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Unit II

2023-24 (Odd): 1st Semester

BE in CV, CY, EC, EI, IM

ME113AT: Fundamentals of Mechanical Engineering

(Category: Engineering Science)

(Theory)

ESC: 'C' Section

Unit – II

VISION SYSTEMS IN MANUFACTURING AND JOINING PROCESSES

Faculty In-Charge:

Dr. V L Jagannatha Guptha

Assistant Professor

Department of Mechanical Engineering

Mobile: 9243447122

Email ID: jagannathagvl@rvce.edu.in

Unit II

Vision Systems in Manufacturing >>

08 Hrs

- Introduction
- Role of Human vision in computer interaction
- Importance
- Types of computer vision in manufacturing
- Architecture of a Vision System
- Artificial Intelligence V/s Computer Vision
- Applications of Computer Vision in various industries
- A Case Study: Computer Inspection of a Two-stage Soldering Defect in PCB board

Joining Processes>>

- Welding – Arc welding
- Gas welding , Types of flames
- Soldering and Brazing

Unit – II	8 Hrs
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Vision Systems in Manufacturing >>

Introduction>>

- Vision Systems are a set of integrated components that are designed to use information extracted from digital images to automatically guide manufacturing and production operations such as go/no testing and quality control processes.
- These systems can also play a role in automated assembly verification and inspection operations through their ability to guide material handling equipment to position products or materials as needed in a given process.
- They have wide applications across different industries and can be used to automate any mundane, repetitive tasks that would become tiring to a human inspector or operator.
- The use of machine vision systems allows for 100% inspection of products or parts in a process, resulting in improved yields, reductions in defect rates, increased quality, lower costs, and greater consistency of process results.
- Usually, computer vision in manufacturing is used for product and quality inspection, structure surveillance, and tracking for damages or faults.
- Cameras allow manufacturing plants to inspect their products for tiny defects.
- They can be much more sensitive than the human eye, and machines' attention is never tired.

Vision Systems in Manufacturing >>

Role of human vision in computer interaction in manufacturing>>

- Vision-based Human-computer interaction provide a wider and more expressive range of input capabilities by using computer vision techniques to process data from one or more cameras.
- Human–computer interaction (HCI) is research in the design and the use of computer technology, which focuses on the interfaces between people (users) and computers. HCI researchers observe the ways humans interact with computers and design technologies that allow humans to interact with computers in novel ways.
- Human–machine interaction (HMI) refers to the communication and interaction between a human and a machine via a user interface.

  Nowadays, natural user interfaces such as gestures have gained increasing attention as they allow humans to control machines through natural and intuitive behaviours.

Vision Systems in Manufacturing >>

Types of computer vision in manufacturing>>

- Image segmentation
- Object detection
- Edge detection
- Pattern detection
- Image classification
- Feature matching

Image segmentation:

- This involves converting an image into a collection of regions of pixels that are represented by a mask or a labelled image.
- By dividing an image into segments, you can process only the important segments of the image instead of processing the entire image.

Object detection:

- The object detection works by Gathering and organizing data
- The computer interprets either a pixel-based or vector-based image, identifies the important data from the image, and classifies it into distinct objects to be analysed and retained.

Vision Systems in Manufacturing >>

Types of computer vision in manufacturing>> contd…

Edge detection:

- This is an image processing technique for finding the boundaries of objects within images.
- It works by detecting discontinuities in brightness. Edge detection is used for image segmentation and data extraction in areas such as image processing, computer vision, and machine vision.

Pattern detection / Pattern recognition:

- It is a data analysis method that uses machine learning algorithms to automatically recognize patterns and regularities in data.
- This data can be anything from text and images to sounds or other definable qualities. Pattern recognition systems can recognize familiar patterns quickly and accurately.

Vision Systems in Manufacturing >>

Types of computer vision in manufacturing>> contd…

Image classification:

- **Industrial image processing** is generally used in automated inspection systems.
- **Image processing operations** are used to improve the image quality, enhance desired features, and so on. Analysis of the enhanced images enables pattern recognition.
- **There are two types of methods** used for image processing namely:
  - ✓ Analogue image processing
  - ✓ Digital image processing
- **Analogue image processing** can be used for the hard copies like printouts and photographs.
- **Image analysts** use various fundamentals of interpretation while using these visual techniques.

Feature matching:

- **A manufacturing feature** is commonly defined as a collection of related geometric elements which correspond to a particular manufacturing method or process or which can be used to reason about the suitable manufacturing methods or processes for creating that geometry.

Fundamentals of Mechanical Engineering

VISION SYSTEMS IN MANUFACTURING

Assignment – Unit 2 - 01

<<for Practice>>

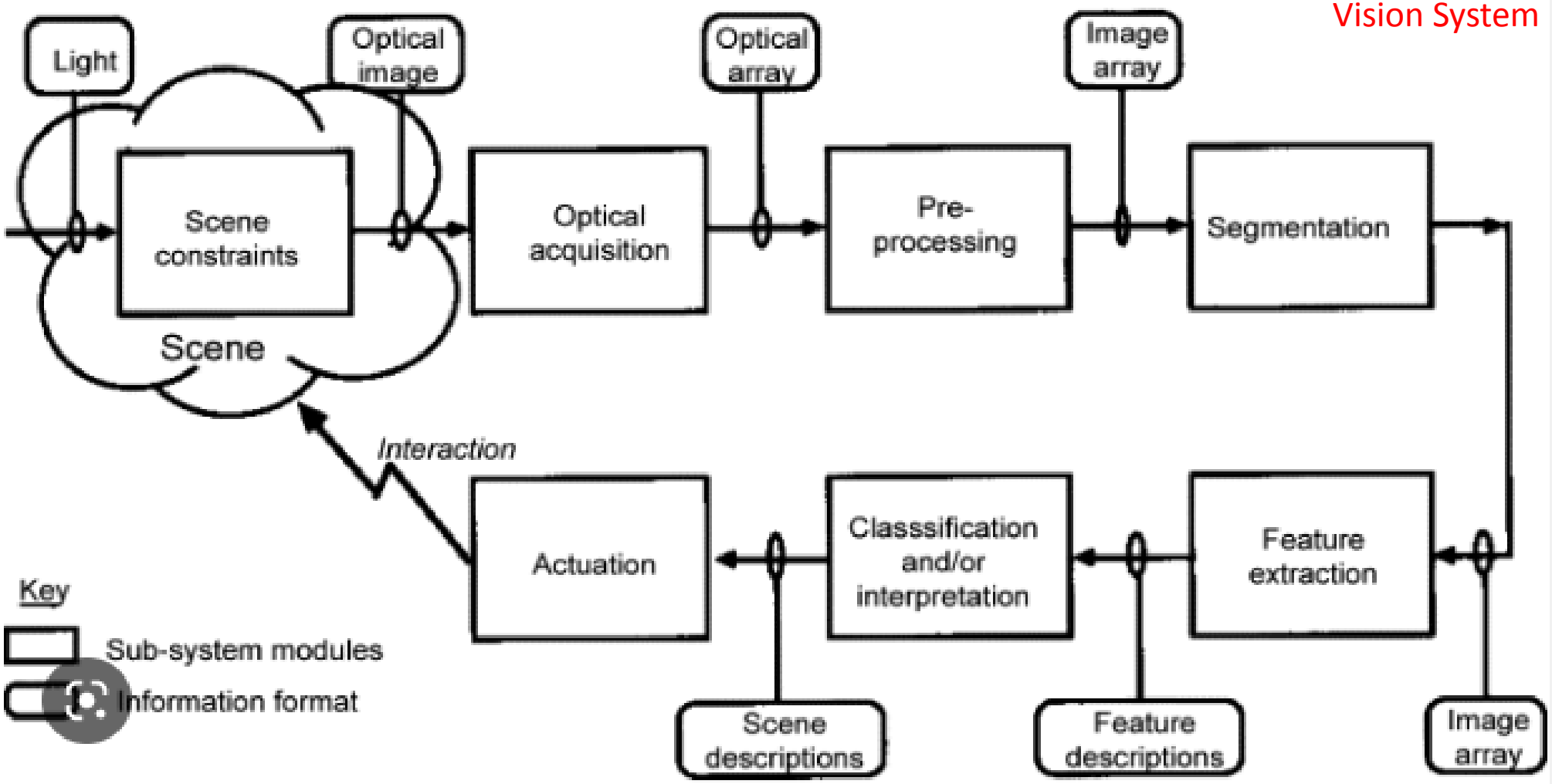
1) Explain with neat sketch ….
2) Brief about …..

