

Introduction to Welding

Introduction to Welding – Study Notes

1. What Is Welding?

- **Definition:** A fabrication process that joins two or more metal (or thermoplastic) parts by heating the base material—often to its melting point—and applying pressure, filler material, or both.
 - **Key Objectives**
 - Create a permanent, strong joint.
 - Preserve the mechanical properties of the base material.
 - Minimize distortion and defects.
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2. Basic Principles

Principle	Description
Heat Generation	Produced by electric arc, flame, laser, or resistance. Sufficient heat melts the workpiece edges.
Fusion	Molten zones of the base metals (and filler, if used) coalesce to form a solid joint upon cooling.
Solidification	Controlled cooling solidifies the weld pool, determining grain structure and strength.
Pressure (if applicable)	In processes like TIG or friction welding, pressure helps expel impurities and improve bond quality.

3. Major Welding Processes

Process	Energy Source	Typical Applications	Advantages	Limitations
Shielded Metal Arc Welding (SMAW / Stick)	Electric arc	Construction, repair, outdoor work	Simple equipment, portable	Slower speed, limited to thicker sections

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Process	Energy Source	Typical Applications	Advantages	Limitations
Gas Metal Arc Welding (GMAW / MIG)	Electric arc + shielding gas	Automotive, sheet metal, production lines	High deposition rate, easy automation	Sensitive to wind, requires clean metal
Gas Tungsten Arc Welding (GTAW / TIG)	Electric arc + inert gas	Aerospace, pipe welding, thin metals	Precise control, high-quality welds	Slower, requires skill
Flux-Cored Arc Welding (FCAW)	Electric arc + flux-filled wire	Heavy-section steel, shipbuilding	High productivity, can be semi-automatic	Produces more spatter, may need shielding gas
Submerged Arc Welding (SAW)	Electric arc + granular flux	Large structural components, pipelines	Deep penetration, high deposition	Limited to flat or horizontal positions
Oxy-Fuel (Oxy-Acetylene) Welding	Combustion of fuel gas & oxygen	Cutting, repair of cast iron, low-tech settings	No electricity needed, portable	Lower heat input, slower
Resistance Spot Welding	Electrical resistance & pressure	Automotive body panels, sheet metal	Fast, repeatable, minimal filler	Limited to thin sheet metals
Laser Welding	Focused laser beam	Precision parts, electronics, medical devices	Minimal heat-affected zone, high speed	Expensive equipment, requires optics

4. Components of a Welding System

1. Power Source

- *Transformer (AC)* – common for SMAW.
- *Inverter* – lightweight, efficient, variable output.
- *Generator* – for portable, off-grid work.

2. Electrode / Filler Material

- **Consumable:** Stick electrodes, MIG wire, FCAW wire.

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- **Non-consumable:** TIG tungsten, laser optics.

3. Shielding

- **Gas:** Argon, CO₂, He, or mixtures (protects molten metal from oxidation).
- **Flux:** Granular (SAW) or core-filled (FCAW) that generates protective gases when heated.

4. Delivery System

- Torch, gun, or handheld electrode holder.
- Gas hoses,