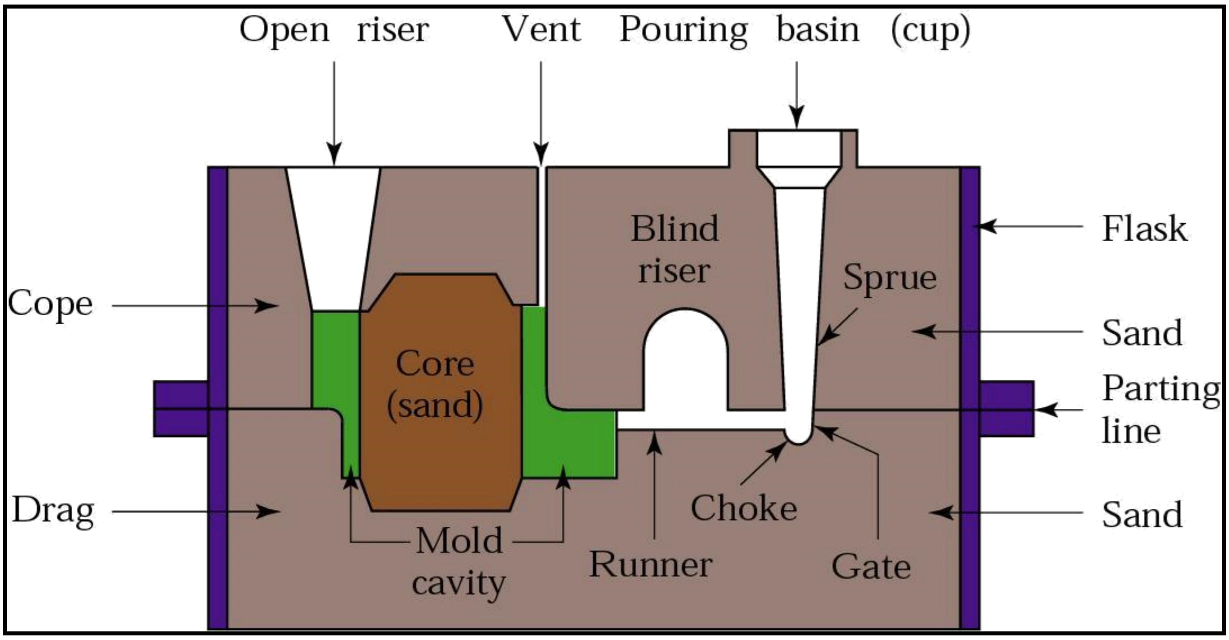

Fig: 1. Cross-section of a typical two-part sand mould, indicating various mould components and terminology.

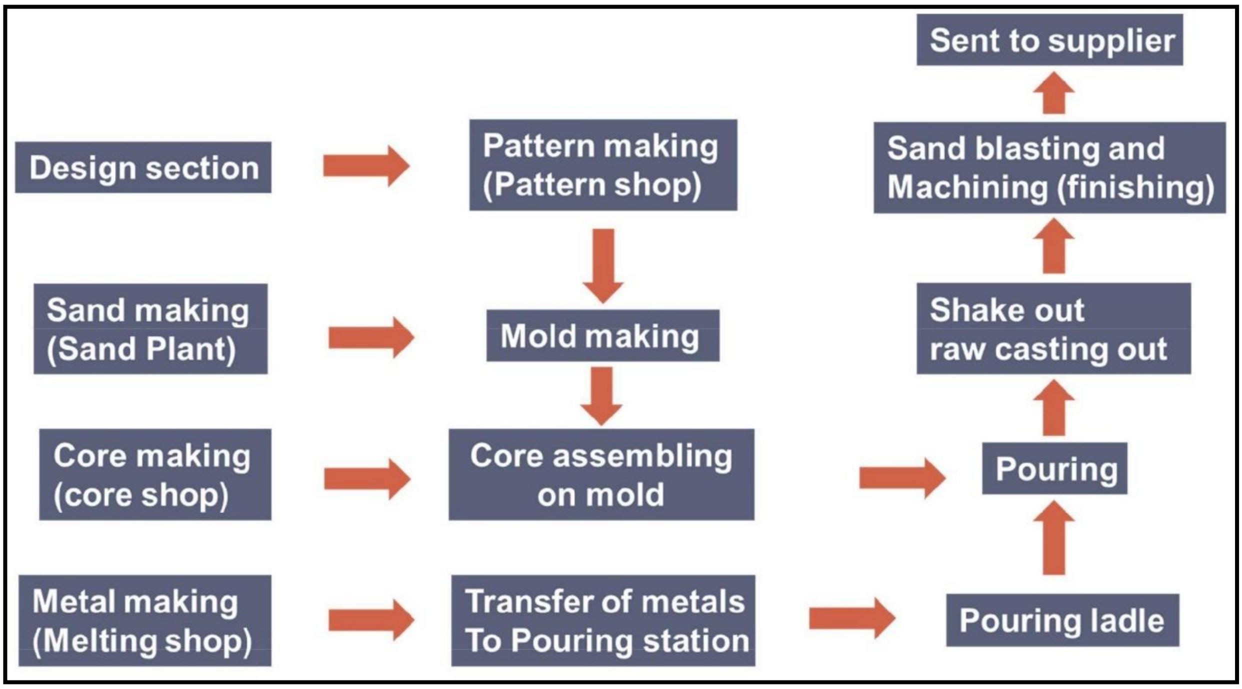

Fig: 2. Schematic illustration of the sequence of operations for sand casting.

