Practical Workbook

MY-304: Metallurgy of Welding

Name	______________________
Roll No	______________________
Batch	______________________
Year	______________________
Department	______________________

Metallurgical Engineering Department

NED University of Engineering & Technology,

Karachi-75270, Pakistan

Practical Workbook

MY-304 Metallurgy of Welding

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This is to certify that this practical book contains 33 pages.

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Course Teacher

TABLE OF CONTENTS

MY- 304: Metallurgy of Welding

SAFETY RULES AND PRECAUTIONS

General Guidelines

1. Become trained and read the instructions before working on the machine or welding or cutting.
2. Read material safety data sheets (MSDSs) for metals, consumables, and coatings.
3. Read the equipment owner's manual for more complete safety information.
4. Wear a safety harness if working above floor level.
5. Keep children away from all equipment and processes.
6. Do not install or place machine on or over combustible surfaces.
7. Have only qualified persons install, use, or service all equipment.
8. When the work circuit is hot (current is flowing) DO NOT touch the electrode, workpiece, or worktable with bare skin, wet gloves or wet clothing.
9. Never pick up hot objects; pieces of metal which have just been welded or heated, or the stub ends of electrodes which have been discarded.
10. Welding helmets with safety goggles.
11. Clothing with a leather apron with safety shoes.
12. Use welding helmet with correct shade or filter.
13. Wear welders cap and safety glasses with side shields. Use ear protection when welding out of persons or in confined spaces.
14. Never under any circumstances look directly at the arc without proper eye protection. Arc rays could cause permanent damage to the eyes. If someone is present make sure they know to look away or put on a welding helmet.
15. Never chip or grind metal without goggles.
16. Do not touch live electrical parts.
17. Do not use AC weld output in damp, wet, or confined spaces, or if there is a danger of falling.
18. Protect yourself from electric shock by insulating yourself from work and ground.
19. Use non flammable, dry wood or plywood, or other dry insulating material big enough to cover your full area of contact with the work or ground, and watch for file.
20. Keep your head out of the fumes.

PRACTICAL NO.1

OBJECTIVE

To study the Arc welding Process

THEORY

The term arc welding applies to a large and varied group of processes that use an electric arc as the source of heat to melt and join metals. In arc welding processes, the joining of metals or weld is produced by the extreme heat of an electric arc drawn between an electrode and the work piece. The arc is struck between the work piece and an electrode that is mechanically or manually moved along the joint. The metal wire not only carried the welding current, but as melted in the arc, it also supplied the necessary filter.

Arc welding processes employs the same basic circuit. If distinct current is used and the work is made positive (the anode of the circuit), the condition is known as polarity. When the work is negative and the electrode is positive, reverse polarity is employed.

In one large group of welding processes, the electrode is consumed (consumable electrode pressure) and thus supplies the metal needed to fill the voids in the joints. Consumable electrodes have a melting temperature below the temperature of the arc. Small droplets are melted from the end of the electrode and pass to work piece. The size of these droplets varies greatly and the mechanism of the transfer depends on the type of electrode welding current, and other processes parameters. As the electrodes melt, the arc length and the electrical resistances of the arc path will vary. To maintain a stable arc and satisfactory welding condition, the electrode must be towards the work at controlled arte. Manual arc welding is almost always performed with shielded electrodes.

Continuous bare metal wire can be used as the electrode in automatic or semiautomatic arc welding, but is always in conjunction with a separate shielding and arc stabilizing medium and automatic feed controlling devices that maintain the proper arc length.

Weld joints

The weld joint is where two or more metal parts are joined by welding. The five basic types of weld joints are the butt, corner, tee, lap, and edge, as shown in figure 1a.

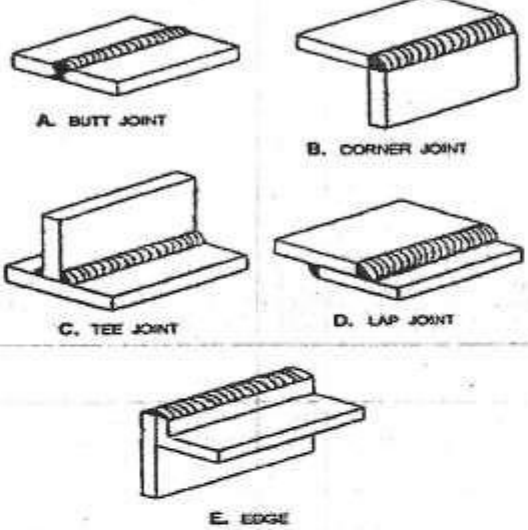


Figure 1a: weld joints

A butt joint is used to join two members aligned in the same plane . This joint is frequently used in plate, sheet metal, and pipe work. A joint of this type may be either square or grooved. Some of the variations of this joint are discussed later in this chapter.
Corner and tee joints are used to join two members located at right angles to each other. In cross section, the corner joint forms an L-shape, and the tee joint has the shape of the letter T. Various joint designs of both types have uses in many types of metal structures.
A lap joint, as the name implies, is made by lapping one piece of metal over another. This is one of the strongest types of joints available; however, for maximum joint efficiency, you should overlap the metals a minimum of three times the thickness of the thinnest member you are joining. Lap joints are commonly used with torch brazing and spot welding applications.
An edge joint is used to join the edges of two or more members lying in the same plane. In most cases, one of the members is flanged. While this type of joint has some applications in platework, it is more frequently used in sheet metal work An edge joint should only be used for joining metals 1/4 inch or less in thickness that are not subjected to heavy loads.
In order to produce weldments, it is necessary to combine the joint types with weld types to produce weld joints for joining the separate members. Each weld type cannot always be combined with each joint type to make a weld joint. Below table shows the welds applicable to the basic joints.