Note:

i) Use new A4 size sheets, provide 1” left and top margin for each sheet.
ii) Write Roll No., Name (at right top), Topic and Assignment No. (at top Middle) in the 1st sheet.
iii) Use red pen to write the questions and blue or black pen for answer
iv) Draw neat sketches using instruments (avoid free hand sketching)

Vision Systems in Manufacturing >>
Architecture of a Vision System>>

Architecture of a Vision System



Vision Systems in Manufacturing >>

Differences between Artificial Intelligence and Computer Vision >>

- Computer vision is different from artificial intelligence because computer vision is used to process images with a set of general rules. At the same time, AI is a field where machines can learn to perform complicated tasks for themselves. For example, consider object recognition.
- Computer vision is a branch of AI. It only deals with helping machines discern what's in images or videos. AI also involves algorithms that deal with language, algorithms that predict things, algorithms that understand patterns changing over time, and much more.
- Computer Vision is the ability to recognize and discriminate between things in the same manner that humans do when walking or watching a movie that is at the heart of computer vision. A) conventional programming i.e. hard coding the description of all existent items in this world, which is impractical/impossible; or b) we can teach a computer the capacity to recognize and interact with any object in the universe. AI technologies like deep learning can be used to teach computers instead of handing them a set of instructions
- Computer vision is very similar to human vision, only superior. Systems equipped with this type of AI can inspect and analyse thousands of products or processes in a matter of minutes, unlike the human brain.

Vision Systems in Manufacturing >>

Industrial Applications of Computer Vision System>>

1. Automated assembly

- Cycle time control
- 3D vision monitoring
- Optimizing Supply Chains
- Digital Lean Manufacturing

2. Quality inspection of the products

3. Safety:

- Computer vision helps object tracker in a video and detects them in an image, thus allowing businesses to enhance their security significantly.

Vision Systems in Manufacturing >>

Industrial Applications of Computer Vision System>>

4. Factory synchronization and dynamic scheduling:

- Manufacturing systems (e.g., enterprise resource planning and manufacturing execution system) provide dynamic resource allocation and schedule.
- In addition, those systems accumulate and use visual data for real-time tracking of material and product movement. As a result, agility improves, inventory reduces, and overall equipment effectiveness grows.

5. Predictive maintenance:

- Equipment downtimes can be expensive, thus leading to substantial losses.
- Computer vision technology can consistently and accurately monitor production machinery for the early signs of degradation.
- Reinforced with IoT and deep learning, these computer vision systems can be highly accurate and consistent.
- As a result, they can alarm engineers for maintenance before it is too late and the issue occurs.

Industrial Applications of Computer Vision System>>

6. Reading barcodes and QR codes:

- It is a popular computer vision use case in the manufacturing industry.
- Recognizing and reading barcodes and text is not an easy task to do every day.
- Smart factories use modernized artificial intelligence as well as computer vision-powered systems and applications to solve this problem and flag off green signals for industrial automation.

7. Training:

- Computer vision could be used as a part of a machine learning system to create a virtual environment for training and skill development.

8. Track-and-trace:

- Some manufacturers must track and trace their products from the production line to the client.
- It is especially crucial for fresh food and medicine.

Vision Systems in Manufacturing >>

A Case Study: Computer Inspection of a Two-stage Soldering Defect in PCB board >>

Prepare a short note on the topic

Fundamentals of Mechanical Engineering

VISION SYSTEMS IN MANUFACTURING

Assignment – Unit 2 - 02

<<for Practice>>

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2) Brief about …..

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Joining Processes>>

- Welding – Arc welding
- Gas welding , Types of flames
- Soldering and Brazing

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Joining Processes>>

Welding > Introduction>

- Welding is a process of joining two pieces of metal by the application of heat with or without the application of pressure and filler material.
- Welding produces a permanent joint.
- Welding is used in joining pressure vessels, tanks, bridges, railways, machine frames & brackets, building the body of automobiles, aircrafts & ships etc.

Welding >> Classification>

Welding process may be broadly classified as

1. Plastic welding or Pressure welding
2. Fusion welding or Non Pressure welding

1. Plastic welding or Pressure welding

- In this type of welding, the metal pieces to be joined are heated to a plastic state and then joined together by the application of pressure without the addition of filler material.
- Ex: Forge welding, Resistance welding.