EXERCISE-1

MOULD MAKING & CASTING

Objectives

1. To prepare a pattern for a given object for lost form casting.
2. To prepare a Greensand mould from the prepared pattern.
3. To melt and pour Aluminum metal into the mould.

Equipment and Materials

Pattern, Core box, Moulding flasks, Moulding tools, Sand muller, Riddle, Sand, Bentonite, Core baking oven, Thermocol, Melting furnace, Fluxes, Pouring ladle, Pyrometer, Hacksaw, File

Procedure

A pattern for lost form casting

Fig: 3 Foam pattern and the corresponding cast object.

Mould Making

(i) Place the drag part of the moulding flask and riddle moulding green sand to a depth of 2 cm in the drag.

(ii) Place the pattern at the centre of the drag (flask)

(iii) Pack the sand carefully around the pattern, as shown in figure 4. Heap more moulding sand in the drag and ram with rammer carefully

(iv) Place the core half of the pattern over the drag pattern matching the guide pins and also place the gating system with sprue and riser in proper positions.

(v) Complete the cope half by repeating steps 3. Remove the extra sprue and riser pins and make a pouring basin.

Fig: 4. Equipment for sand mixing and a prepared mould.

Melting and Pouring

(i) Melt the metal in the furnace. Use appropriate fluxes at proper stages to prevent the oxidation of the metal. Measure metal temperature from time to time.

(ii) Pour the molten metal into the pouring ladle kept at a higher temperature (say 100^{o}C higher) than the pouring temperature. As soon as desired pouring temperature is achieved, pour the liquid metal into the mould in a steady stream with ladle close to the pouring basin of the mould. Do not allow any dross or slag from the surface to go in the ladle.

(iii) Allow sufficient time for the metal to solidify in the mould. Break the mould carefully and remove the casting.

(iv) Cut-off the riser and gating system from the casting and clean it for any sand etc.

(v) Inspect the casting visually and record any surface and dimensional defects observe.

Fig: 5. Furnace for melting metal for pouring into the mould

INTRODUCTION TO SHEET METAL FORMING

Introduction

Many products are manufactured from sheet metal involving a combination of processes such as shearing, bending, deep drawing, spinning etc. These processes are characterized by localized deformation and configuration changes and are together called “Sheet Metal Forming”. These processes do not result in a bulk shape change of the parts but lead to configurational changes. Sheets have large surface area to volume ratio of starting metal which distinguishes these from bulk deformation. Sheet metal forming is often called ‘press working’ as presses are required to perform these operations. Parts are usually called stampings, and usual tools involve punches and dies. Sheet metal operations can involve a combination of stresses, for example,

- Stretching of the metal (tensile stresses)
- Bending of the metal (tensile and compressive stresses)
- Cutting of the metal (shear stresses)