Table ... WELDS APPLICABLE TO THE BASIC JOINT COMBINATIONS

Weld Type	Symbol	Basic Joint Types				
		B Butt	C Corner	E Edge	L Lap	T Tee
Fillet	[illegible]	Special	Yes	Special	Yes	Yes
Plug or slot	[illegible]				Yes	Yes
Spot or projection	[illegible]				Yes	Special
[illegible]	[illegible]		Special	-	Yes	Special
Square groove	[illegible]	Yes	Yes	Yes		Yes
Vee groove	[illegible]	Yes	Yes	Yes		Yes
Bevel groove	[illegible]	Yes	Yes	Yes	Yes	Yes
[illegible]	[illegible]	Yes	Yes	Yes		-
J-groove	[illegible]	Yes	Yes	Yes	Yes	Yes
[illegible]	[illegible]	Yes	Yes	-	-	
Flare bevel groove	[illegible]	Yes	Yes	-	Yes	Yes
Backing weld	[illegible]	Combin	Combin	-		Combin
Surfacing	[illegible]	-	-			
Flange edge	[illegible]	-		Yes	-	
Flange corner	[illegible]	-	Yes	-		-

Welding position

General

Welding is often done on structures in positions in which they are found. Techniqres have been developed to allow welding in any position. Some welding processes have all-positions capabilities, while others may be used in only one or two positions all welding can be classified according to the position of the work piece or the position or the position of the welded joint on the plates or sections being welded. There are four basic welding positions, which are illustrated in figure.

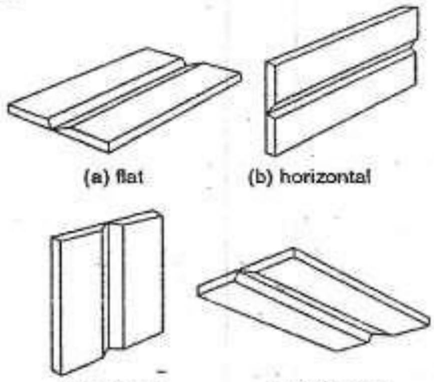


Figure1b: welding positions

Flat position welding

In this position the welding is performed on the upper side of the joint, and the face of the weld is approximately horizontal. Flat welding is the preferred term: however, the same position is sometimes called down hand

Horizontal position welding

Fillet weld

In this position, welding is performed on the upper side of an approximately Horizontal surface and against an approximately vertical surface.

Groove weld

In this position the axis of the weld lies in an approximately horizontal, plane and the face of the weld lies in an approximately vertical plane.

Horizontal fixed weld

In this pipe welding positio0n, the axis of the pipe is approximately horizontal, and the pipe is not rotated during welding.

Horizontal rolled weld

In this pipe welding position, welding is performed in the flat position by rotating the pipe

Vertical position welding

1. In this position, the axis of the weld is approximately vertical.
2. In vertical position pipe welding, the axis of the pipe is vertical and the welding is performed in the horizontal position.

Overhead position welding

In this welding position the welding is performed from the underside of a joint.

REVIEW QUESTIONS

Q.1 Explain the basic principles of Arc Welding process?

Q.2 Describe the function and characteristics of electrodes. What functions do coatings have?

Q.3 Enlist the types of welding joints?

Q.4 Define straight polarity and reverse polarity?

Q.5 What is continuous bare metal?

PRACTICAL NO.2

OBJECTIVE
To carry out the Shielded Metal Arc Welding (SMAW) of carbon steel

EQUIPMENT, MATERIAL AND ELECTRODE USED
Welding power supply, electrode, electrode holder, a ground clamp, and welding cables (also known as welding leads) connecting the two,Steel plate and Carbon steel electrode.

THEORY
SMAW is a 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.

Because of the versatility of the process and the simplicity of its equipment and operation, manual metal arc welding is one of the world's most popular welding processes. It dominates other welding processes in the maintenance and repair industry, and though flux-cored arc welding is growing in popularity, SMAW continues to be used extensively in the construction of steel structures and in industrial fabrication. The process is used primarily to weld iron and steels (including stainless steel) but aluminum, nickel and copper alloys can also be welded with this method

Welding Electrode Classification by American AWS-ASTM System -
E XX XX or E 60 1 2

E XXX XX or E 100 15

Letter E signifies that electrode is suitable for metal (electric) arc welding. XX/XXX First two or three digits indicate minimum tensile strength of weld metal in thousands of pounds per sq. inch, e.g. 60,000 and 100,000 lbs/sq. inch. Other values of XX and XXX are 45, 70, 80, 90 and 120. Last but one digit indicates the welding position. It can be represented by numbers like 1, 2 and 3 which indicate that welding can be carried out in any position, flat and horizontal positions, and flat position respectively.

Last digit which may be 0, 1, 2, 3, 5 or 6 tells about power (2): supply, type of covering, type Of arc, penetration characteristics, etc.

(a) Electrode is meant for metal (electric) arc welding,
(b) It possesses a minimum tensile strength of 60,000 pounds per Square inch,
(c) It can weld satisfactorily in all positions,
(d) Electrode covering has a high titania (rutile) content, is bounded with sodium silicate, and be operated on DCSP or AC, produces medium penetration, heavy slag, a convex weld bead appearance and a medium quality weld deposition.

AWS (A 5.1) Carbon Steel Electrodes for Shielded Metal Arc Welding
Covered Carbon Steel Arc Welding Electrodes – Example ASTM (E7018-1)

1. E designates an electrode.
2. The first two digits, in this case 70, indicate the minimum tensile strength of the deposited metal in the as-welded condition. For E7018-1, the minimum tensile strength is 70 ksi (70000 psi).

3. The third digit, in this case "1", indicates the position in which satisfactory welds can be made.
a. "1" means the electrode is capable of satisfactory welds in all positions (i.e. flat, vertical, overhead, & horizontal).
b. "2" indicates the electrode is only suited to flat position welding and to horizontal position welding of fillet welds.
c. "4" indicates the electrode is suitable for vertical-down welding and for other positions as described in AWS (A5.1).
4. The last two digits taken together indicate the type current with which the electrode can be used, and the type of covering on the electrode. In the E7018-1. Example, the number "8" identifies the electrode as suitable for AC or DC operation, with a predominantly lime (calcium carbonate) coating.

PROCEDURE

REVIEW QUESTIONS

Q.1 What are the alternative names of MMAW?

Q.2 Enlist the equipments used in MMAW?

Q.3 What are range of covered electrodes used in MM· W?

Q.4 Describe the basic principle of MMAW?

Q.5 Which type of electrode used in MMAW?