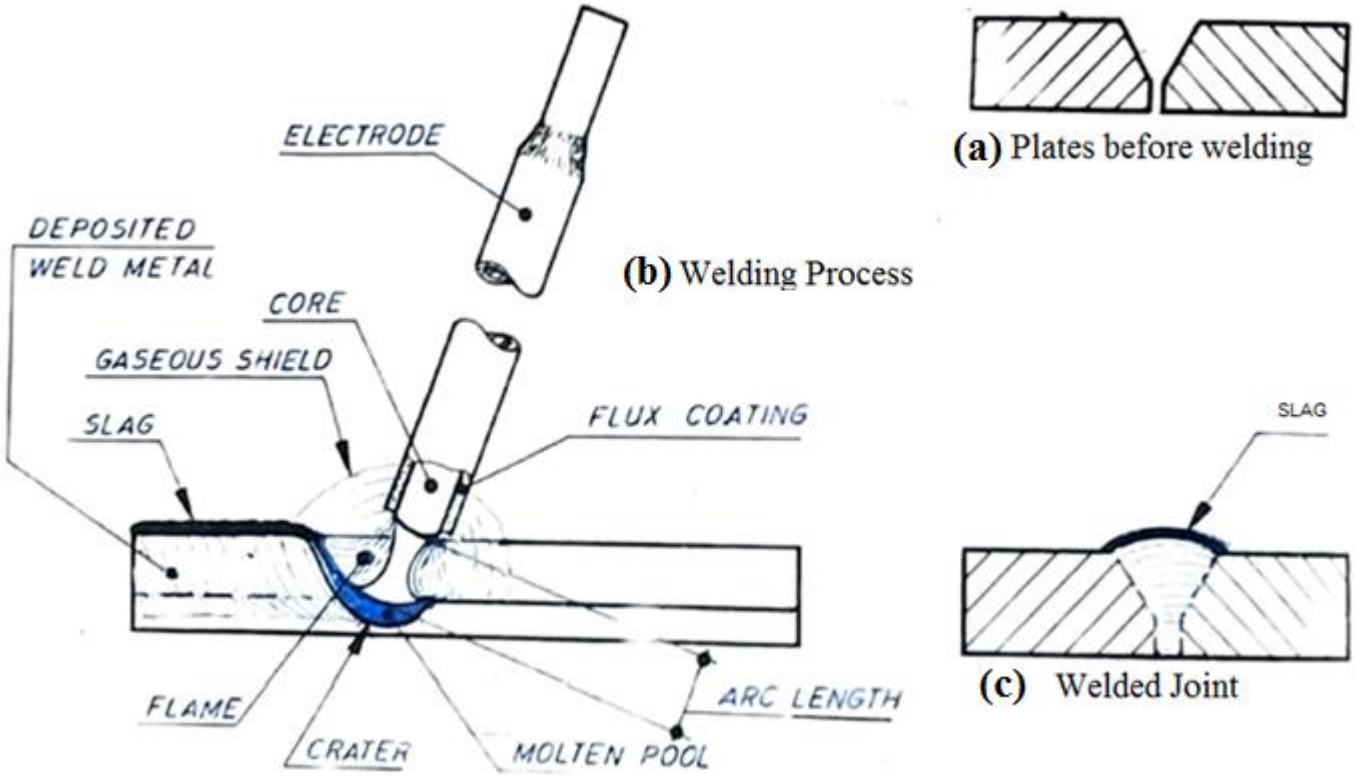
2. Fusion welding or Non Pressure welding

- In this type of welding, the metal pieces to be joined are heated to molten state and allowed to solidify without the application of pressure. A filler material is used during the welding process.
- Ex: Arc welding, Gas welding.

