

Introduction to Welding Technology

Introduction to Welding Technology – Study Notes

1. What Is Welding?

Aspect	Description
Definition	A fabrication process that joins two or more metal (or thermoplastic) parts by heating the material to its melting point, applying pressure, or both, to create a permanent bond.
Key Objectives	• Achieve a strong, continuous joint • Minimize defects and distortion • Ensure the joint meets design specifications (strength, fatigue, corrosion resistance)
Typical Applications	Automotive frames, shipbuilding, pipelines, aerospace structures, construction, HVAC, art & sculpture, repair work.

2. Basic Concepts & Terminology

Term	Meaning
Base Metal	The workpiece(s) being joined.
Filler Metal	Additional metal (rod, wire, or consumable electrode) added to the joint to fill the gap.
Heat-Affected Zone (HAZ)	Area of base metal whose microstructure changes due to welding heat but does not melt.
Weld Pool / Molten Zone	The localized region of molten metal during welding.
Penetration	Depth that the weld pool extends into the base metal.
Weld Bead	The solidified shape of a single pass of weld metal.
Joint Design	Geometry of the parts to be welded (e.g., butt, lap, T-joint, corner).
Preheat / Interpass Temperature	Controlled heating before welding or between passes to reduce thermal gradients.
Post-Weld Heat Treatment (PWHT)	Controlled heating after welding to relieve residual stresses and improve properties.

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3. Major Welding Processes

Process	Energy Source	Consumable?	Typical Use	Advantages	Limitations
Shielded Metal Arc Welding (SMAW)	Electric arc	Consumable electrode with flux coating	Construction, pipelines, repair	Simple, portable, low cost	Slower, limited to thicker sections
Gas Metal Arc Welding (GMAW / MIG)	Electric arc	Continuous solid wire (no flux) + shielding gas	Automotive, fabrication shops	High speed, easy automation	Sensitive to wind, requires gas supply
Gas Tungsten Arc Welding (GTAW / TIG)	Electric arc	Non-consumable tungsten electrode; optional filler rod	Aerospace, stainless steel, thin sections	Precise, clean welds, low spatter	Slower, requires high skill
Flux-Cored Arc Welding (FCAW)	Electric arc	Flux-cored tubular wire (with/without shielding gas)	Shipbuilding, heavy-section steel	High deposition rates, portable	Some variants produce fumes, may need gas
Submerged Arc Welding (SAW)	Electric arc	Consumable electrode + granular flux covering weld	Large structural components, pipe	Deep penetration, high efficiency	Limited to flat or horizontal positions
Resistance Spot Welding (RSW)	Electrical resistance heating	No filler (or optional)	Automotive sheet metal	Fast, repeatable, low heat input	Limited to thin sheet, requires good contact
Laser Beam Welding (LBW)	High-power laser	Usually no filler (but can be used)	Precision components, aerospace, electronics	Very narrow HAZ, high speed	Expensive equipment, requires line-of-sight
Electron Beam Welding (EBW)	Focused electron beam (vacuum)	Usually no filler	Aerospace, nuclear, high-performance		