PRACTICAL NO.3

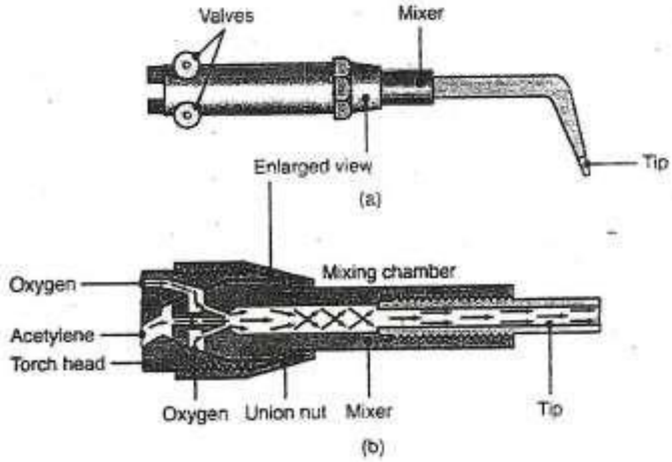
OBJECTIVE

To carry out Oxy-Acetylene Gas welding of given material

EQUIPMENT, MATERIAL AND ELECTRODE USED

Oxygen & Acetylene Cylinder. Oxygen & Acetylene Regulators. Oxyacetylene Welding Torch. hose and Carbon steel

THEORY



Oxy-Acetylene Gas Welding

Oxy-acetylene gas welding refers to a group of welding process that uses, as thin heat source, the flame produced by the combustion of a fuel gas and oxygen. The combustion of oxygen and acetylene by means of a welding torch of the type produces a temperature of about 5850°F(3250°C) in a two-stage reaction.

AWS (A 5.2) Carbon and Low Alloy Steel Rods for Oxyfuel Gas Welding

Carbon and Low Alloy Steel Rods for Oxyfuel Gas Welding - Example R60

1. The letter R at the beginning of each classification designation stands for rod.
2. The digits (45, 60, 65, and 100) designate a minimum tensile strength of the weld metal, in the nearest thousands of pounds per square inch, deposited in accordance with the test assembly preparation section of specification.

Types of flame

The two stage combustion process produce a flame having two distinct regions. The maximum temperature occurs near the end of the inner cone, where the first stage of combustion is complete. Most welding should be performed with the torch positioned so that the point of maximum temperature is just above the metal being welded. The outer envelope of the flame serves to preheat the metal, and the same time, provides shielding from oxidation, since oxygen from the surrounding air is used in the secondary combustion.

Three different types of flames can be obtained by varying the oxygen / acetylene (or oxygen / fuel gas) ratio, If the ratio is about 1:1 to 1.15:1, all reactions are carried to completion and a neutral flame is produced. Most welding is done with a neutral flame, since it will have the least chemical effect on the heated metal.


OUTER FLAME
WHITE CORE
WHITE CORE
OUTER FLAME
WHITE CORE
Oxidizing Flame
Carburizing Flame

PROCEDURE

REVIEW QUESTIONS

Q.1 What are some of the problems that might occur when high temperatures are used in welding?

Q.2 Why does an oxyfuel gas-welding torch usually have a flame with two distinct regions?

Q.3 What three types of flames varying the oxygen/fuel ratio can produce?

Q.4 What is the location of the maximum temperature in an oxyacetylene flame?

Q.5 What function or functions are served by outer zone of the welding flame?

PRACTICAL NO.4

OBJECTIVE

To carry out the Gas metal arc welding of given material

EQUIPMENT, MATERIAL AND ELECTRODE USED

welding gun, a wire feed unit, a welding power supply, an electrode wire, and a shielding gas supply

Welding gun and wire feed unit

The typical GMAW welding gun has a number of key parts—a control switch, a contact tip, a power cable, a gas nozzle, an electrode conduit and liner, and a gas hose. The wire feed unit supplies the electrode to the work, driving it through the conduit and on to the contact tip.

Material and electrode used

Copper or Aluminum

THEORY

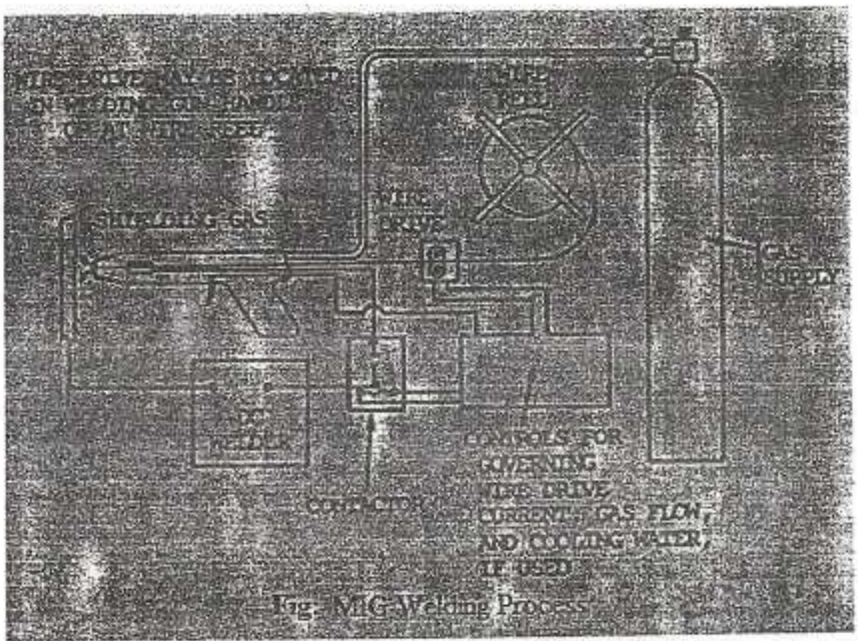


Figure 4a: A GMAW wire feed unit

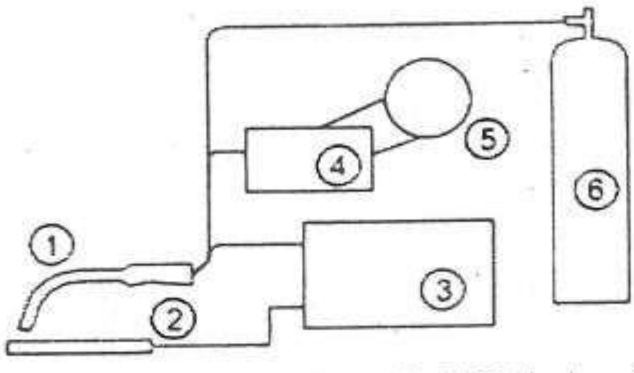


Figure 4b: GMAW circuit diagram (1) Welding torch, (2) Work piece, (3) Power source, (4) Wire feed unit, (5) Electrode source, (6) Shielding gas supply.