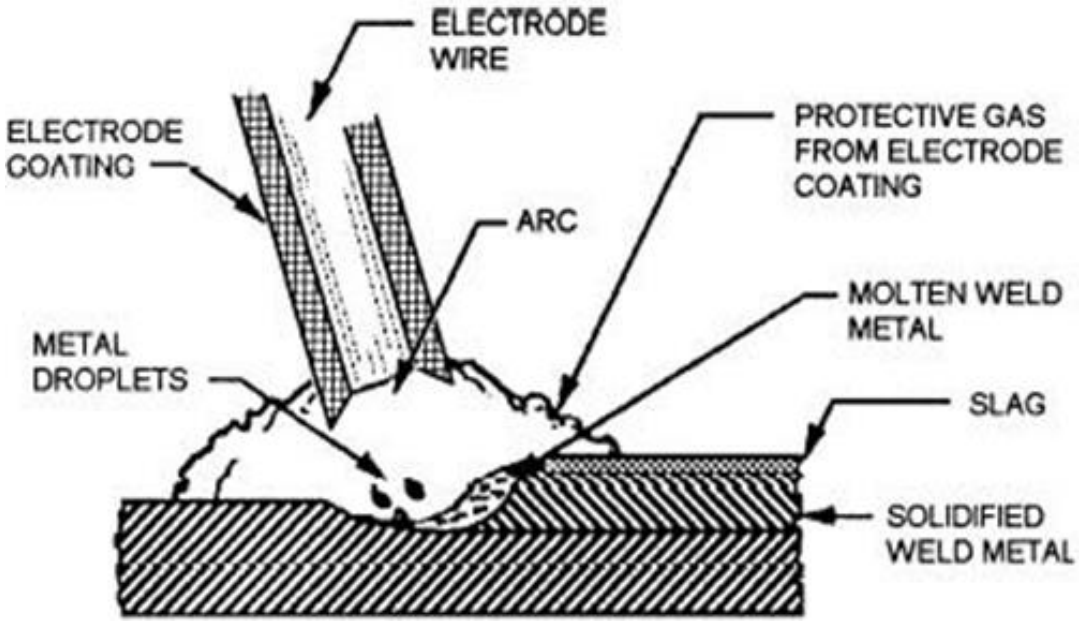
Joining Processes>>

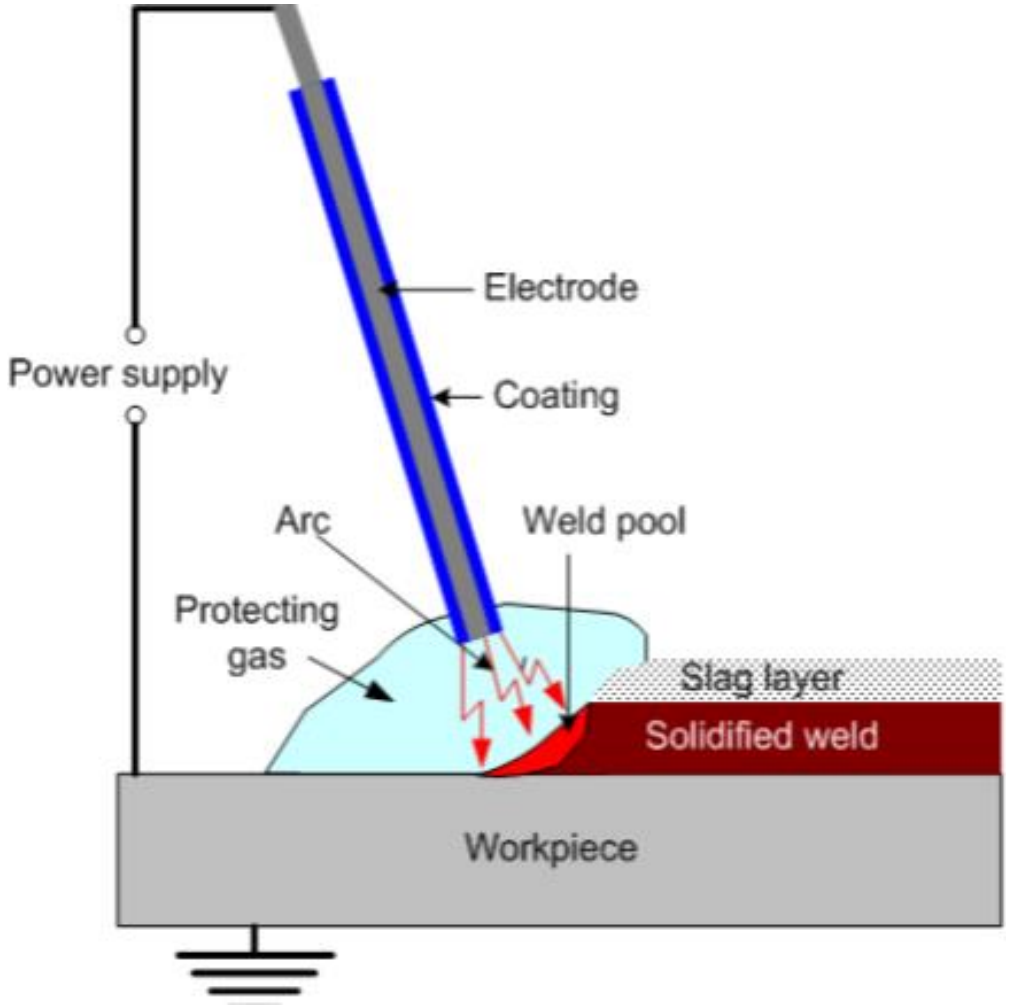
Arc Welding Process>

- The principle of arc welding is that, when two conductors of an electric circuit are touched together momentarily and then instantaneously separated slightly, an electric arc is formed.
- A high heat density is produced throughout the length of the arc at a temperature of 5000 to 6000 Centigrade.
- The parts to be welded are wired as one pole of the circuit, and the electrode held by the operator forms the other pole.
- When the arc is produced, the intense heat quickly melts the work piece metal which is directly under the arc, forming a small molten metal pool.
- At the same time the tip of the electrode at the arc also melts, and this molten metal of the electrode is carried over by the arc to the molten metal pool of the workpiece.
- The molten metal in the pool is agitated by the action of the arc, thoroughly mixing the base and the filler metal. A solid joint will be formed when the molten metal cools and solidifies.
- The flux coating over the electrode produces an inert gaseous shield surrounding the arc and protects the molten metal from oxidizing by coming in contact with the atmosphere.



Shielded Metal Arc Welding (SMAW)





Schematics of Shielded Metal Arc Welding (SMAW) Process and weld Zone

Joining Processes>>

Arc Welding Machine>>

- **The function of a welding machine** is to generate a low voltage (10 to 50 V) and high current (50 A to 300 A).
- **The current may be alternating current or direct current** and the polarity of the electrode may be positive or negative, depending on the type of electrode and the metals to be welded.
- **In AC arc welding**, a step down transformer is used to step down the voltage from 220/440 V to 80 to 100 V & a current of 100 to 400 A.
- **In DC welding,** the work piece is connected to the +ve pole of a D.C generator and the electrode to –ve pole. It is called 'straight polarity' and is used when high heat is required.
- **When less heat is required**, the polarity is reversed.
- **Because of the option of reversing the polarity,** D.C welding may be used to weld many metals which require more heat to melt.
- **In AC welding,** the polarity changes in every cycle.
- **Also the current & the voltage** acquire a value of zero twice in every cycle, and hence higher voltage is required to maintain the arc.

Arc Welding Machine

Joining Processes>>

Arc Welding Electrodes>>

- The electrode used in arc welding is of consumable type & it is coated with flux.
- The flux coating is usually made of chalk (lime), Ferro manganese, cellulose, Starch, Kaolin (China clay), iron powder, etc.
- The flux forms a slag after welding which can be removed by chipping hammer & a wire brush.
- The purpose of coating the electrodes are;
  - Protection of molten metal from oxidation
  - To prevent rapid cooling of molten metal
  - To establish & maintain the arc.
  - Addition of alloying elements.

Arc Welding Electrode

Joining Processes>>

Purpose of Each Ingredient of Flux Coating>>

- **China clay, mica** etc. produce a slag which because of its light weight forms a layer on the molten metal and protects the same from atmospheric contamination.
- Ingredients, like **cellulose, wood, starch,** calcium carbonate etc., form a protective gas shield around the electrode end, arc and weld pool.
- Deoxidizing elements like **Ferro manganese** refine the molten metal.
- Alloying elements like **Ferro alloys of manganese, molybdenum** etc. may be added to impart suitable properties and strength to the weld metal.
- **Iron powder** in the coating improves arc behaviour, bead appearance; helps increase metal deposition rate and arc travel speed.

Safety Devices used in Arc Welding>>

- The welding shield protects the eyes from infra-red & ultra -violet radiations.
- Gloves are used to protect the hands from spark & to insulate from electric shocks
- Chipping hammer & wire brush to clear the slag.
- Apron to protect the clothing from sparks & spatter.
- Earthing clamp will avoid the risk of electric shock.

Fundamentals of Mechanical Engineering

JOINING PROCESSES

Assignment – Unit 2 - 03

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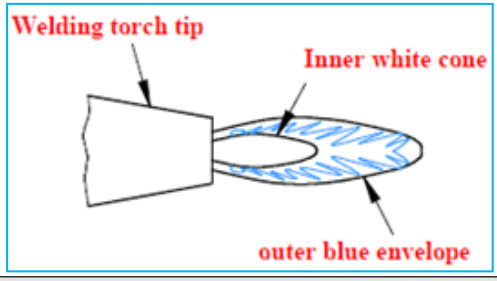
Joining Processes>>

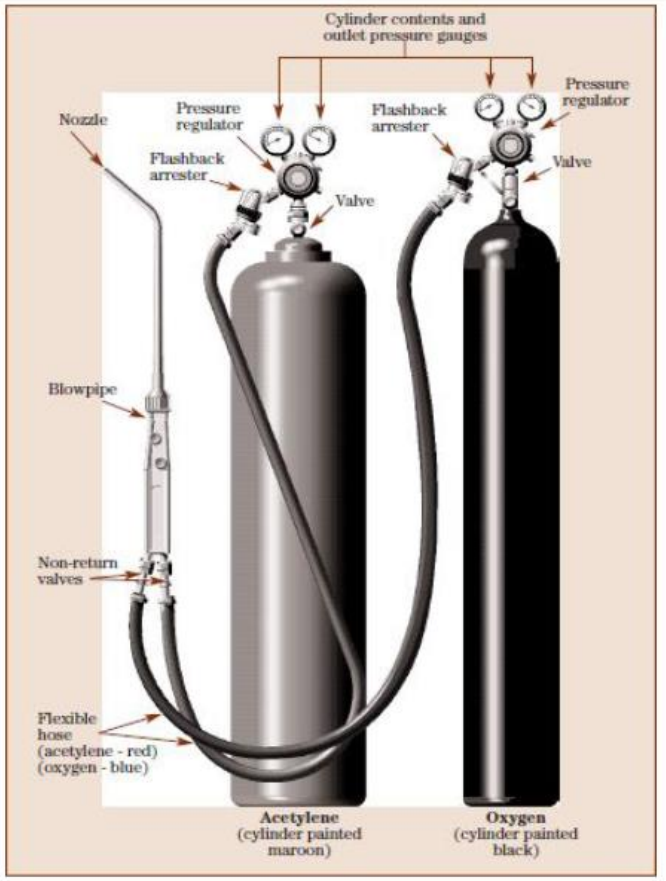
Gas Welding>>

- Gas welding is a fusion method of welding in which a strong gas flame is used to raise the temperature of the work piece to melt them. As in arc welding, a filler material is used to fill the joint.
- The gas combinations that can be used for heating are;
  - 1. Oxygen & Acetylene
  - 2. Oxygen & Hydrogen



