

Introduction to Welding

Introduction to Welding

Key concepts, processes, safety, and applications

1. What Is Welding?

Aspect	Description
Definition	A fabrication process that joins two or more pieces of metal (or thermoplastic) by heating the material to its melting point, often adding a filler material, and allowing it to solidify.
Goal	Create a permanent, strong bond that can withstand mechanical loads, temperature changes, and environmental exposure.
Typical Materials	Steel, stainless steel, aluminum, copper alloys, nickel alloys, titanium, and certain plastics.

2. Basic Principles

Principle	Explanation
Heat Generation	Produced by an electric arc, flame, laser, electron beam, or friction.
Melting & Fusion	Base metal(s) are melted; a filler (if used) melts and mixes with the molten pool.
Solidification	As the pool cools, the metals fuse, forming a metallurgical bond.
Protection	Inert gases, fluxes, or shielding gases prevent oxidation and contamination of the molten metal.

3. Major Welding Processes

Process	Energy Source	Typical Shielding	Common Uses	Advantages	Limitations
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Shielded Metal Arc Welding (SMAW / Stick)	Electric arc	Flux-coated electrode (produces its own gas)	Construction, pipelines, repair work	Portable, simple equipment	Slower, more slag cleanup
Gas Metal Arc Welding (GMAW / MIG)	Electric arc	Inert/active gas (Ar, CO ₂ , Ar/CO ₂)	Automotive, sheet metal, production	High speed, easy automation	Sensitive to wind, requires gas supply
Gas Tungsten Arc Welding (GTAW / TIG)	Electric arc	Inert gas (Ar, He)	Aerospace, stainless steel, thin sections	Precise, high-quality welds	Slower, requires skill
Flux-Cored Arc Welding (FCAW)	Electric arc	Flux core (self-shielded) or external gas	Heavy-section steel, shipbuilding	High deposition rate, portable	More smoke/fumes, slag removal
Submerged Arc Welding (SAW)	Electric arc	Granular flux covering the weld	Large structural components, pipe	Deep penetration, high efficiency	Limited to flat/horizontal positions
Oxy-Fuel Welding (Oxy-Acetylene)	Combustion flame	No external shielding (use of flux)	Cutting, repair of cast iron, low-tech settings	Simple, works without electricity	Lower heat input, slower
Laser Beam Welding (LBW)	Laser beam	Typically inert gas shield (Ar, He)	Precision components, electronics, automotive	Very narrow welds, high speed	Expensive equipment, limited thickness
Electron Beam Welding (EBW)	High-energy electron beam (vacuum)	Vacuum environment	Aerospace, nuclear, high-performance alloys	Deep penetration, low distortion	Very high cost, requires vacuum chamber

4. Welding Joint Types

Joint	Geometry	Typical Applications
Butt Joint	Two edges abutting each other	Pipes, plates, sheet metal

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Joint

Geometry

Typical Applications

Lap Joint Overlapping plates Sheet metal, automotive panels

T?Joint One piece perpendicular to another Frames, brackets

Corner Joint Two pieces meeting at a right angle Box structures, tanks

**Edge