Gas metal arc welding (GMAW), sometimes referred to by its subtypes metal inert gas (MIG) welding or metal active gas (MAG) welding, is a semi-automatic or automatic arc welding process in which a continuous and consumable wire electrode and a shielding gas are fed through a welding gun. A constant voltage, direct current power source is most commonly used with GMAW, but constant current systems, as well as alternating current, can be used. There are four primary methods of metal transfer in GMAW, called globular, short-circuiting, spray, and pulsed-spray, each of which has distinct properties and corresponding advantages and limitations.

Originally developed for welding aluminum and other non-ferrous materials in the 1940s, GMAW was soon applied to steels because it allowed for lower welding time compared to other welding processes. The cost of inert gas limited its use in steels until several years later, when the use of semi-inert gases such as carbon dioxide became common. Further developments during the 1950s and 1960s gave the process more versatility and as a result, it became a highly used industrial process.

AWS (A 5.27) Low Alloy Steel Electrodes for Gas Shielded Metal Arc Welding
Copper and Copper Alloy Gas Welding Rods -
Examples RCuZn-C, ERCu, and RBCuZn-D

1. "R", "ER", and "RB" at the beginning of each classification indicates that the welding consumable may be an oxyfuel gas welding rod, either an electrode or brazing filler metal, and either a welding rod or a brazing filler metal.
2. "Cu" is used to identify the welding rods as copper-base alloys and the additional chemical symbol indicates the principal alloying element of each group.
3. Where more than one classification is included in a basic group, the individual classifications in the group are identified by the letters "A", "B", "C," etc.

PROCEDURE

REVIEW QUESTION

Q.1 What is CO_2 Welding?

Q.2 Which type of electrode is used in MIG Welding?

Q.3 Enlist the name of the gases used for providing shielding atmosphere in MIG Welding?

Q.4 Which power source is used in MIG Welding and of what polarity?

Q.5 How we change the current in MIG Welding?

PRACTICAL NO.5

OBJECTIVE

To carry out the Gas tungsten arc welding of given material

EQUIPMENT, MATERIAL AND ELECTRODE USED

Shielding gas cylinder, pressure regulator and flow meter, welding machine(AC or DC), hose, electrode lead, torch(electrode holder), welding rod etc..

Figure 5a: GTAW torch with various electrodes, cups, collets and gas diffusers

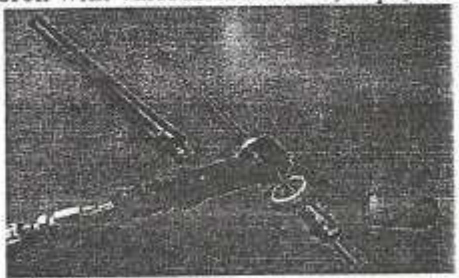


Figure 5b: GTAW torch, disassembled

The equipment required for the gas tungsten arc welding operation includes a welding torch utilizing a no consumable tungsten electrode, a constant-current welding power supply, and a shielding gas source.

Material and electrode used

Aluminum or aluminum alloy welding rods and electrode

THEORY

Gas tungsten arc welding (GTAW), also known as tungsten inert gas (TIG) welding, is an arc welding process that uses a no consumable tungsten electrode to produce the weld. The weld area is protected from atmospheric contamination by a shielding gas (usually an inert gas such as argon), and a filler metal is normally used, though some welds, known as autogenously welds, do not require it. A constant-current welding power supply produces energy which is conducted across the arc through a column of highly ionized gas and metal vapors known as plasma.

GTAW is most commonly used to weld thin sections of stainless steel and light metals such as aluminum, magnesium, and copper alloys. The process grants the operator greater control over the weld than competing procedures such as shielded metal arc welding and gas metal arc welding, allowing for stronger, higher quality welds. However, GTAW is comparatively more complex and difficult to master, and furthermore, it is significantly slower than most other welding techniques.

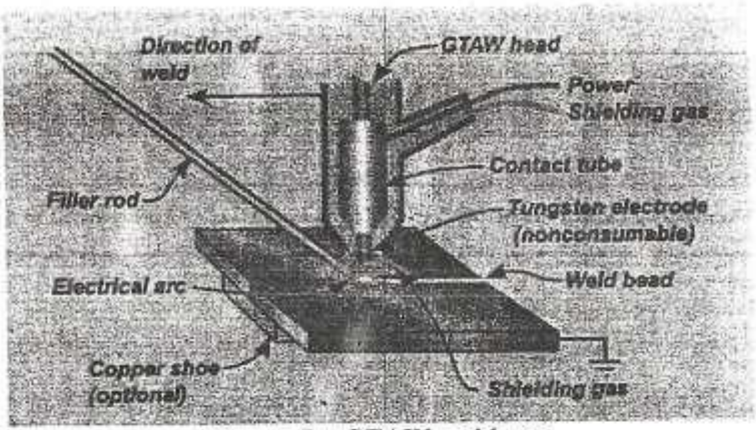


Figure 5c: GTAW weld area

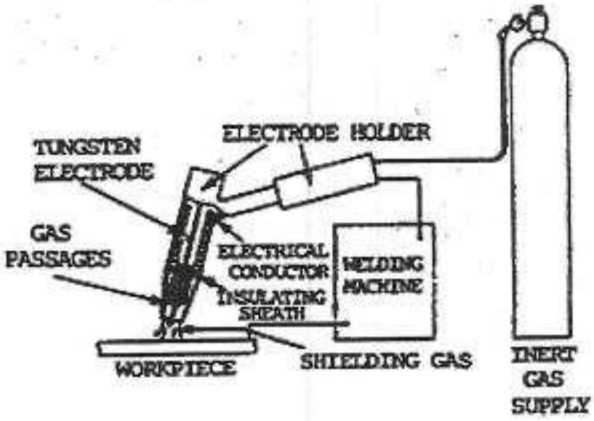


Figure 5d: GTAW system setup

AWS specification for filler metals suitable for gas TIG welding

Specification No.	Title
A 5.2	Iron and steel gas welding rods
A 5.7	Copper and copper alloy bare welding rods and electrodes
A 5.9	Corrosion resisting chromium and chromium-nickel steel bare and composite metal cored and stranded arc welding electrodes and welding rods
A 5.10	Aluminum and aluminum alloy welding rods and electrodes
A 5.13	Surfacing welding rods and electrodes
A 5.14	Nickel and nickel alloy bare welding rods and electrodes
A 5.16	Titanium and titanium alloy bare welding rods and electrodes
A 5.18	Mild steel electrodes for gas metal arc welding
A 5.19	Magnesium-alloy welding rods and electrodes
A 5.21	Composite surfacing welding rods electrodes
A 5.24	Zirconium and zirconium alloy bare welding rods and electrodes