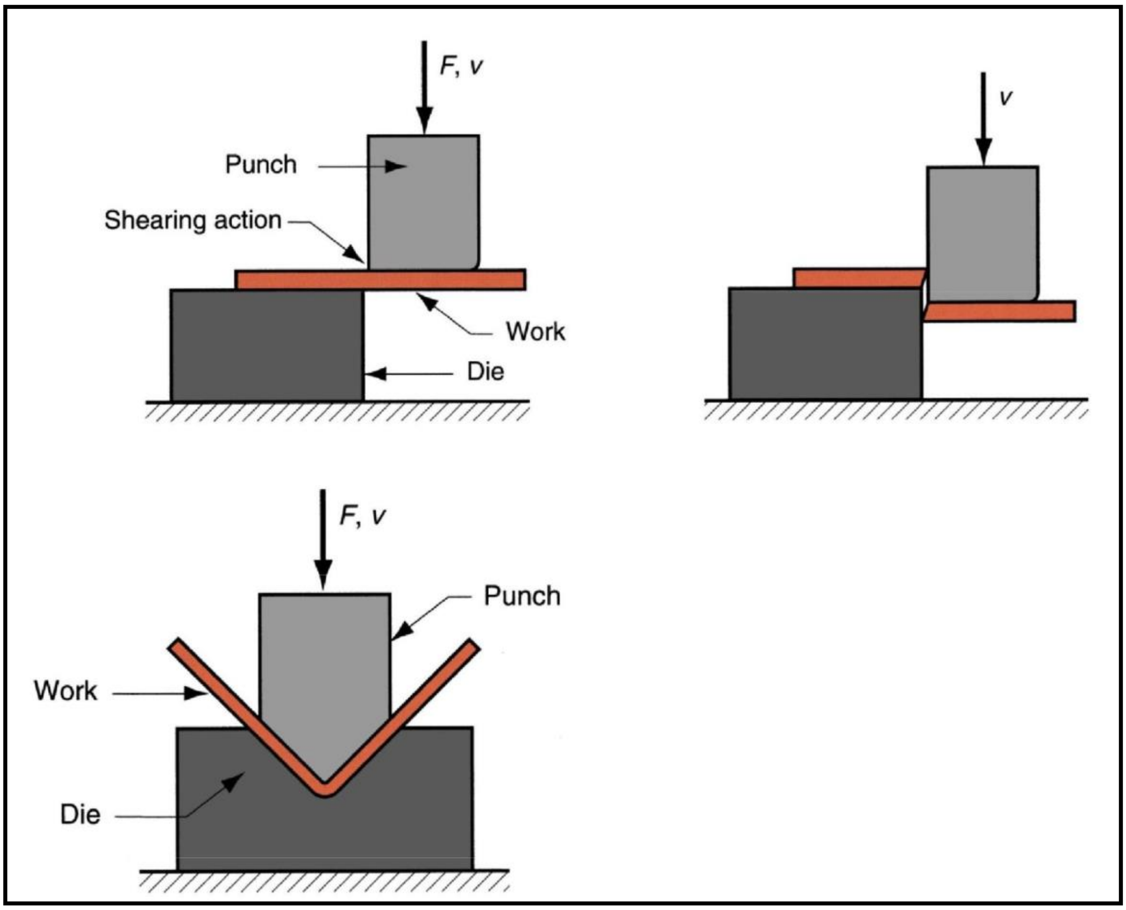

Fig.: 6. Schematic of a few sheet metal working operations (top) shearing (bottom) bending

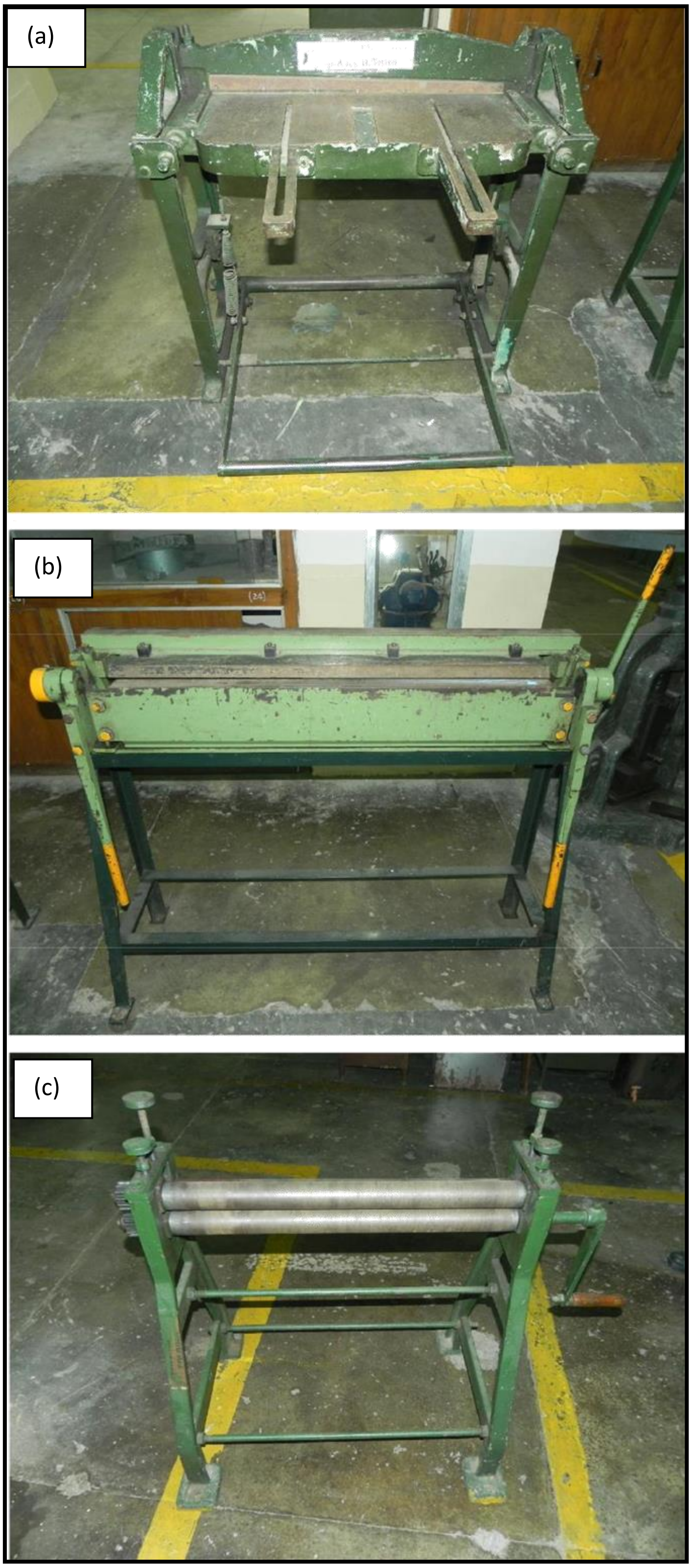

Fig.:7. Some of the apparatus available in engineering metallurgy lab to perform sheet metal forming (a) Shearing equipment (b) Bending equipment (c) Folding equipment

EXERCISE-2

SHEET METAL FORMING

Objectives

(i) To prepare a sheet metal product (Funnel).
(ii) Report various parameters for the various passes during the rolling of the given metal piece.

