

WELDING and INSPECTION DOMAIN Credit -30

Total Credit 30		
Course Work	Project	Internship
20	6	4

Course Outline

Domain Objectives:

- To develop understanding & skill of B. Tech students for Welding Technology
- Additionally, students pursuing this domain will be ready for industrial employment
- The students develop passion for higher education and research in Welding Engineering

Importance:

Basic welding knowledge can enhance chances of employment. The industrial sectors like fabrication units, high pressure boilers manufacture, ship building, automobile, space engineering and cross country pipelines require welding skill. Learning of quality and reliability criteria to be met by welded joints and standards will empower students for placement. More specifically, this domain will expose students on technological and institutional aspects of welding, both in theory and practice.

Employment Opportunities:

- ASNT Level II (LPI and UT) or NSQF skill certification will make the candidate recognised in national and international levels in the industry.
- He/she can be self employed by opening a small scale welding shop to a medium scale industry.

Courses covered:

The students will practice and do for themselves welding with a short briefing or demonstration. They will learn different welding techniques along with metal transfer technology and weld metallurgy. Students will do Design for Welded Joints using CATIA and Welded joint testing as per ASME standard. They will learn by doing the welding of Stainless Steel structural joints, Aluminium, Copper, Cast Iron parts and Hard Surfacing methods. Students will be trained and certified in Destructive Testing (DT) and Non-Destructive Testing (NDT).

Approach of Delivery:

The domain will be taught in Practice + Project mode with required theory input in practical class. ASNT Level II certification course is added to the curriculum. A student will be undergoing rigorous practice session to gain hands on skill experience and NSQF certification. This domain is intended to develop welding skill there by creating opportunities for employment.

WELDING AND INSPECTION Credit-20 (Course Work)

Module-I: Introduction to Welding

Key points:

Physics of arc welding, SMAW Principle and Equipment, Types of Electrodes, Functions of Coatings, TIG (GTAW), MIG (GMAW) & Flux-Cored Arc Welding, Submerged Arc Welding, Weld Cladding & Surfacing, Plasma Cutting and Spraying, Atomic Hydrogen Welding. Welding Positions, types of Joints, Residual Stress. Oxy-Acetylene Welding, Flux and Filler, types of Gas Flames, Gas Welding Techniques, difference between Gas Welding and Cutting Torch. Spot and Seam Welding Parameter, Projection Welding, different types of Resistance Welding Electrodes. Flash Butt Welding, Friction Welding, Explosive Welding, Thermit welding of Rails, Electro-Slag Welding, Electro-Gas Welding, Stud Welding, Plasma Arc, Laser Beam, Electron Beam, Ultrasonic, Explosive Welding, Under Water Welding, High Frequency Resistance and Induction Welding. Electricity in Welding: Power Source and Equipment used for AC, DC Welding.

Practices:

- Experiment 1. **Welding Safety Practice:** Welding Fumes, Eye Protection, Personal Protective Equipment, Electrical Safety.
- Experiment 2. **Brazing Practice:** Torch, Flame, Flux required, Cleaning, making of two types of Brazed Parts- Cu and Brass, A/C Tubes.
- Experiment 3. **Soldering Practice:** Types of Solders, Equipment details, Different Joints, making of two components through Soldering, viz. Electrical Elements, Electronics.
- Experiment 4. **Gas welding Practice:** Gas Welding Equipment- Torch, Gas Cylinder, Hose, Three Types of Flames, Welding of M.S. Sheet and Pipe by Gas Welding process.
- Experiment 5. **Gas Cutting Practice:** Oxy-acetylene cutting process: Straight, Bevel & Circular Cutting on MS. Plate.
- Experiment 6. **Shielded Metal Arc Welding–Manual Metal Arc Practice:** Welding of M.S. Plate in all position by SMAW process, Effect of Voltage, Current and Welding Speed, Repair & Maintenance works.
- Experiment 7. **GTAW Welding Practice:** GTAW Welding of M.S, SS & Aluminium Plate
- Experiment 8. **GMAW Practice:** Welding Torch, Electrode, Shielding Gas, GMAW Welding on M.S Sheet & M.S plate.
- Experiment 9. **Resistance Welding Practice:** Operating skills of SPOT Welding machine, Resistance Welding Machine Operation and Parameters.
- Experiment 10. AC, DC Welding power source, joint configuration and edge preparations
- Experiment 11. Identifying Defects and Remedial Measures for Welded Joints. (LPI)
- Experiment 12. PUG Cutting Machine, SAW and PAW Demonstration.

Module: II Design of Welded Joints (CATIA)

Key points:

Introduction to Design; Engineering Properties of Steels; Type of Welds and Weld Joints. Description of Welds: Terminology, Definitions and Weld Symbols; Edge Preparation; Sizing of Welds in Structure. Design for Static Loading, Weld Calculations in Lap, Butt and Fillet Welds; How to Design Various Kinds of Welding Joints. Design of a Butt Joint, the main Failure Mechanism of Welded Butt Joint. Design of Transverse Fillet Joint, Shear Mechanism in Fillet Weld, Design Stresses of Welds. Use of CATIA Weld Design Module. ASME & IBR Evaluation, All Weld Tensile, Transverse Tensile, Bend Test 180° and 90°.