PROCEDURE

REVIEW QUESTIONS

Q.1 What is meant by TIG welding?

Q.2 Which type of electrode used in TIG welding?

Q.3 Enlist the materials names which are commonly welded by TIG welding?

Q.4 Which power source used in TIG welding?

Q.5 What polarity used in TIG welding?

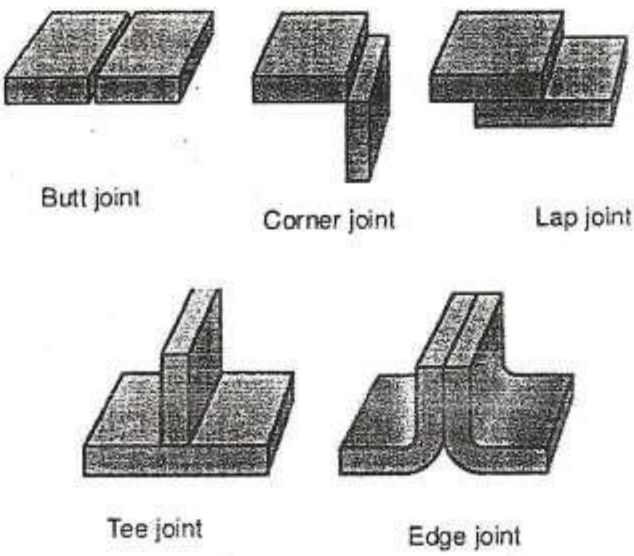
PRACTICAL NO.6

OBJECTIVE: Inspection of weldment of different types of joints

INTRODUCTION:

Critical appraisal involving examination, measurement, testing, gauging, and comparison of materials or items are called inspection. An inspection determines if the material or item is in proper quantity and condition, and if it conforms to the applicable or specified requirements. Weldment is a unit formed by welding together an assembly of pieces.

DIFFERENT TYPES OF WELD JOINTS



FUSION ZONE:

The **fusion zone (referred to as FZ)** can be characterized as a mixture of completely molten base metal (and filler metal if consumable electrodes are in use) with high degree of homogeneity where the mixing is primarily motivated by convection in the molten weld pool. The microstructure in the weld fusion zone is expected to change significantly due to remelting and solidification of metal at the temperature beyond the effective liquidus temperature.

WELD BEAD:

A weld deposit resulting from a pass is called weld bead. The more peaked and narrow the weld bead, the greater the chance that poor fusion may occur. The weld bead characteristics may be altered via both size and shape. Welding current and travel speed are the welding parameters primarily used to control weld bead size. For instance, when the current is decreased, the weld bead will become smaller. The converse is also true. Weld bead size can also be changed by varying the arc travel speed. bead size and travel speed are inversely related. A decrease in travel speed will result in an increase in the weld bead height and width and vice versa.

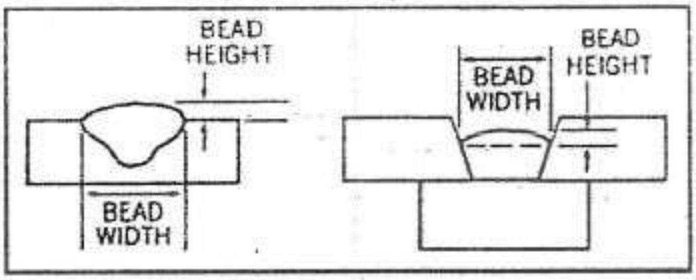


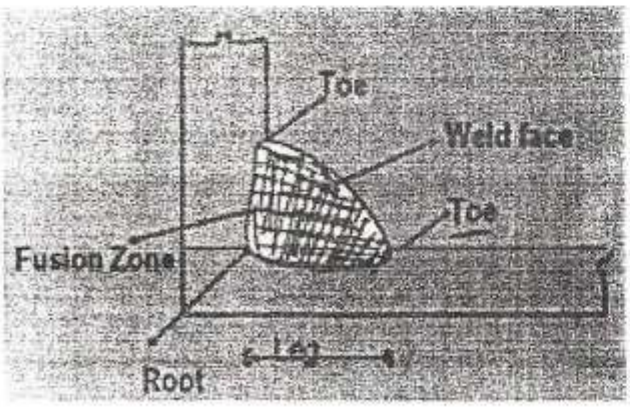
Figure – Weld Bead Characteristics

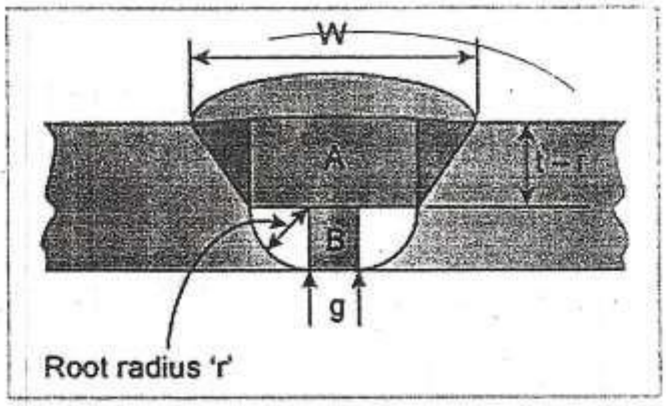
HEAT AFFECTED ZONE (HAZ) AREA:

The HAZ is a region of base metal surrounding the fusion zone in which melting has not occurred, but temperatures from welding were high enough to cause solid state microstructural changes.

