Tishk International University
Mechatronics Engineering Department
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Joining Process

Instructor: Sara Serwer Youns
Email:sara.sarwer@tiu.edu.iq

JOINING PROCESSES

• Joining includes welding, brazing, soldering, adhesive bonding of materials.

• They produce permanent joint between the parts to be assembled.

• They cannot be separated easily by application of forces.

• They are mainly used to assemble many parts to make a system.

• Welding is a metal joining process in which two or more parts are joined or coalesced at their contacting surfaces by suitable application of heat or/and pressure.

• Some times, welding is done just by applying heat alone, with no pressure applied

• In some cases, both heat and pressure are applied; and in other cases only pressure is applied, without any external heat.

• In some welding processes a filler material is added to facilitate coalescence(Joining)

•Coalescence is the uniting or merging of two or more separate parts into one continuous body.

Advantages of welding:

• Welding provides a permanent joint.

• Welded joint can be stronger than the parent materials if a proper filler metal is used that has strength properties better than that of parent base material and if defect less welding is done.

• It is the economical way to join components in terms of material usage and fabrication costs. Other methods of assembly require, for example, drilling of holes and usage of rivets or bolts which will produce a heavier structure.

Disadvantages of welding:

• Labour costs are more since manual welding is done mostly.

• Dangerous to use because of presence of high heat and pressure.

• Disassembly is not possible as welding produces strong joints.

• Some of the welding defects cannot be identified which will reduce the strength.

Video on Welding Process

Video on welding

Joining Processes: Welding, Brazing, Soldering

1. Brazing and Soldering: Melting of filler rod only
   - Brazing: higher temperature, ~brass filler, strong
   - Soldering: lower temp, ~tin-lead filler, weak
2. Welding: Melting of filler rod and base metals

Video:**Welding vs Soldering vs Brazing - Basic Brazing Tutorial**

Video on brazing and soldering welding

Types of welding:

Welding processes can be broadly classified into

(i) fusion(non-pressure) welding, and (ii) solid state welding(pressure welding)

Fusion welding:

In fusion-welding processes, heat is applied to melt the base metals. In many fusion welding processes, a filler metal is added to the molten pool during welding to facilitate the process and provide strength to the welded joint.

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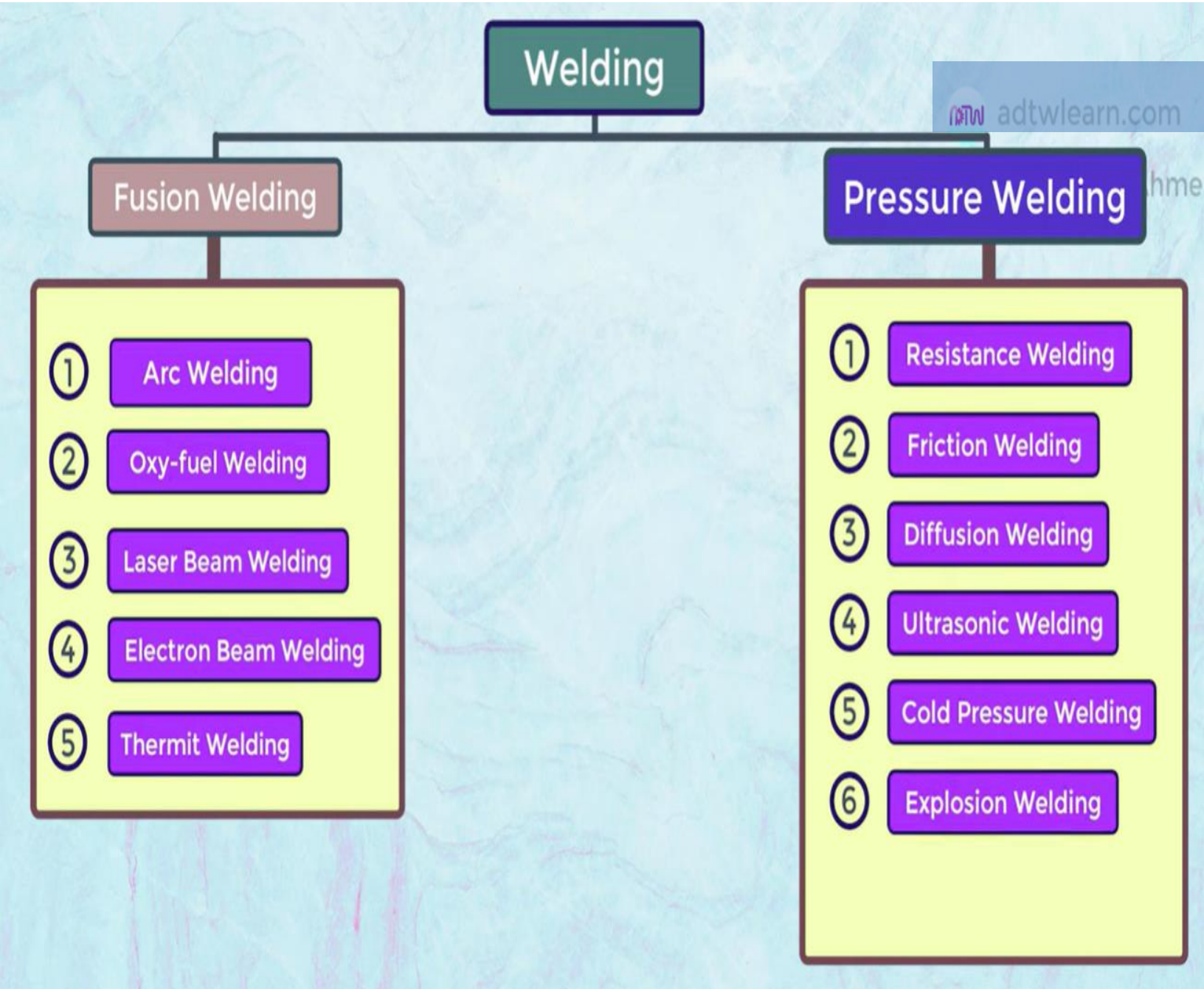
Types: Arc welding, Resistance welding, Gas welding, electron beam welding, laser welding