Equipment & material

Mallet, hand snip, bench vice, grooving tool, scriber, scale, marker, light weight hammer, divider and metal sheet

Demonstration

Self secured sheet metal joints

(a) Internal grooved joint

- Mark out portions of given sheets near edges to be joined with a marker.
- Fold the sheets at edges in the portion marked, first at right angles to the plane of the sheet and then at 180° to the plane.
- Insert one folded sheet into the other.
- Groove the seam using grooving die.

(b) Double grooved joint

- Fold sheets after making them as per the instructions are given.
- Cut a piece of a sheet (called strap) of required width.
- Strap width = (4x size of marked edges) + (4 x thickness of sheet).
- Close the edges of the strap slightly.
- Slip the strap on the curved edges of the sheets after bringing them.

(c) Knocked-up joint

- Fold one sheet and close edges slightly.
- Bend one sheet to form a right angles band.
- Slip the second sheet in the folded one.
- Close the right-angled sheet using a mallet.

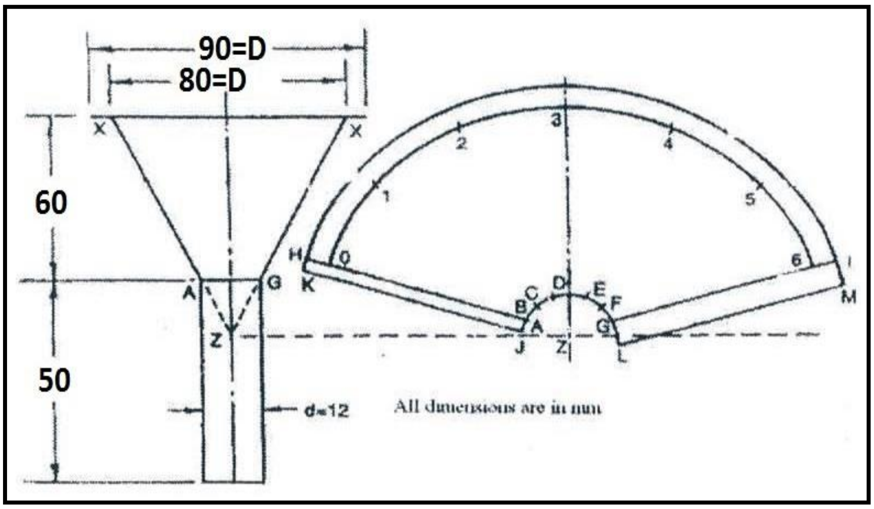

Fig: 8 Approximate dimensions of the funnel to be fabricated

Procedure for funnel:

- Draw the elevation on full scale
- Complete the cone by extending the lines A and G
- Choose a point Z and draw curves with Z as a center, and ZA and ZX as a radius
- Draw the vertical line Z3, meeting the internal curve at D, and external curve at 3
- Starting from D mark lengths DC, CB, BA, DE, EF and FG, each equal to $\pi d/6$.
- Again starting from 3 mark length 3-2, 2-1, 1-0, 3-4, 4-5 and 5-6, each equal to $\pi d/6$. (D and d are major and minor diameters)
- Draw another curve with Z as a center and ZX+5 mm as a radius.
- Joint AO and G6 and extend it to cut the outer curve at points H and I, respectively.
- Provide a margin of 5 mm on one side, and 10 mm on another side for joint.
- Cut out the required portion and form the conical portion.
- Make the bottom half of the funnel.

Fig: 9. The final form of funnel to be fabricated in the lab.

INTRODUCTION TO JOINING PROCESSES

Objectives

To study and observe the welding techniques through demonstration and practice (MMAW, MAG, Spot or resistance)

Background

Solid materials need to be joined together in order that they may be fabricated into useful shapes for various applications such as industrial, commercial, domestic, art ware and other uses. Depending on the material and the application, different joining processes are adopted such as, mechanical (bolts, rivets, etc.), chemical (adhesive) or thermal (welding, brazing or soldering). Thermal processes are extensively used for joining of most common engineering materials, namely, metals. This exercise is designed to demonstrate specifically: gas welding, arc welding, resistance welding, brazing.

WELDING PROCESSES

Welding is a process in which two materials, usually metals, are permanently joined together by coalescence, resulting from temperature, pressure, and metallurgical conditions. The particular combination of temperature and pressure can range from high temperature with no pressure to high pressure with an increase in temperature. Thus, welding can be achieved under a wide variety of conditions and numerous welding processes have been developed and are routinely used in manufacturing.