Weld Leg length

It is defined from the point of intersection of the joint to the end of the weld.





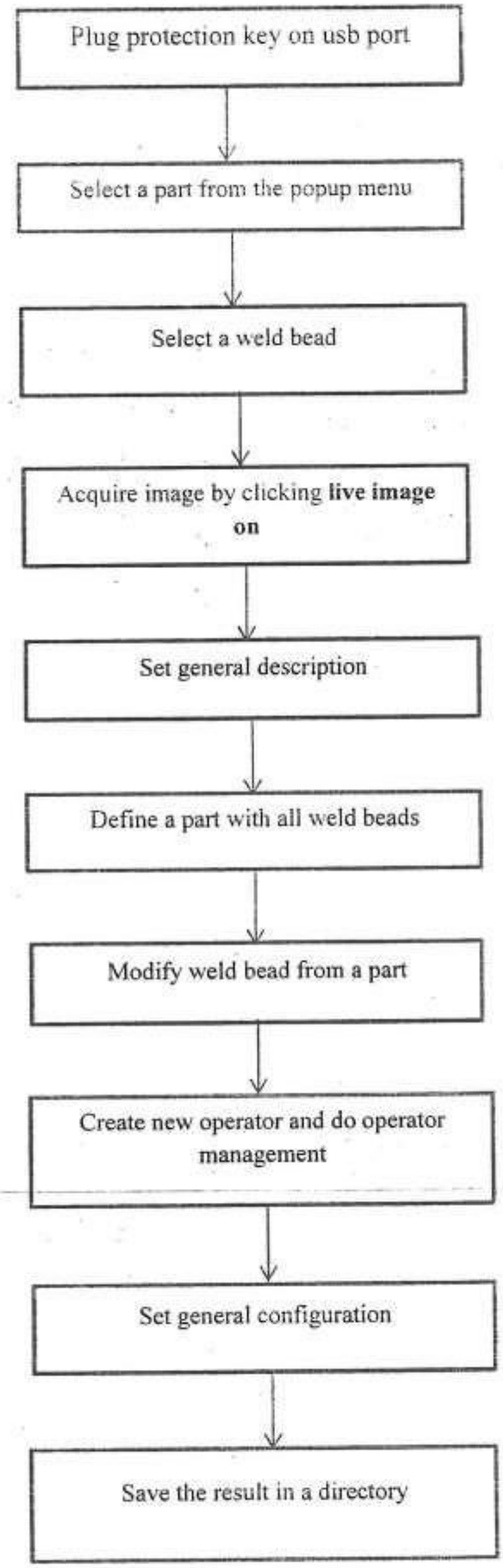
W =Width

A = Fusion Zone

B = Gap B/W Metals

Procedure:

This practical is based on software **"welding expert"**. The following are the basic steps to be followed


Plug protection key on usb port
Select a part from the popup menu
Select a weld bead
Acquire image by clicking **live image on**
Set general description
Define a part with all weld beads
Modify weld bead from a part
Create new operator and do operator management
Set general configuration
Save the result in a directory

OBSERVATIONS:

S #	Material	Types Of Joint	Fusion Zone of Weld Bead	Radius Of Weld Bead	Gap B/W Metals	HAZ Area	Thickness Of Metal 1	Thickness Of Metal 2	Width Of Weld Bead	I le

PRACTICAL NO.7

OBJECTIVE

To carry out the spot welding

THEORY

Resistance welding is a process used to join metals with electric current. There are several forms of resistance welding, including spot welding, seam welding, projection welding, and bull welding. In all forms of resistance welding, the parts are locally heated until a molten pool forms. The parts are then allowed to cool, and the pool freezes to form a weld nugget. On a typical machine, the operator has control over the current setting, electrode force and weld time. To create heat, copper eledrodes an electric current through the work pieces. The heat generated depends on the electrical resistance and thermal conductivity of the metal, and the time that the current is applied. The heat generated is expressed by the equation.

$$E=I^2.R.t$$

Where is the heat energy, I is the current, R is the electrical resistance and t is the time that the current is applied.

Copper is used for electrodes because it has low resistance and high thermal conductivity. This ensures that heal is generated in the work piece instead of the electrodes. When the electrodes are too hot, heat marks on the surface of the work piece can form.

The electrodes are held under controlled force during welding. The amount of force affects the resistance across the interfaces between the work piece and electrodes. The force is adjusted to immediately create heat at the interface between the work pieces.