Welding
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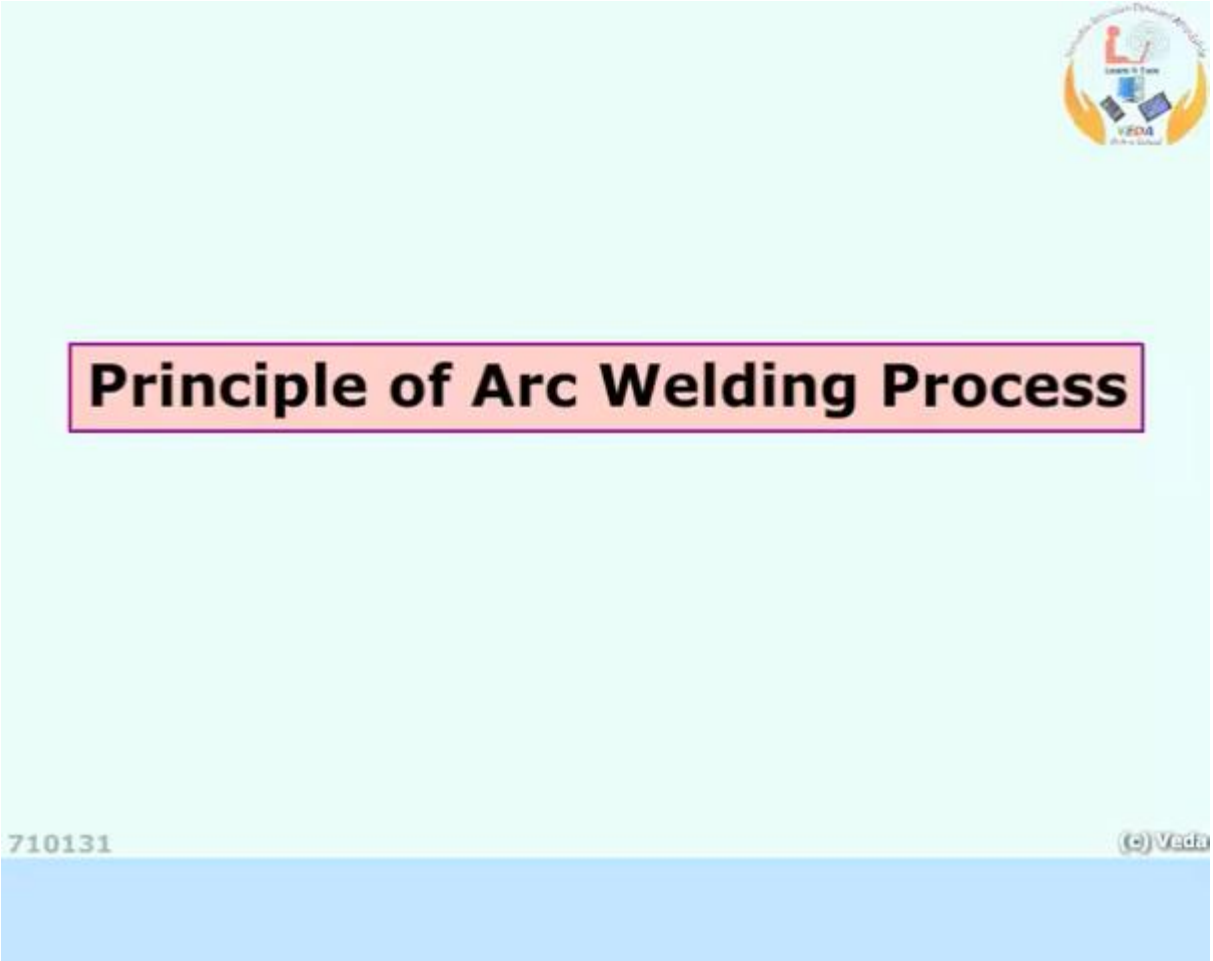
Fusion Welding
Pressure Welding
1 Arc Welding
2 Oxy-fuel Welding
3 Laser Beam Welding
4 Electron Beam Welding
5 Thermit Welding
1 Resistance Welding
2 Friction Welding
3 Diffusion Welding
4 Ultrasonic Welding
5 Cold Pressure Welding
6 Explosion Welding