Oxy-Acetylene Welding>>

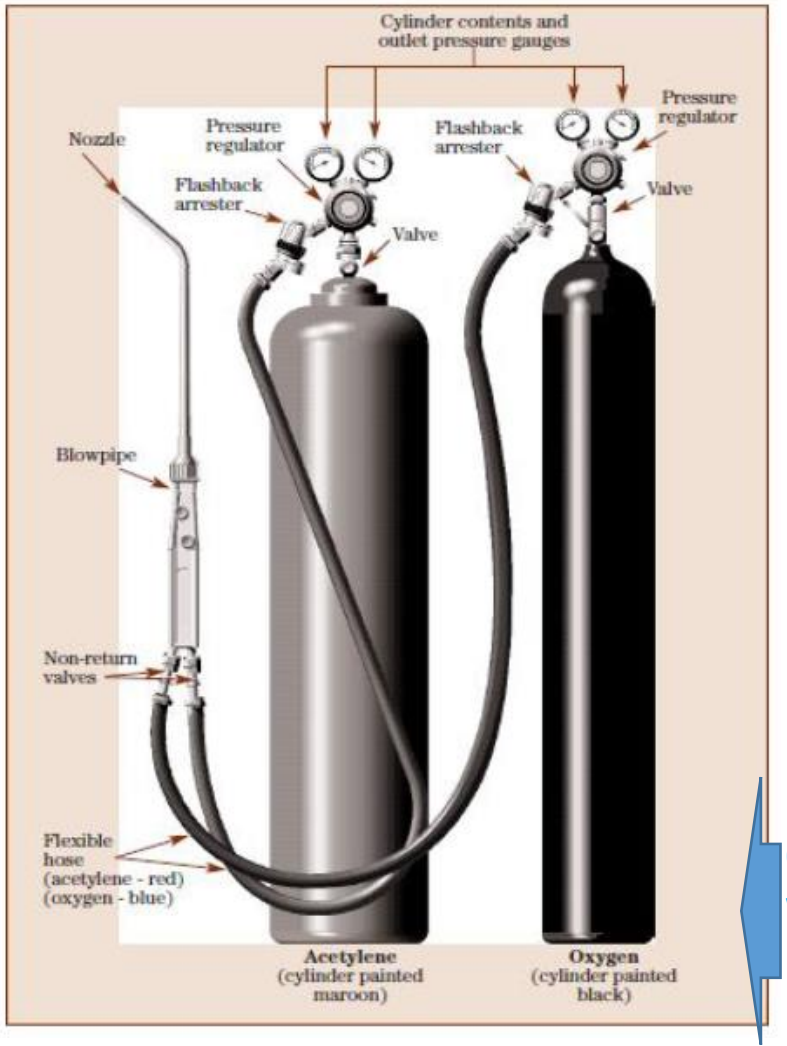
- When right proportions of oxygen and acetylene are mixed in the welding torch and when ignited, the flame produced at the nozzle tip is called as the Oxy-Acetylene Flame. This flame when used in welding becomes Oxy-acetylene Welding.
- The temperature attained by the Oxy-acetylene flame is around 3200 Centigrade and therefore has the ability to melt all commercial metals. Thus, there is a complete bonding of the joining metals that can be achieved during welding
- The oxy-acetylene gas equipment consists of two large steel cylinders; one containing oxygen at high pressure and the other dissolved acetylene also at high pressure.
- It also consists of rubber tubes, pressure regulators, & blow torch.
- The oxygen and acetylene are supplied to the blow torch separately where both of them get mixed together and come out through the nozzle of the blow torch.