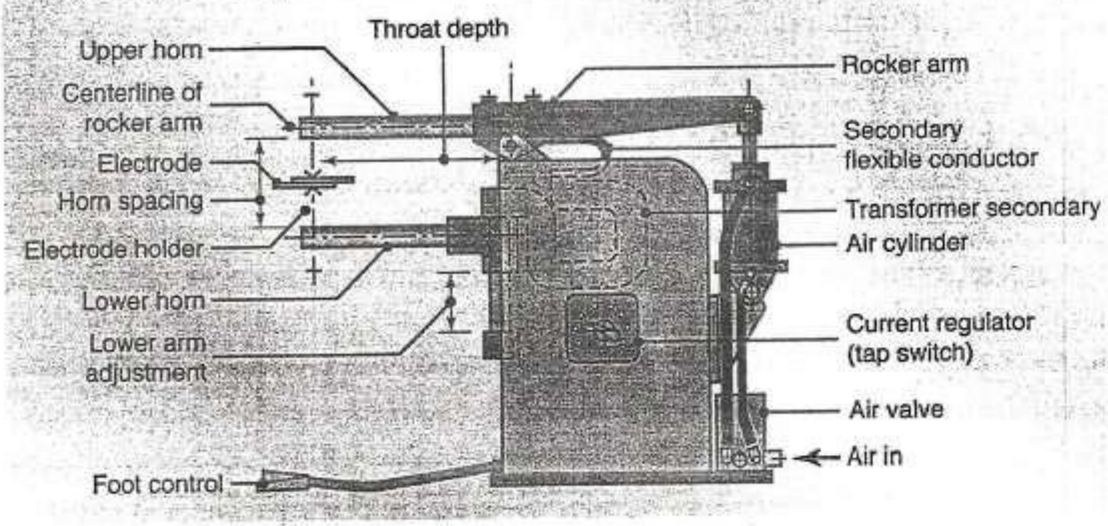


Figure 9a: Spot Welding Machine

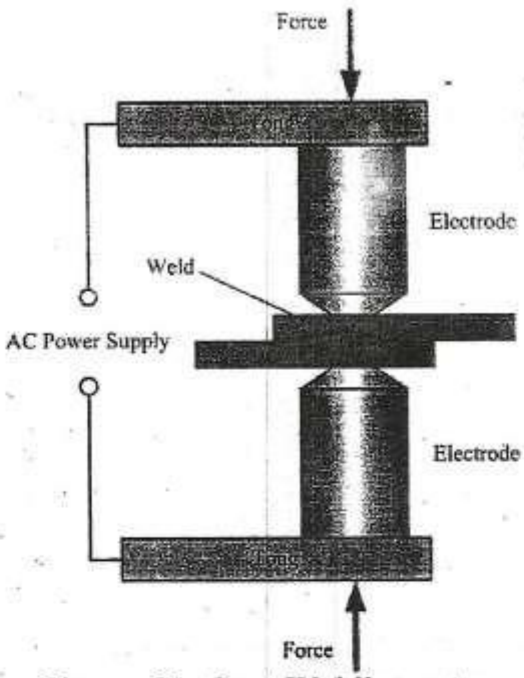


Figure 9b: Spot Welding setup

Spot-welding

A spot weld is made by applying pressure to two pieces of overlapping metal, then passing an electrical current through a localized contact area, for very specific time period, to heat the area till a weld nugget forms. Force is continued to be applied after the weld time until the weld has solidified and forged. To minimize heat dissipation the weld is formed very quickly. This requires very large electrical transformer.

Using schedule to setup machine

PCT (pressure, current, time) are the factors used to construct a weld schedule. To use the schedule you look up the size of the thinnest piece of the metal being welded. Looking acres, you will see values for the correct amount of force, the proper weld time value, and the amount of amperage necessary to weld. Also you will typically see values for electrode diameter, electrode size and weld strengths.

The relationship b/w the factors can be expressed as:

$\mathbf{H = I^2 \times R \times T \times K}$

Where,

H = heat R = resistance.

I = current T = time.

K = heat losses through conduction and radiation

Components

The three main components of the welding machine are the control, transformer, and secondary conductor.

Control

The purpose of the weld control is to accurately time the functions involved ion resistance welding. The various functions that are timed as squeeze weld hold and off.

Transformer

Transformer takes a primary voltage of 220 V and current of 800 amps. And gives off a secondary amount of 2-15V with a current of 100,000amps.

Secondary Conductor

This includes everything that is attached to the secondary winding of the transformer. The weld arms, holders, and tips are all parts of the secondary circuit.

PROCEDURE

REVIEW QUESTIONS

Q.1 What are the two major roles of applied pressure in resistance welding?

Q.2 What are the three components that contribute to the total resistance between the electrodes?

Q.3 What measure can be taken to reduce the resistance between the electrodes and the work pieces?

Q.4 What are the consequences of too little pressure during the cycle? Too much pressure?

Q.5 What is the typical size of a spot-weld nugget?

PRACTICAL NO.8

OBJECTIVE

To carry out the soldering process by tin-lead solder

THEORY

Soldering

Common solder is an alloy of one-half lead with one-half tin, and is called "half and half." Hard solder is made with two-thirds tin and one-third lead. These alloys, when heated, are used to join surfaces of the same or dissimilar metals such as copper, brass, lead, galvanized iron, zinc, tinned plate, etc. These metals are easily joined, but the action of solder with iron, steel and aluminum is not so satisfactory and requires greater care and skill.

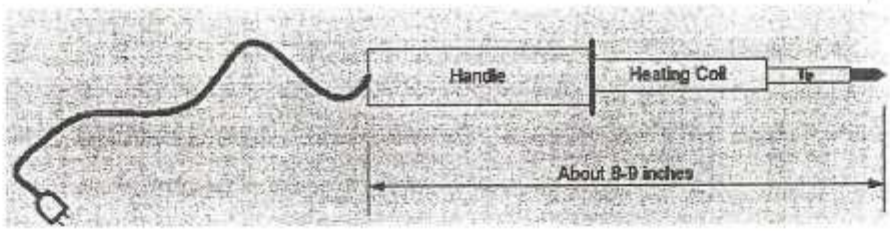
Soldering is a process in which two or more metal items are joined together by melting and flowing a filler metal into the joint, the filler metal having a relatively low melting point. **Soft soldering** is characterized by the melting point of the filler metal, which is below 400 °C (752 °F). The filler metal used in the process is called solder.

Hard soldering is actually a regular brazing process where filler metals use melting temperatures above 800 C (427 F).

Soldering is distinguished from brazing by use of a lower melting-temperature filler metal; it is distinguished from welding by the base metals not being melted during the joining process. In a soldering process, heat is applied to the parts to be joined, causing the solder to melt and be drawn into the joint by capillary action and to bond to the materials to be joined by wetting action. After the metal cools, the resulting joints are not as strong as the base metal, but have adequate strength, electrical conductivity, and water-tightness for many uses. Soldering is an ancient technique mentioned in the Bible and there is evidence that it was employed up to 5000 years ago in Mesopotamia

There are various type of soldering.

1. Pipe soldering
2. Mechanical and aluminum soldering
3. Stained glass soldering



According to ASTM AWS standard

ASTM Solder Classification	Composition, wt %		Solidus temperature in centigrade	Liquidus temperature in centigrade	Melting Range in centigrade
	Tin	Lead			
5	5	95	300	314	14
10	10	90	268	301	33
15	15	85	225	290	65
20	20	80	183	280	97
25	25	75	183	267	84
30	30	70	183	255	72
35	35	65	183	247	64
40	40	60	183	235	52
45	45	55	183	228	45
50	50	50	183	217	34
60	60	40	183	190	7
70	70	30	183	192	9

PROCEDURE

REVIEW QUESTIONS

Q.1 How does soldering differ from high temperature brazing?

Q.2 During the soldering process, why should parts be held firmly in a place?

Q.3 What type of heating devices can be used for soldering purposes?

