

MTPC3004 JOINING OF METALS (3-0-0)

Objectives of the Course:

This course aims to introduce students to the science and technology of material joining processes used in engineering and manufacturing industries. It focuses on the fundamental principles, metallurgical aspects, process parameters, and joint performance of various joining techniques. Emphasis is given to welding, brazing, soldering, and adhesive bonding — along with advancements in solid-state and fusion joining technologies. The objective is to enable students to select suitable joining methods for specific materials and applications while ensuring quality, safety, and cost efficiency.

Module – I: (06 hours)

Introduction to Material Joining and Welding Fundamentals

Importance and classification of joining processes. Comparison between mechanical fastening, welding, brazing, and adhesive bonding. Basic welding terms and definitions. Fundamental principles of fusion welding: heat source, energy transfer, and cooling rates. Welding metallurgy — microstructure evolution, heat-affected zone (HAZ), and residual stresses.

Module – II: (06 hours)

Fusion Welding Processes

Arc welding processes: Shielded Metal Arc Welding (SMAW), Gas Metal Arc Welding (GMAW/MIG), Gas Tungsten Arc Welding (GTAW/TIG). Submerged Arc Welding (SAW), Electroslag, and Plasma Arc Welding. Power sources and current characteristics. Oxy-fuel gas welding principles and applications. Defects in welded joints – causes, types, and preventive measures.

Module – III: (06 hours)

Solid-State Welding and Other Joining Techniques

Principles of solid-state welding: Friction welding, Friction Stir Welding (FSW), Diffusion bonding, Ultrasonic welding, Cold pressure welding. Resistance welding – spot, seam, projection, and flash butt welding. Thermite welding and explosion welding. Metallurgical aspects and applications of solid-state processes. Comparison between fusion and solid-state joining.

Module – IV: (06 hours)

Brazing, Soldering, and Adhesive Bonding

Principles of brazing and soldering; differences and similarities. Filler materials, fluxes, and joint design. Capillary action and wetting phenomena. Surface preparation and cleaning. Adhesive bonding – classification, surface treatment, curing, and bonding mechanisms. Applications in electrical, aerospace, and automotive industries.

Module – V: (06 hours)

Inspection, Testing, and Modern Developments in Joining

Destructive testing: tensile, bend, impact, and hardness tests of welded joints. Non-destructive testing (NDT): radiography, ultrasonic testing, magnetic particle, and dye penetrant methods. Automation and robotics in welding. Laser and Electron Beam Welding. Safety in welding and environmental aspects.

Course Outcomes:

After completing this course, the student will be able to:

- CO1: Explain the principles, classifications, and mechanisms of various material joining processes.
- CO2: Analyze the metallurgical phenomena occurring during fusion and solid-state welding.
- CO3: Select appropriate joining methods and parameters for different materials and service conditions.
- CO4: Evaluate joint integrity using destructive and non-destructive testing techniques.
- CO5: Understand modern developments and automation in welding and joining technologies.

Books:

1. R. S. Parmar. Welding Engineering and Technology, Khanna Publishers.
2. S. V. Nadkarni. Modern Arc Welding Technology, Oxford & IBH Publishing.
3. Linnert, G. E. Welding Metallurgy, AWS.

Reference Books:

1. Little, R. L. Welding and Welding Technology, McGraw-Hill.
2. Kou, Sindo. Welding Metallurgy, Wiley-Interscience.
3. Balasubramanian, V. Welding Technology and Design, Universities Press.
4. Lancaster, J. F. Metallurgy of Welding, Elsevier.

Digital Learning Resources:

Course Name : Welding Technology
Course Link : <https://nptel.ac.in/courses/112/105/112105238>
Course Instructor: Prof. Pradeep Kumar, IIT Guwahati
Course Name : Joining of Materials
Course Link : <https://nptel.ac.in/courses/112/106/112106295>
Course Instructor: Prof. K. Balasubramanian, IIT Madras