Arc welding and resistance

Arc welding and resistance welding are two major groups of fusion and solid-state welding processes used to join metals in manufacturing and construction.



Video on Arc welding

Fusion welding processes

Arc welding: An electric arc between an electrode and the workpiece melts the base metal and usually a filler rod/wire, forming a molten weld pool that solidifies into the joint

Oxy-fuel welding: A flame from burning a fuel gas (commonly acetylene) with oxygen melts the edges of the base metals and possibly a filler rod; used for thin plates, pipelines, and repair because equipment is simple and portable.

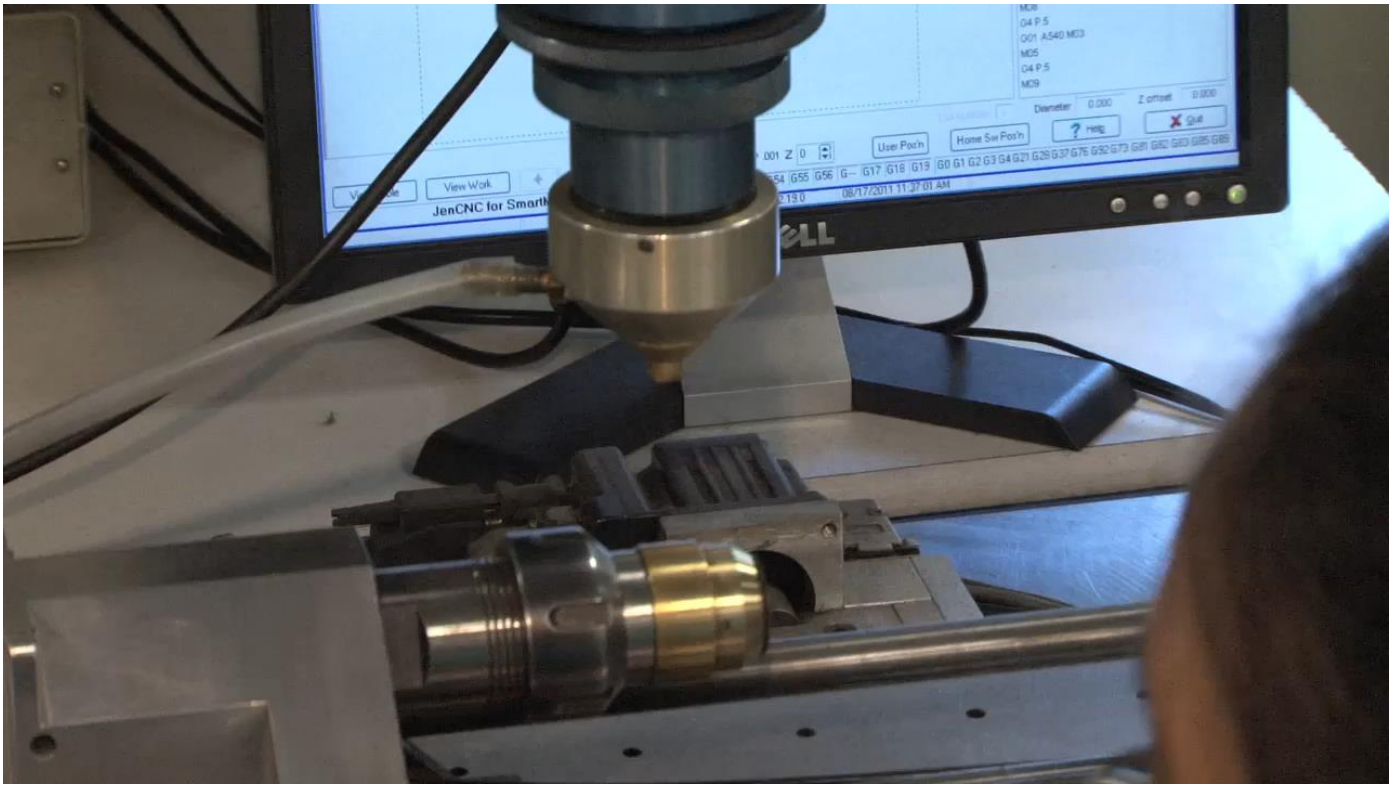
Laser beam welding: A focused laser beam delivers very high power density to a small spot, producing a deep, narrow fusion zone with low distortion and high speed; widely used in automotive body, electronics, and precision assemblies

Electron beam welding: A high-velocity electron beam, usually in vacuum, strikes the workpiece and converts kinetic energy to heat, giving extremely deep, clean welds with minimal distortion, useful for aerospace and nuclear components.

Thermit (thermite) welding: A chemical reaction between aluminum powder and metal oxide produces molten steel at very high temperature; this molten metal flows into a mould around the joint and fuses the parts, commonly used for joining railway rails and heavy sections