Q.4 Give the names of tools which are used in soldering?

Q.5 Define desoldering?

PRACTICAL NO.9

OBJECTIVE

To carry out the brazing process

THEORY

This is a process for joining metal parts, very similar to soldering, except that brass is used to make the joint in place of the lead and zinc alloys which form solder. Brazing must not be attempted on metals whose melting point is less than that of sheet brass.

Two pieces of brass to be brazed together are heated to a temperature at which the brass used in the process will melt and flow between the surfaces. The brass amalgamates with the surfaces and makes a very strong and perfect joint, which is far superior to any form of soldering where the work allows this process to be used, and in many cases is the equal of welding for the particular field in which it applies

Brazing is the joining of metals through the use of heat and a filler metal - one whose melting temperature is above 840°F (450°C) but below the melting point of the metals being joined. It is distributed between two or more close-fitting parts by capillary action. At its liquid temperature, the molten filler metal interacts with a thin layer of the base metal, cooling to form an exceptionally strong, sealed joint due to grain structure interaction. The brazed joint becomes a sandwich of different layers, each metallurgical linked to each other.

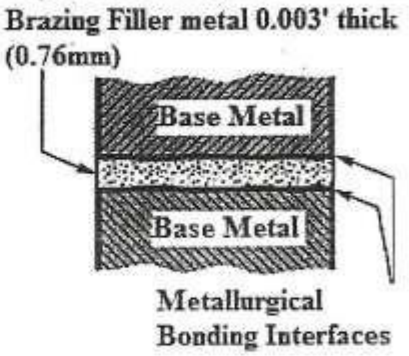


Figure 11a: brazing

AWS (A 5.8) Filler Metal for Brazing and Braze Welding

Filler Metals For Brazing and Braze Welding - Examples BCu-P, RBCuZn-A, BVAg-32

Brazing filler metals are standardized into eight alloy systems: silver, precious metals, aluminum-silicon, copper-phosphorus, copper and copper-zinc, nickel, cobalt, and magnesium filler metals. The primary alloy system is identified according to chemical symbol.

1. At the beginning of the classification

a. "R" indicates a brazing filler metal

b. "RB" indicates that the filler metal is suitable as a welding rod and as a brazing filler metal

c. "BV" indicates a "vacuum grade" filler metals for use in some electronic devices.

2. The letters inflowing the "B", "RB" or "BV" are chemical symbols representing the primary alloy composition. CuP in the example refers to a copper-phosphorus alloy.

3. Suffix numerals are used to indicate a particular chemical analysis within an alloy group.

4. A grade suffix is added after any suffix numerals for vacuum grade filler metals as follows:

a. Grade 1 indicates the most stringent requirements on the emitter impurities

b. Grade 2 indicates less stringent requirements on emitter impurities

AWS (A 5.30) Fluxes for Brazing and Braze Welding

Consumable Inserts - Example 1N308

1. The prefix "IN" designates a consumable insert.
2. The numbers 308 designate the chemical composition.

Note that, while the solid products are classified on the basis of chemical composition, their cross-sectional configurations are another consideration that must be selected and. specified when ordering.

AWS (A 5.31) Welding Shielding Gases

Fluxes For Brazing and Braze Welding

a. "FB" indicates Flux for brazing or braze welding

b. The third character refers to group of applicable base metals as listed in the standard.

c. A fourth character represents a change in form and attendant composition, within the broader base

PROCEDURE

REVIEW QUESTIONS

Q.1 What is brazing?

Q.2 What type of filler metals are used in brazing?

Q.3 How does brazing differ from welding?

Q.4 Why is brazing an appropriate method for joining dissimilar metal with widely different melting point?

Q.5 Names the different types of technique of brazing?

F/OBEM 01/05/00

NED University of Engineering & Technology

Department of ____________________ Engineering

Course Code and Title: ____

Psychomotor Domain Assessment Rubric-Level P3					
Skill Sets	Extent of Achievement				
	0	1	2	3	4
Equipment Identification Sensory skill to ***identify*** equipment and/or its component for a lab work.	Not able to identify the equipment.	--	--	--	Able to identify equipment as well as its components.
Equipment Use Sensory skills to ***demonstrate*** the use of the equipment for the lab work.	Doesn't demonstrate the use of equipment.	Slightly demonstrates the use of equipment.	Somewhat demonstrates the use of equipment.	Moderately demon strates the use of equipment.	Fully demonstrates the use of equipment.
Procedural Skills ***Displays*** skills to act upon sequence of steps in lab work.	Not able to either learn or perform lab work procedure.	Able to slightly understand lab work procedure and perform lab work.	Able to somewhat understand lab work procedure and perform lab work.	Able to moderately understand lab work procedure and perform lab work.	Able to fully understand lab work procedure and perform lab work.
Response Ability to ***imitate*** the lab work on his/her own.	Not able to imitate the lab work.	Able to slightly imitate the lab work.	Able to somewhat imitate the lab work.	Able to moderately imitate the lab work.	Able to fully imitate the lab work.
Observation's Use ***Displays*** skills to use the observations from lab work for experimental verifications and illustrations.	Not able to use the observations from lab work for experimental verifications and illustrations.	Slightly able to use the observations from lab work for experimental verifications and illustrations.	Somewhat able to use the observations from lab work for experimental verifications and illustrations.	Moderately able to use the observations from lab work for experimental verifications and illustrations.	Fully able to use the observations from lab work for experimental verifications and illustrations.
Safety Adherence Adherence to ***safety*** procedures.	Doesn't adhere to safety procedures.	Slightly adheres to safety procedures.	Somewhat adheres to safety procedures.	Moderately adheres to safety procedures.	Fully adheres to safety procedures.
Equipment Handling ***Equipment care*** during the use.	Doesn't handle equipment with required care.	Rarely handles equipment with required care.	Occasionally handles equipment with required care.	Often handles equipment with required care.	Handles equipment with required care.
Group Work ***Contributes*** in a group based lab work.	Doesn't participate and contribute.	Slightly participates and contributes.	Somewhat participates and contributes.	Moderately participates and contributes.	Fully participates and contributes.

Laboratory Session No. _____________ Date: _______________________

Weighted CLO (Psychomotor Score)	
Remarks	
Instructor's Signature with Date:	