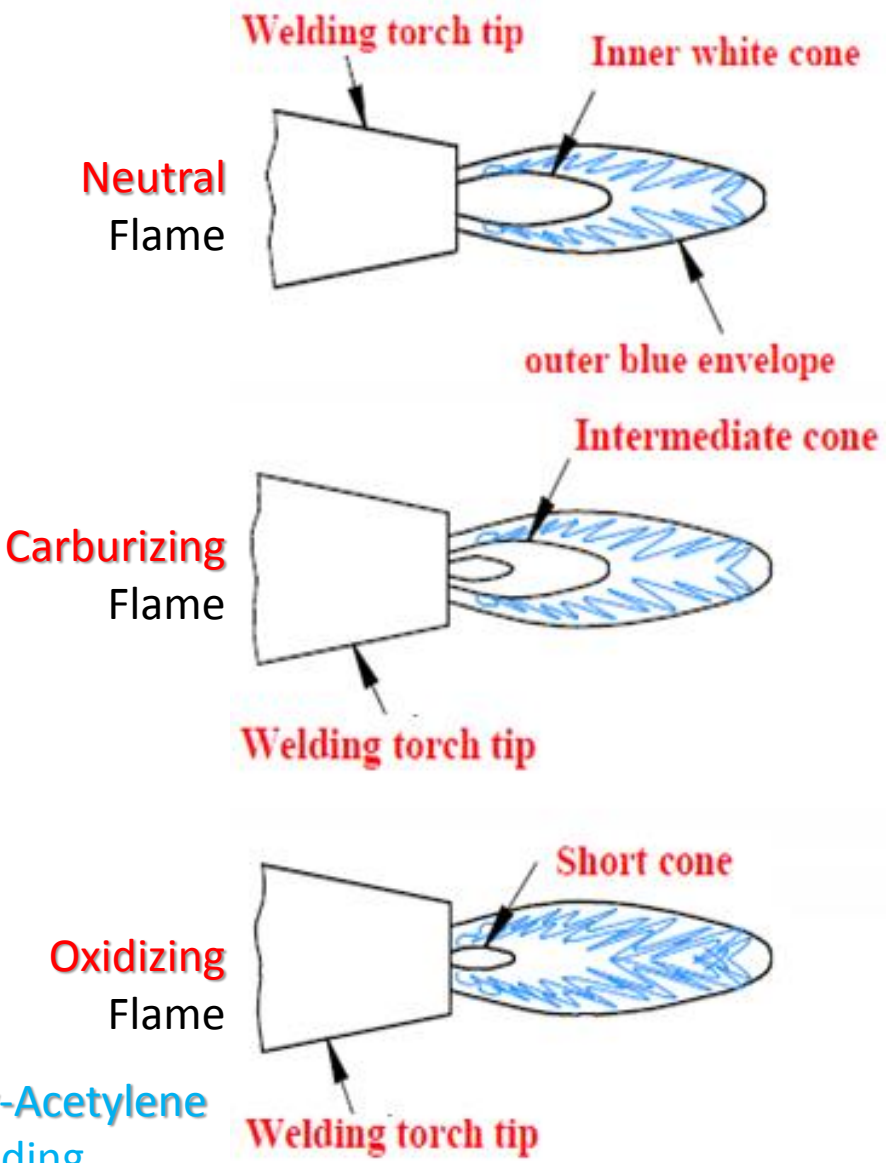
Joining Processes>>

Types of Oxy-Acetylene Flames>

- Neutral Flame
- Carburizing Flame
- Oxidizing Flame



Oxy-Acetylene Welding Facility



Schematic of Flame

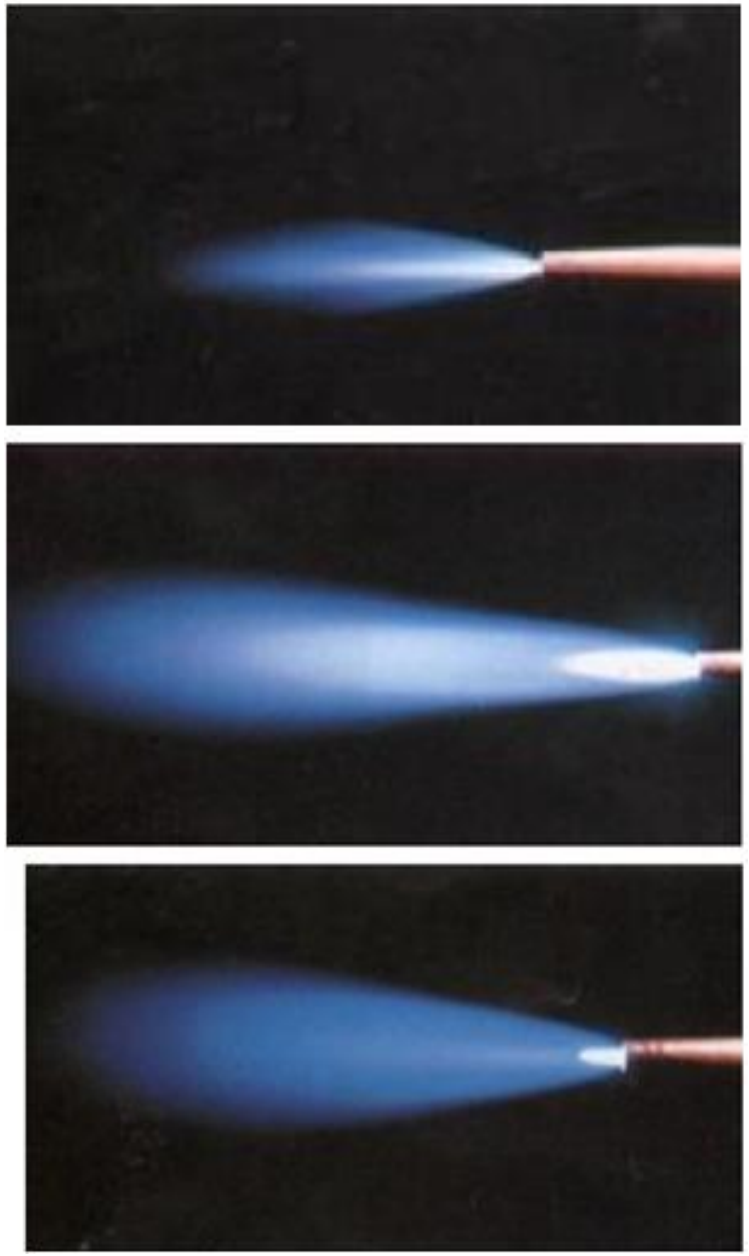


Image of Flame

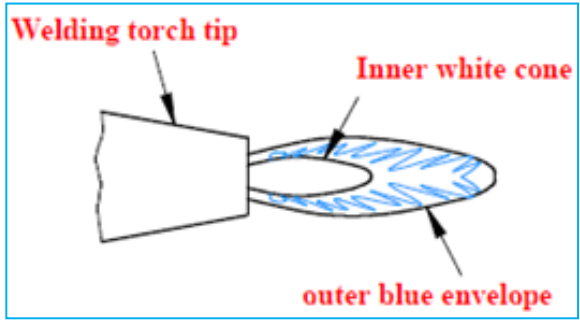
Joining Processes>>

Types of Oxy-Acetylene Flames>

- Neutral Flame
- Carburizing Flame
- Oxidizing Flame

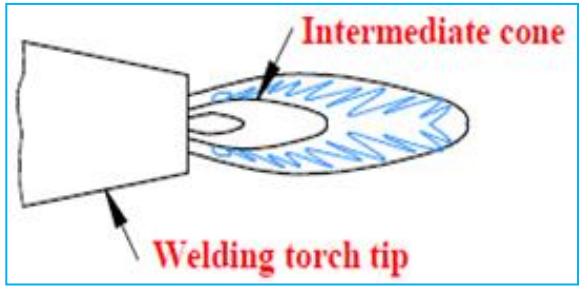
Neutral Flame :

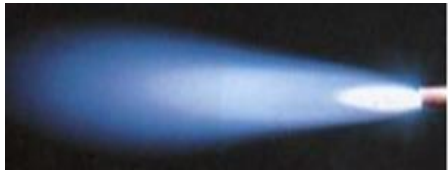
- A Neutral flame is obtained by supplying equal volumes of oxygen & acetylene. (Oxygen: Acetylene = 1: 1)
- A neutral flame consists of an inner small whitish cone surrounded by a sharply defined blue flame.
- Most of the oxy-acetylene welding is done with the neutral flame.



Carburizing Flame :

- A Carburizing flame or reducing flame is obtained by supplying excess acetylene. (Oxygen : Acetylene = 0.95 :1)
- It has three cones; an inner white cone, surrounded by an intermediate whitish cone & a bluish envelope flame.
- Carburizing flame is used for welding alloy steels, cast iron & aluminium to protect from oxidizable elements.



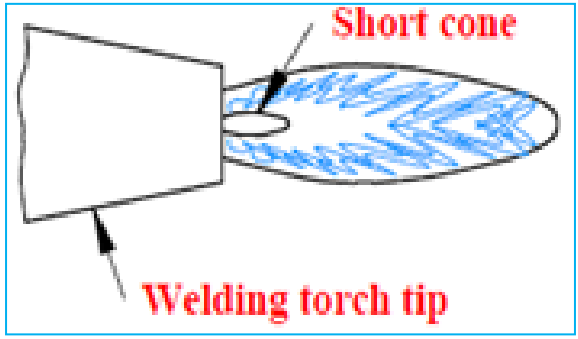


Joining Processes>>

Types of Oxy-Acetylene Flames>

Oxidizing Flame:

- The Oxidizing flame is obtained when there is excess oxygen having gas ratio as high as 1.5. (Oxygen: Acetylene = 1.5 : 1)
- In appearance, it resembles a neutral flame except that the inner white cone is somewhat shorter.
- It is used for welding nickel and many non ferrous materials.
- This is used for oxy-acetylene cutting and is not suitable for welding, since the weld metal will be oxidized



Joining Processes>>

Defects in Welding>

Common weld defects include:

- **Lack of fusion:**
  It results from too little heat input and too rapid traverse of the welding torch (gas or electric)
- **Porosity:**
  This occurs when gases are trapped in the solidifying weld metal.
- **Inclusions:**
  These can occur when the slag covering a weld is not totally removed before another weld run.
- **Cracking:**
  This can occur due to thermal shrinkage.
- **Undercut:**
  This is due to excess melting of the parent metal which reduces the strength of the joint.

Joining Processes>>
Soldering > Introduction>

- Soldering is a process in which two or more metal items are joined together by melting and flowing a filler metal (solder) into the joint.
- The filler metal will have a lower melting point than the work piece *(between 1500C-3500C).*
- Soldering differs from welding in that *soldering does not involve melting the work pieces.*
- To clean the surfaces to be joined & to prevent oxidation, Zinc chloride is used as a flux.
- A soldering iron is used to apply heat produced from an electrical source.
- An alloy of lead & tin called '**Soft solder**' is used for sheet metal work, plumbing work & electrical junctions. The melting temperature of the soft solder will be between **150 to 350 C**.
- An alloy of Copper, Tin and Silver known as **Hard solder** is used for stronger joints. The soldering temperatures of hard solders ranges from **600 to 900 C**.