Video On Arc Welding

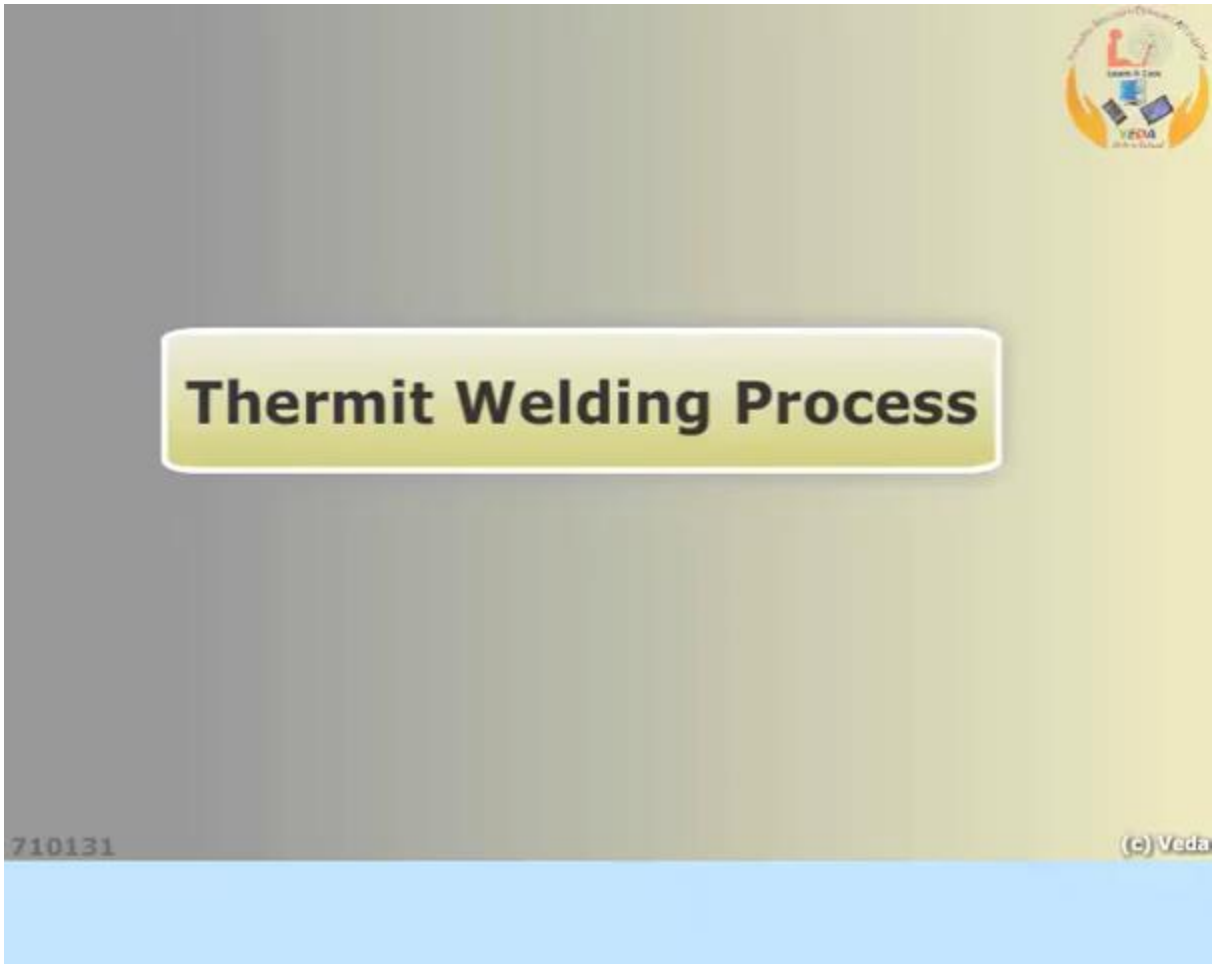
Video On oxcy Feul welding



Laser Beam welding video

Electron Beam Welding

Video on thermit welding process



Solid State Welding:

- In this method, joining is done by application of pressure only or a combination of heat and pressure.
- Even if heat is used, the temperature in the process is less than the melting point of the metals being welded (unlike in fusion welding).
- No filler metal is utilized.

Diffusion welding: Two part surfaces are held together under pressure at elevated temperature and the parts join by solid state diffusion.

Friction welding/Stir welding: Friction welding: Relative motion (rotational or linear) under axial pressure generates frictional heat and plasticizes the interface; motion stops and pressure forges the parts together, producing high-quality welds, especially for round bars and dissimilar metals; friction stir welding uses a rotating tool to stir plasticized material along a joint line in plates.

Ultrasonic welding: Moderate pressure is applied between the two parts and an oscillating motion at ultrasonic frequencies is used in a direction parallel to the contacting surfaces

Vdeo On Friction Welding

Diffusion welding

Comparison between Welding,soldering and brazing

Sl. No.	Welding	Soldering	Brazing
1.	These are the strongest joints used to bear the load. Strength of a welded joint may be more than the strength of base metal.	These are weakest joint out of three. Not meant to bear the load. Use to make electrical contacts generally.	These are stronger than soldering but weaker than welding. These can be used to bear the load upto some extent.
2.	Temperature required is upto 3800°C of welding zone.	Temperature requirement is upto 450°C.	It may go to 600°C in brazing.
3.	Workpiece to be joined need to be heated till their melting point.	No need to heat the workpieces.	Workpieces are heated but below their melting point.

4.	Mechanical properties of base metal may change at the joint due to heating and cooling.	No change in mechanical properties after joining.	May change in mechanical properties of joint but it is almost negligible.
5.	Heat cost is involved and high skill level is required.	Cost involved and skill requirements are very low.	Cost involved and sill required are in between others two.
6.	Heat treatment is generally required to eliminate undesirable effects of welding.	No heat treatment is required.	No heat treatment is required after brazing.
7.	No preheating of workpiece is required before welding as it is carried out at high temperature.	Preheating of workpieces before soldering is good for making good quality joint.	Preheating is desirable to make strong joint as brazing is carried out at relatively low temperature.