Evaluation of Test Plate (Practice)

Practice:

- Experiment 13. Design of Lap Joint
- Experiment 14. Design of Butt Joint
- Experiment 15. Tensile Testing of Welded Joints
- Experiment 16. Bend Test of Welded Joints

Module-III: Metal transfer

Key points:

Metal Transfer in AC and DC Arc Welding, Metal Transfer in TIG, MIG and MAG Welding, Study of different modes of Metal Transfer in MIG welding. Theory and Principle of Process, Key Variables, Intermediate Materials. Fe-C Equilibrium Diagram, Cooling Curve, HAZ, Microstructure, Pre Heat & Post Heat, Stress Relieving and Normalizing. Concept and significance, Percentage equivalence of Carbon in Weldability, Weldability of Carbon Steels. Welding Defects due to improper Metal Transfer and improper Filler Material, Hot Cracks and Cold Cracks, Porosity, Embrittlement, Lamellar Tearing, Distortion etc. Weldability of stainless steels, Weldability of Titanium and Alloys, Weldability of High Strength Low Alloy Steels. Shot Pinning, Stress Reliving through Vibration. Ultra-sonic Welding for Dissimilar Metals.

Practice:

- Experiment 17. Metal transfer in TIG welding
- Experiment 18. Different modes of Metal transfer in MIG welding
- Experiment 19. Welding defects in TIG welding
- Experiment 20. Welding defects in MIG welding
- Experiment 21. Practice on Stress Relieving and Normalizing in Welding
- Experiment 22. Experiments for demonstrating Weld-ability
- Experiment 23. Identification of general Welding Defects
- Experiment 24. Heat treatment of Welded Structures

Module-IV: Welding of Stainless Steel, Aluminium, Cast Iron and Hard Surfacing

Key points:

Stainless Steel-Types, properties of Stainless steels; Use in Industry, Type of Welds and Weld Joints; Stainless Steels - Austenitic, Martensitic, Ferritic Stainless Steels, Sensitization, Hot Cracking, Precipitation Hardening Stainless Steels, Duplex Stainless Steels, Physical Properties, Mechanical Properties. Selection of a Stainless Steel, Design for Welding Stainless Steels, Selection of Filler Metals, Selection of a Welding Process, Procedures for Welding Stainless Steels. Properties of Aluminum, GTAW (TIG), Fundamentals on Aluminum, AC Welding Machine Fundamentals, Shielding Gases (Purging), Filler Wire/Electrode Selection. Material Preparation, Weld Faults (Causes and Remedial Major), GTAW (TIG) Welding Techniques on Aluminum, SMAW Electrode for Aluminum. Surface Coating, Use of SMAW Electrode in Hard Facing, Flux Cored Wire Surfacing.

Practice:

- Experiment 25. Weldability of stainless steel
- Experiment 26. Practice for Hot Cracking
- Experiment 27. Demonstration of Welding Defect
- Experiment 28. Selection of Electrode and its effect
- Experiment 29. Faults in Welding and methods to solve them
- Experiment 30. Repair methods for Cast Iron Welded Parts
- Experiment 31. Surface Coating Procedure

Module-V: Testing of Welded Joints

Key points:

NDT and Welding Defects: Weld Defects and NDT Welded Joints. ASME Section IX- WPS and PQR

ASNT course for 3 days

Practice:

Destructive Tests:

Experiment 32-34: Tensile, Impact and Bend tests using Standard Equipment.

Experiment 35-36: Hardness test using Standard Equipment

Non Destructive Tests:

Experiment 37: Visual Inspection

Experiment 38: Liquid Penetrant Test

Experiment 39: Magnetic Particle Inspection

Microstructure:

Experiment 40: Analysis of HAZ by Image Analyzer

Experiment 41: Analysis of Microstructure by SEM

Project work: Credit-06

Each student will prepare and submit a project involving any of the welding practices carried out in the subject, in consultation with the faculty in charge; at the end of the domain laboratory work. Some sample project work is listed below as example: (Student is free to choose project topic)

1. SMAW welding of mild steel and analysis
2. TIG welding of aluminium alloy and analysis
3. Submerged Arc Welding of Mild Steel and analysis
4. MIG Welding of Mild Steel and analysis
5. Optimization of Spot Welding parameters
6. SMA welding of Aluminium alloy and analysis of result
7. TIG welding of Stainless Steel and optimization of input parameters
8. Energy consumption characteristics for MIG welding of carbon steel, etc.

Internship: Credit-04 (Industry Exposure)

Each student of Welding and Inspection shall acquire hands-on industrial experience by undergoing practical exposure in an industrial environment for 3 months. He/she has to prepare a compiled report comprising of daily activity reports at the end of the tenure of 3 months and submit to the university. One visit per month by faculty will be conducted to monitor planned progress of the student and also resolve any grievance of the students.