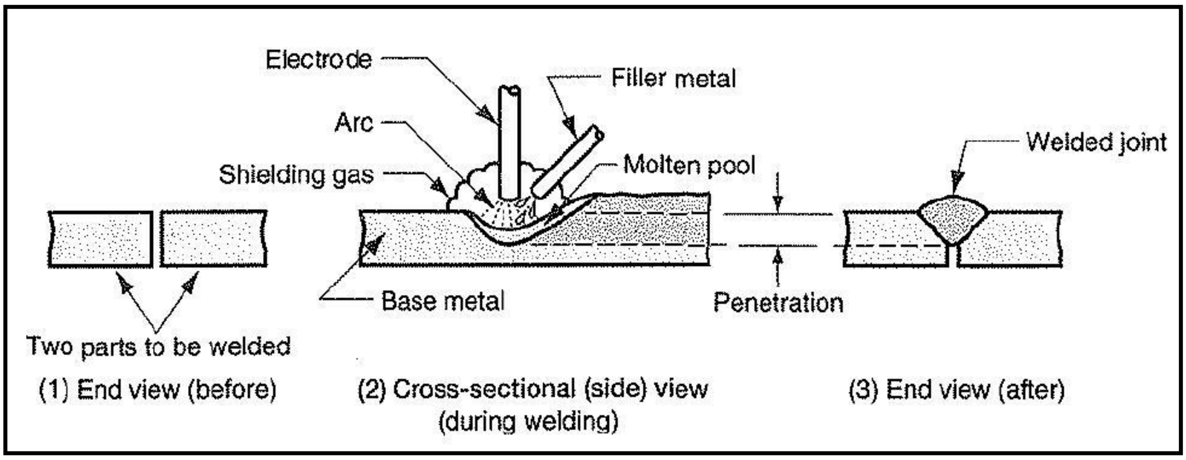

Fig: 10. Schematic of a welding process

To obtain coalescence between two metals following requirements need to be met: (1) perfectly smooth, flat or matching surfaces, (2) clean surfaces, free from oxides, absorbed gases, grease and other contaminants, (3e) metals with no internal impurities. These are difficult conditions to obtain. Surface roughness is overcome by pressure or by melting two surfaces so that fusion occurs.

Contaminants are removed by mechanical or chemical cleaning before welding or by causing sufficient metal flow along with the interface so that they are removed away from the weld zone friction welding is a solid-state welding technique. In many processes, the contaminants are removed by fluxing agents. The production of quality welds requires (1) a satisfactory heat and/or pressure source, (2) a means of protecting or cleaning the metal, and (3) caution to avoid, or compensate for, harmful metallurgical effects.

Arc Welding

In this process, a joint is established by fusing the material near the region of a joint by means of an electric arc struck between the material to be joined and an electrode. A high current low voltage electric power supply generates an arc of intense heat, reaching a maximum temperature of approximately 5500°C. The electrode held externally may act as a filler rod (consumable electrode) or it is fed independently of the electrode (non-consumable electrode). Due to higher levels of heat input, joints in thicker materials can be obtained by the arc welding process. It is extensively used in a variety of structural applications. A schematic of the process is shown below in Fig. 11.

There are many types of the basic arc welding process such as shielded metal arc welding (SMAW), gas metal arc welding (GMAW), gas tungsten arc welding (GTAW), submerged arc welding

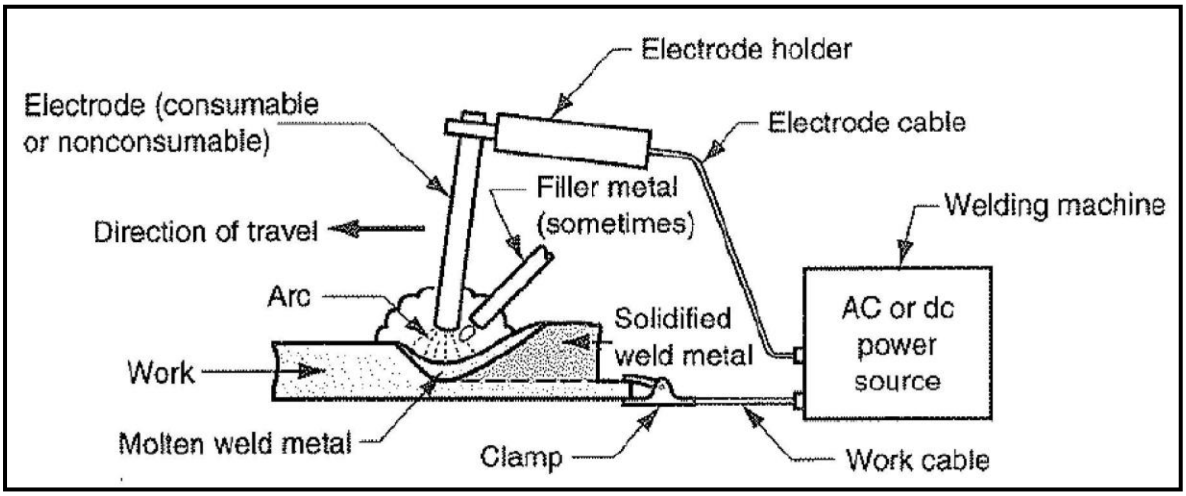

Fig: 11. Schematic of a shielded metal arc welding process

EXERCISE-3

ARC WELDING

Objectives

To prepare a butt joint with mild steel strip using Metal Active Gas Welding (MAG) & Manual Metal Arc Welding (MMAW) technique.

