

Introduction to Welding

Introduction to Welding – Study Notes

1. What Is Welding?

- **Definition:** Joining two or more metal (or thermoplastic) pieces by heating the base material—often to its melting point—and allowing it to fuse together, sometimes with a filler material.
 - **Purpose:** Create a permanent, strong joint that can bear mechanical loads, resist corrosion, and maintain dimensional stability.
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2. Basic Concepts & Terminology

Term	Meaning
Base metal	The workpiece(s) being joined.
Filler metal (electrode)	Additional metal added to the joint; may be consumable (e.g., stick electrode) or separate (e.g., MIG wire).
Heat-affected zone (HAZ)	Area of the base metal whose microstructure changes due to welding heat, but which does not melt.
Fusion zone (or weld pool)	The molten region that solidifies to form the joint.
Weld bead	The visible deposit of filler metal after solidification.
Joint design	Geometry of the parts to be welded (e.g., butt, lap, T-joint, corner).
Shielding	Gas or flux that protects the molten metal from atmospheric contamination (oxygen, nitrogen, moisture).
Preheat / Interpass temperature	Controlled heating before welding or between passes to manage cooling rates and reduce cracking.

3. Major Welding Processes

Process	Power Source	Typical Materials	Shielding	Typical Applications
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Shielded Metal Arc Welding (SMAW)	Manual electric arc (DC/AC)	Steel, cast iron, stainless steel	Flux-coated electrode (provides gas & slag)	Construction, pipelines, repair work
Gas Metal Arc Welding (GMAW / MIG)	Continuous wire feed, electric arc	Steel, aluminum, stainless steel, copper alloys	Inert gas (Ar, He) or mixed (Ar/CO ₂)	Automotive, sheet metal, production lines
Gas Tungsten Arc Welding (GTAW / TIG)	Non-consumable tungsten electrode, electric arc	Stainless steel, aluminum, titanium, exotic alloys	Inert gas (Ar, He)	Aerospace, thin-wall work, high-quality welds
Flux-Cored Arc Welding (FCAW)	Wire feed, electric arc	Similar to MIG; can weld thicker sections	Flux-filled core (self-shielded) or external gas	Shipbuilding, heavy-section structural steel
Submerged Arc Welding (SAW)	Continuous wire feed, electric arc	Carbon steel, low-alloy steel	Granular flux covering the arc	Long straight welds, pipe, pressure vessels
Resistance Welding (Spot, Seam, Projection)	High current, low voltage	Sheet metal, automotive bodies	No external shielding (heat generated by resistance)	Automotive assembly, appliance manufacturing
Oxy-Fuel Welding (OFW)	Combustion of fuel gas (acetylene, propane) with oxygen	Steel, cast iron (limited to ferrous metals)	Atmospheric (no shielding)	Repair, artistic work, field service
Laser & Electron Beam Welding	Concentrated laser or electron beam	Wide range, especially high-strength alloys	Usually in vacuum or inert gas	Aerospace, medical devices, precision components

4. Joint Types & Preparation

Joint Type	Description	Typical Use
Butt joint	Edges of two plates are placed edge-to-edge.	Sheet metal