Soldering Wire

Soldering Flux

Soldering Iron

Joining Processes>>

Soldering >> Tools[1]>

The following are the tools used in soldering:

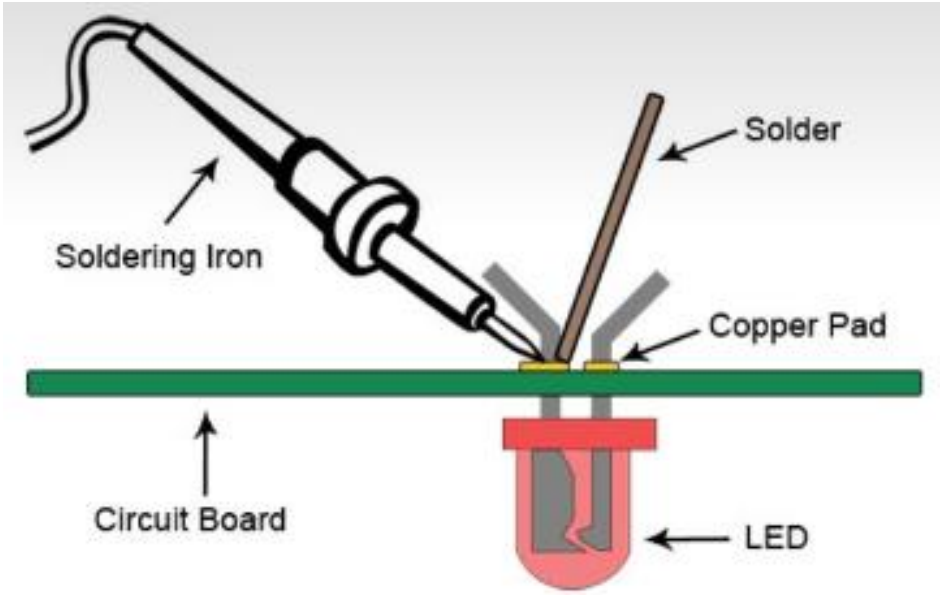
1. Soldering iron
2. Soldering station
3. Iron tips
4. Brass or conventional sponge
5. Soldering iron stand
6. Solder
7. Helping Hand

Helping hand a device consisting of 2 or more clips and sometimes a magnifying glass/light is attached.

Joining Processes>>

Soldering>> Method >

- **Cleaning of Joining surfaces:**
  The joining surfaces are cleaned mechanically to make them free from dust, oil, scales etc and ensure that the molten filler wets the surfaces.
- **Application of flux:**
  The joining surfaces are coated with a flux, usually rosin or borax. This cleans the surfaces chemically and helps the solder in making a bond.
- **Tinning of the surfaces to be soldered:**
  Before carrying out the soldering operation, the soldering iron must be “tinned”. This is to remove a thin that forms on the copper bit.
- **Heating:**
  The soldering iron is then heated and the flowing molten filler metal fills the joint interface. Allow the soldered area to cool and then solidify thus making the joint.
- **Final clean Up :**
  After completing the soldering, and the joints are formed, clean it with steel wool or solvent to remove left –over flux. After this clean the soldering iron using a damp sponge.



Schematic of Soldering [2]

Joining Processes>>

Soldering >> Safety, Advantages and Disadvantages [1]>

Safety in Soldering>

1. The temperature of soldering irons can reach 800 F (Fahrenheit), so it is very important to know where the iron is at all times.
2. When doing soldering, one should use a soldering iron stand to prevent accidental damage.
3. When solder is heated, fumes are released which are very dangerous to the eyes and lungs. It recommends using a fume extractor, a fan with a charcoal filter that absorbs harmful solder fumes.
4. One must wear protective eyewear when doing soldering, to protect from an accidental splash of hot solder.

Advantages of Soldering>

The following are the advantages of soldering:

1. It is a simple and economical process.
2. Since it has been done at relatively low temperatures, no metallurgical damage to the base metal.
3. The soft solder joint can easily be dismantled by simple heating.
4. Operator fatigue is less compared to the welding process. Soldering is divided into two classifications: soft and hard.

Disadvantages of Soldering>

The following are the disadvantages of soldering:

1. The process is limited to the minimum thickness(3mm).
2. A skilled operator is required.
3. The strength of the joint, when compared to welding, is lower.

Extra information...

Joining Processes>>

Soldering >> Applications >

The main applications of soldering are:

1. Soldering is used to join automobile radiator cores.
2. Used to plumbing.
3. Mainly useful in electronic industries like radio, TV, and computers.
4. For joining wires and cables to lugs in electrical industries

Solder is commonly used in:

- Electronics
- Heating
- Air conditioning
- Fire sprinkler
- Radiator manufacturing, repair and
- Sheet metal work

It is also used in

- Jewellery and
- Stained glass work

Extra information….

Many industries, including metalwork and plumbing use soldering techniques [3].

Electronics

Without the use of solder, modern electronics wouldn't be able to function. Solder is a low-melting-point babbitt metal that connects components to substrates and brings electrical continuity so these devices can work perfectly. Printed circuit boards are primarily soldered by using these connections; without them, PCBs would have no way for electricity transfer or signals transmission between parts in the board itself – making it useless!

Metalwork

The world of jewelry-making is often a laborious process requiring precision and patience. One way to make the job easier can be found in soldering, where various pieces are bonded together by heating them up until they fuse into one solid piece. This form of bonding has been used for centuries on jewelry and musical instruments such as violins and trumpets.

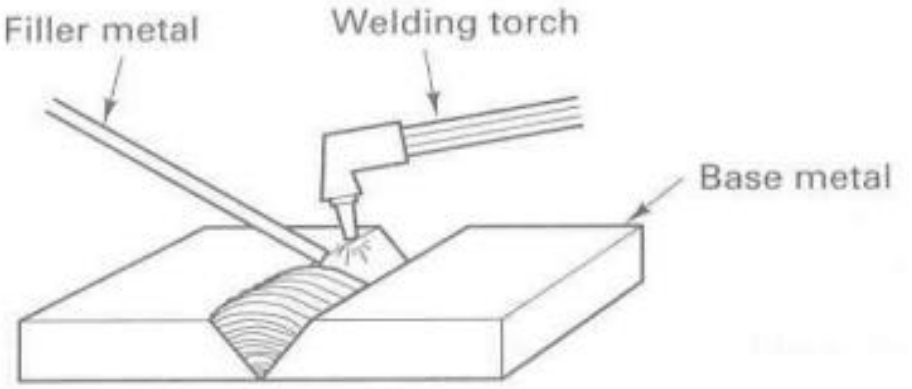
Plumbing

Plumbing technicians use soldering to repair and seal leaky pipes, radiators, fuel tanks, or anything that needs a liquid-tight connection. The most common application is in the water supply line, where heat from an oxyacetylene torch melts solder into the copper joint to be fused with pressure while cooling down.

Joining Processes>>

Brazing>>

- Brazing is akin to soldering in that it also uses filler for joining two metals, albeit a high-temperature one. Similar to welding, brazing creates a mechanical connection between to metal parts[4].
- In a very general sense, brazing is a joining process that relies on the melting, flow, and solidification of a brazing filler metal to form a leak-tight seal, a strong structural bond, or both between materials.
- It is a joining process that produce the coalescence of materials by heating them to the brazing temperature in the presence of a brazing filler metal that has a liquidus temperature above 450ºC and below the solidus temperature of the base materials.
- The process is unique in that this metallurgical bond is formed by melting the brazing filler metal only; the components being joined undergo no melting.
- Brazing is a well-established commercial process capable of producing strong joints.