Equipment and materials

Welding unit, Consumable mild steel wire, Mild steel flats (100 x 25 x 5 mm), Protecting gas, Wire Brush, Tongs, etc.

Procedure

- Clean the mild steel flats to be joined by a wire brush.
- Arrange the flat pieces properly providing the gap for full penetration for butt joint(gap ½ thicknesses of flats).
- Practice striking of arc, speed and arc length control
- Set the welding current, voltage according to the type of metal to be joined.
- Strike the arc and make tacks at both ends to hold the metal pieces together during the welding process
- Lay beads along the joint maintaining proper speed and arc length (Speed 100-150 mm/min).
- Clean the welded zone and submit.

Fig: 12. Welding equipment and operation available at the Engineering Metallurgy Lab.

INTRODUCTION TO JOINING PROCESSES

Objectives

To study and observe the brazing techniques through demonstration and practice

Gas Welding

In this process, a joint is established by fusing the material near the region of a joint using a gas flame. The common gas used is a mixture of oxygen and acetylene, which on burning gives a flame temperature of 3500°C. Hence this is also termed as Oxy-Acetylene Welding (OAW). A filler rod is used to feed molten material in the gap at the joint region and establish a firm weld. The flame temperature can be controlled by changing the gas composition, i.e. the ratio of oxygen to acetylene. The color of the flame changes from oxidizing to neutral to reducing the flame.

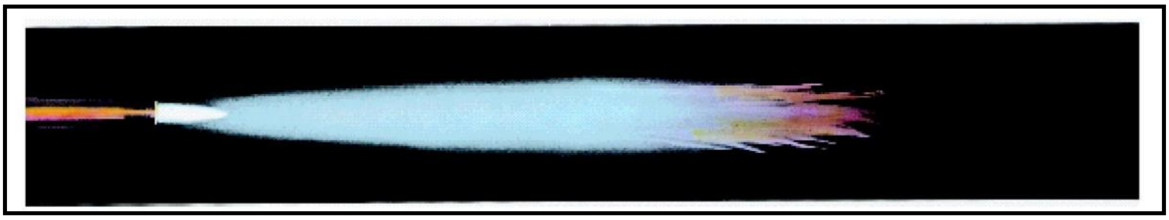

Fig: 13. Oxyfuel gas welding flame used for gas welding as well as for Brazing.

BRAZING

In this process metal parts to be joined are heated to a temperature below the melting point of the parts but sufficient to melt the lower fusion point filler material which is used to fill the gap at the joint and establish a bond between the edges through the filler material. The filler metal is drawn through the joint through the capillarity action to create a joint between the two pieces.

In this process, the base metal does not melt, and hence the metallurgy of the base metal is not disturbed much. However, this also implies that the joints made by this process are not as strong as those made by welding. On the other hand, this process can establish a joint between two dissimilar metals, through a proper choice of filler material. Unlike in welding, the filler rod differs widely in composition from the parent material(s). Gas (oxy-acetylene mixture) is usually used for heating.

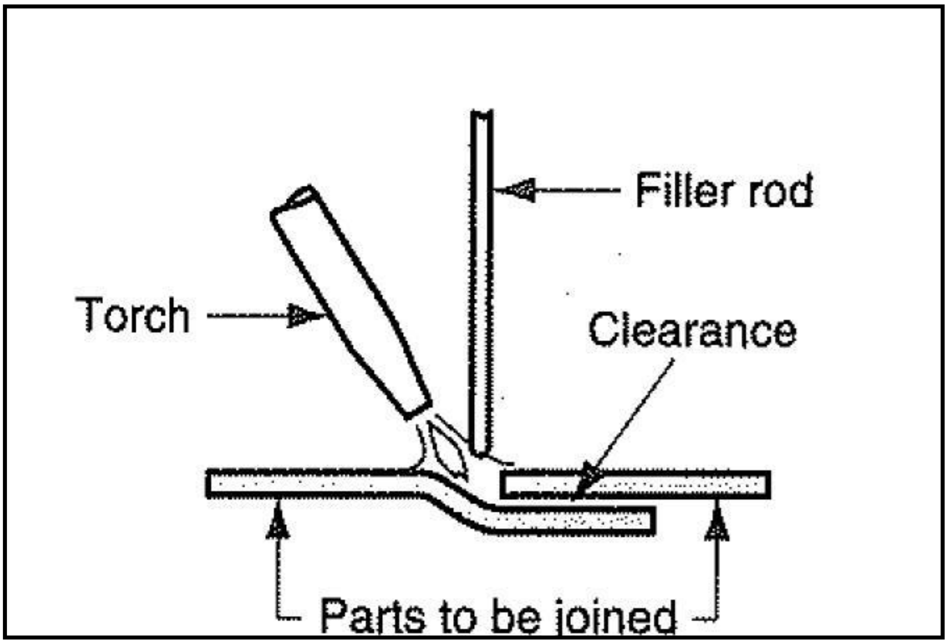

Fig: 14. Schematic of brazing operation.