Schematic of Brazing

Actual process of Brazing

Joining Processes>>

Features of Brazing>>

- **Joining metals by melting filler:** Brazing consists of heating and melting a filler alloy. Once the filler solidifies, the metal pieces are joined.
- **Filler materials:** The filler alloy must have a lower melting temperature than the metal pieces.
- **Dissimilar metals:** Brazing allows for the joining of different metals like aluminum, silver, copper, gold, and nickel.
- **Flux is often used**: Liquid flux material promotes wetting of the metal parts, which lets the filler flow over them, so they can be joined more easily.
- **Special fluxes** are used (Borax) to: remove the oxide improve the fluidity of the fillers wet the joint surfaces
- **Strength**: While properly brazed joins can be stronger than the individual pieces, they are not as strong as welded joints.
- **Brazing Materials:** copper alloys silver alloys aluminium alloys

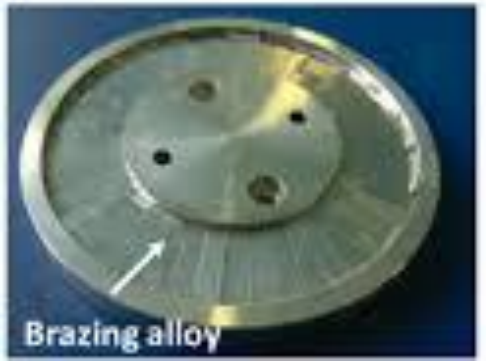
Advantages, Uses / Applications of Brazing>>

- It is widely used in industry because, in large part, it is capable of joining most metallic and ceramic materials.
- It is a versatile process that can be performed using manual techniques as well as automated production modes.
- Brazing lends itself to the production of large assemblies and assemblies composed of dissimilar metals.
- Brazing produces a tiny, clean fillet in contrast to the irregular bead made by welding, an advantage when appearance is critical.
- One of the main advantages of brazing is usually associated with cost savings.
- High production processes adapt well to today's improved processes.
- Brazing especially adapts to large production quantities as well as single individual quantities.

Joining Processes>>

Applications of Brazing>>

Copper - Copper



Alloys

Joining Processes>>

Differences between Brazing, welding and soldering [4]>>

Welding, soldering, and brazing are used for different jobs.
Depending on the work to be done, one has to consider factors like metal type, desired strength, and ultimate purpose to determine how to join two or more pieces of metal.

1. Strength

- Welding joints are the strongest joints used to bear the load.
  Strength of the welded portion of joint is usually more than the strength of base metal.
- Soldering joints are weakest joints out of three.
  Not meant to bear the load.
  Use to make electrical contacts generally.
- Brazing joints are weaker than welding joints but stronger than soldering joints.
  This can be used to bear the load up to some extent.

2. Temperature

- Welding: Temperature required is 3800°C in welding joints.
- Soldering: Temperature requirement is up to 450°C in soldering joints.
- Brazing: Temperature may go to 600°C in brazing joints.

Differences between Brazing, welding and soldering [4]>> Contd…

3. Heating of Work Pieces

- Welding: To join work pieces need to be heated till their melting point.
- Soldering: Heating of the work pieces is not required.
- Brazing: Work pieces are heated but below their melting point.

4. Change in Mechanical Properties

- Welding : Mechanical properties of base metal may change at the joint due to heating and cooling.
- Soldering : No change in mechanical properties after joining.
- Brazing : May change in mechanical properties of joint but it is almost negligible.

5. Heat Treatment

- Welding : Heat treatment is generally required to eliminate undesirable effects of welding.
- Soldering : No heat treatment is required.
- Brazing : No heat treatment is required after brazing.

6. Preheating of Workpiece

- Welding : No preheating of workpiece is required before welding as it is carried out at high temperature.
- Soldering : Preheating of workpieces before soldering is good for making good quality joint.
- Brazing : Preheating is desirable to make strong joint as brazing is carried out at relatively low temperature.

Fundamentals of Mechanical Engineering

JOINING PROCESSES

Assignment – Unit 2 - 04

<<for Practice>>

1) Explain with neat sketch ….
2) Brief about …..

Note:

i) Use new A4 size sheets, provide 1” left and top margin for each sheet.
ii) Write Roll No., Name (at right top), Topic and Assignment No. (at top Middle) in the 1st sheet.
iii) Use red pen to write the questions and blue or black pen for answer
iv) Draw neat sketches using instruments (avoid free hand sketching)

References>

1	https://www.theengineerspost.com/soldering-types-tools/
2	https://webstories.robocraze.com/what-is-soldering-types-applications/
3	https://www.canadametal.com/different-applications-of-soldering/
4	http://austgen.vn/blogs/what-is-the-differences-between-soldering-welding-and-brazing#:~:text=Welding%3A%20To%20join%20work%20pieces,but%20below%20their%20melting%20point.
	Video URLs
	https://youtu.be/TQP8EBQRvr0

Course Outcomes (COs):

Course Outcomes: After completing the course, the students will be able to:-	
CO 1	Understand the knowledge of various properties of Engineering materials and their Joining processes
CO 2	Elucidate the principles and operation of vision system in product inspection.
CO 3	Illustrate the Energy sources, mechanical drives and electrical drives in industrial applications
CO 4	Understand about Mechatronics, Automation and Robotics in Industrial Applications

References:

Reference Books	
1.	Elements of Mechanical Engineering, K. R. Gopalakrishna, Subhas Publications, 18th Edition. ISBN 5551234002884
2.	Material Science & Engineering- William D Callister, 2 / 10th Edition, ISBN 978-1-119-45520-2.
3.	Welding Technology (PB), Khanna O P, Dhanpat Rai publication, 4th Edition, ISBN 9383182555.
4.	Electric and Hybrid Vehicles, Design Fundamentals – Iqbal Husain, CRC Press, 2nd Edition, 2010. ISBN – 13-978-1439811757.
5.	Modern Electric, Hybrid Electric & Fuel Cell Vehicles, Fundamentals, Theory and Design - Mehrdad Ehsani, CRC Press, 1st Edition, 2005. ISBN – 13- 978-0849331541.
6.	Mechatronics – Electronic control systems in Mechanical and Electrical Engineering, William Bolton, Pearson, 6th Edition, ISBN: 978-1-292-07668-3, 2015.

Assessment and Evaluation Pattern:

CONTINUOUS INTERNAL EVALUATION		
ASSESSMENT AND EVALUATION PATTERN Theory & quizzes questions are to be framed using Bloom's Taxonomy Levels - Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating		
WEIGHTAGE	**CIE (50%)**	**SEE (50%)**
A. QUIZZES: Each quiz is evaluated for 10 marks		
Quiz-I for 10 Marks	**20**	*****
Quiz-I for 10 Marks		
B. TESTS: Each test will be conducted for 50 Marks adding upto 100 marks. Final test marks will be reduced to 40		
Test – I for 50 Marks	**40**	*****
Test – II for 50 Marks		
C. EXPERIENTIAL LEARNING: Fabrication of prototype of energy generator – 10 marks Fabrication of Mechatronics/Electrical/Mechanical drive prototype components– 20 marks Prototype models of Robot – 10 marks	**40**	*****
TOTAL MARKS FOR THE COURSE (A+B+C)	**100**	**100**

Practice to Prepare

All The Best