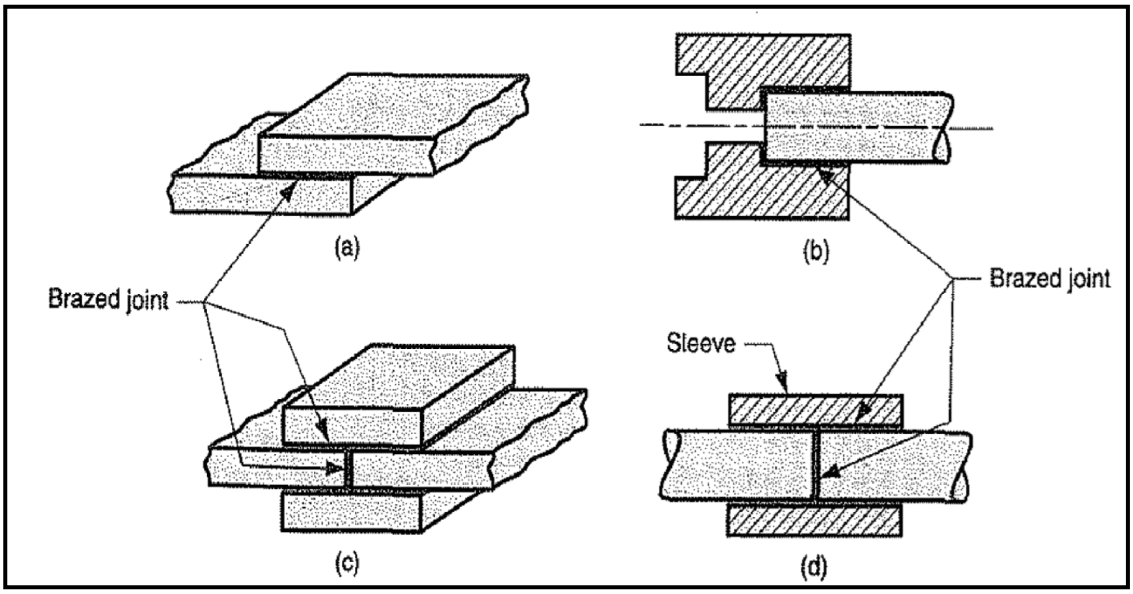

Fig: 15. Various kind of joints that can be obtained using brazing.

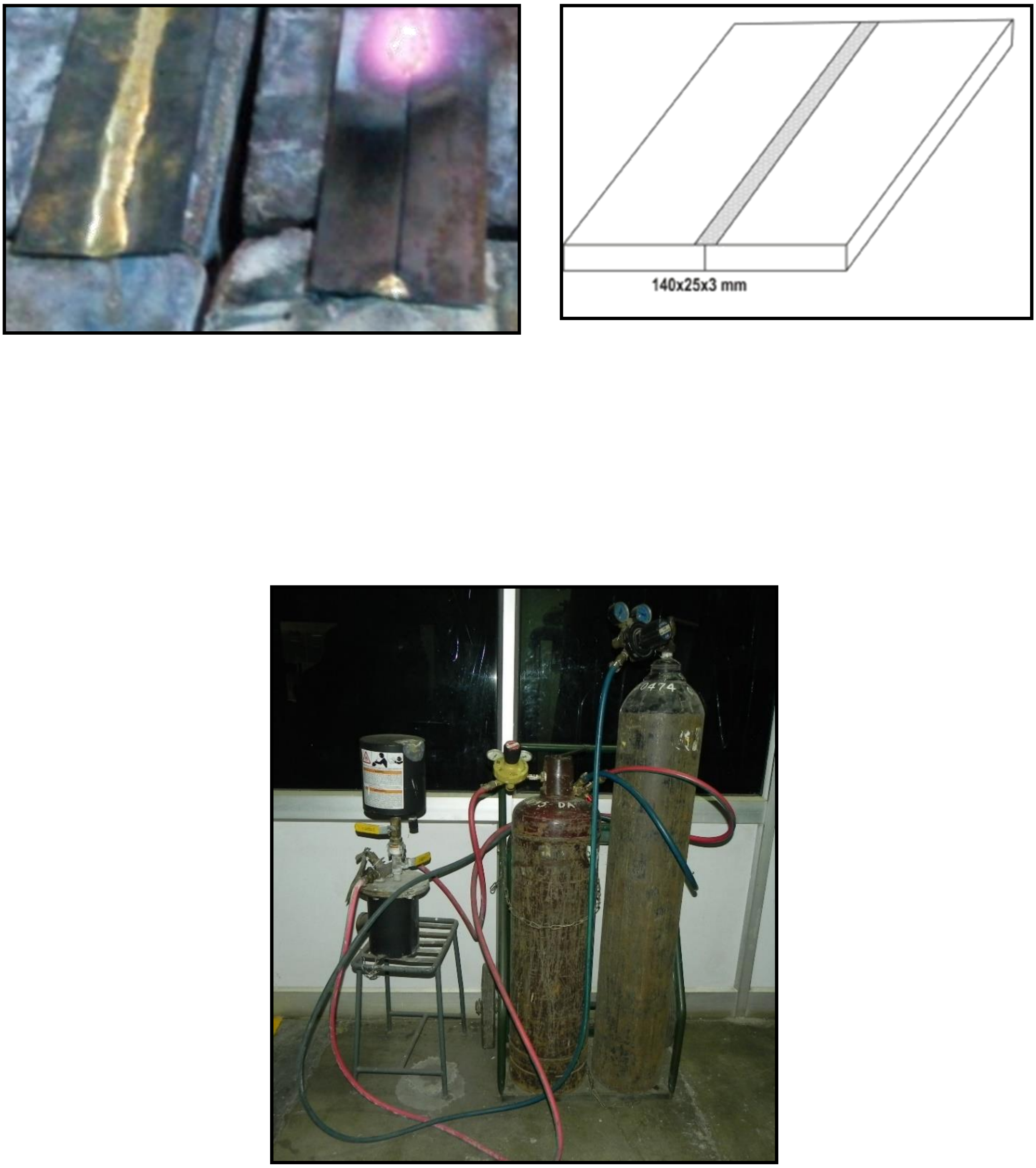

Fig: 16. Brazing operation and equipment, available in the Engineering Metallurgy Lab.

INTRODUCTION TO JOINING PROCESSES

EXERCISE-4

BRAZING

Objective

To prepare a butt joint with mild steel strips using brazing technique.

Equipment & materials

Oxy-Acetylene set, brazing wire, flux, mild steel strips (100 x 25 x 3 mm), wire brush, tongs, safety Gloves, safety goggles etc.

Procedure for Brazing

- Clean the mild steel strip removing the oxide layer and flatten it.
- Keep the metal strip in butt position.
- Tack at the two ends.
- Lay brazing metal at the joint maintaining proper speed and feed.
- Clean the joint and submit

Procedure for Brazing

- Clean the mild steel sheets removing the oxide layer and flatten it.
- Keep the metal sheet in lap position.
- Tack at the two ends.
- Clean the joint and submit

EXERCISE-5

OBJECT FABRICATION

Objectives

To prepare a spring, square frame, ring, hemisphere and rivet joints with using the various technique.

Equipment: Anvil ball pen hammer, hand hacksaw, bench vice, pliers, punch, riveting tool, snip, supporting rod & file, etc.
Materials: - Mild steel rod, copper coated wire, G I sheet and rivet.

(Demonstration Part-1)

1. To learn a hole on a flat using a drill machine.
2. To learn surface grinding techniques on a flat job using a grinding machine.
3. To learn pipe cutting using a horizontal machine.
4. To learn elongation strips using a rolling machine.
5. To learn elongation rod using a swaging machine.

(Experimental Part-2)

Student's part: (These exercises are part of your project)

1. To make a spring with the help of mild steel wire copper coated (0.8 mm)
2. To make a hemisphere using GI Sheet with the help of anvil and ball pen hammer
3. To make a rivet having both fixed and movable joints using G I Sheet.
4. To make a ring with the help of mild steel rod (4.0 mm).
5. To bend a mild steel rod in a square frame.

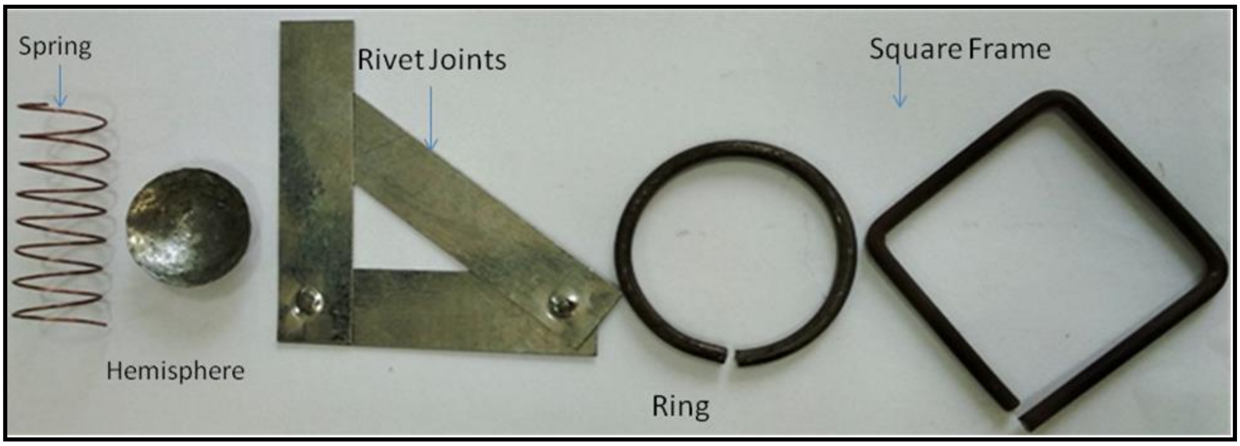

Fig: 17. Exercise components