****

**REPUBLIC OF KENYA**

**COMPETENCY BASED MODULAR CURRICULUM**

**FOR**

**WELDING**

**KNQF LEVEL 4**

**PROGRAMME ISCED CODE: 0715 354A**

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**FOREWORD**

The provision of quality education and training is fundamental to the Government’s overall strategy for social and economic development. Quality education and training contribute to the achievement of Kenya’s development blueprint and sustainable development goals.

Reforms in the education sector are necessary to achieve Kenya Vision 2030 and meet the provisions of the Constitution of Kenya 2010. The education sector had to be aligned to the Constitution, and this resulted in the formulation of the Policy Framework for Reforming Education and Training in Kenya (Sessional Paper No. 14 of 2012). A key feature of this policy is the radical change in the design and delivery of TVET training. This policy document requires that training in TVET be competency-based, curriculum development be industry-led, certification be based on demonstration of competence, and the mode of delivery allow for multiple entry and exit in TVET programmes.

These reforms demand that Industry takes a leading role in curriculum development to ensure the curriculum addresses its competence needs. It is against this background that this curriculum has been developed. For trainees to build their skills on foundational hands-on activities of the occupation, units of learning are grouped in modules. This has eliminated duplication of content and streamlined exemptions based on skills acquired as a trainee progresses in the up-skilling process, while at the same time allowing trainees to be employable in the shortest time possible through the acquisition of part qualifications.

It is my conviction that this curriculum will play a great role in developing competent human resources for the Welding & Fabrication Sector’s growth and development.

**PRINCIPAL SECRETARY**

**STATE DEPARTMENT FOR TVET**

**MINISTRY OF EDUCATION**

**PREFACE**

Kenya Vision 2030 aims to transform Kenya into a newly industrializing middle-income country, providing high-quality life to all its citizens by the year 2030. Kenya intends to create globally competitive and adaptive human resource base to meet the requirements of a rapidly industrializing economy through lifelong education and training. TVET has a responsibility to facilitate the process of inculcating knowledge, skills, and worker behaviour necessary for catapulting the nation to a globally competitive country, hence the paradigm shift to embrace Competency-Based Education and Training (CBET).

TVET Act, CAP 210A and Sessional Paper No. 1 of 2019 on Reforming Education and Training in Kenya for Sustainable Development emphasized the need to reform curriculum development, assessment, and certification. This called for a shift to CBET to address the mismatch between skills acquired through training and skills needed by industry, as well as increase the global competitiveness of the Kenyan labour force.

This curriculum has been developed in adherence to the Kenya National Qualifications Framework and CBETA standards and guidelines. The curriculum is designed and organized into Units of Learning with Learning Outcomes, suggested delivery methods, learning resources, and methods of assessing the trainee’s achievement. In addition, the units of learning have been grouped in modules to concretize the skills acquisition process and streamline upskilling.

I am grateful to all expert trainers and everyone who played a role in translating the Occupational Standards into this competency-based modular curriculum.

**ACKNOWLEDGMENT**

This curriculum has been designed for competency-based training and has independent units of learning that allow the trainee flexibility in entry and exit. In developing the curriculum, significant involvement and support were received from expert trainers, institutions and organizations.

I recognize with appreciation the role of the Welding National Sector Skills Committee (NSSC) in ensuring that competencies required by the industry are addressed in the curriculum. I also thank all stakeholders in the Welding & Fabrication sector for their valuable input and everyone who participated in developing this curriculum.

I am convinced that this curriculum will go a long way in ensuring that individuals aspiring to work in the Welding & Fabrication Sector acquire competencies to perform their work more efficiently and effectively.

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# ABBREVIATIONS

DC Direct Current

KCPE Kenya Certificate of Primary Education

KNQA Kenya National Qualifications Framework

MIG Metal Inert Gas

MMAW Manual Metal Arc Welding

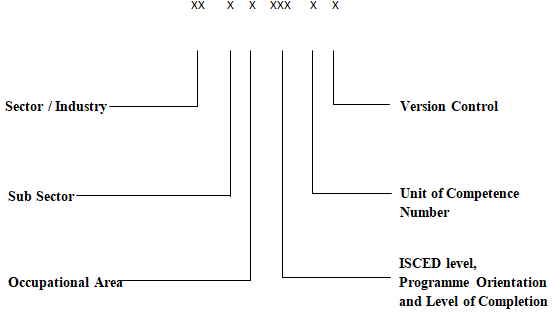
NNP Nyeri National Polytechnic

PPE Personal Protective Equipment

TIG Tungsten Inert Gas

TVETA Technical and Vocational Education and Training Authority

# KEY TO UNIT CODE



# COURSE OVERVIEW

Welding Level 4 qualification consists of competencies that an individual must achieve to enable him/her to work in a welding establishment as a Welder.

The curriculum consists of Core Units of Learning.

The Core Units of Learning comprising Welding Level 4 include the following: Fabrication Processes I, Arc Welding Processes I, Gas welding, Soldering and Brazing processes, Metal Inert Gas Welding and Tungsten Inert Gas Welding.

**SUMMARY OF UNITS OF LEARNING**

|  |  |  |  |
| --- | --- | --- | --- |
| **Unit Code** | **Unit Title** | **Unit Duration (Hrs)** | **Credit Factor** |
| **MODULE I** | | | |
| 0715 251 01A | Fabrication Processes I | 150 | 15 |
| 0715 251 02A | Arc Welding Processes I | 100 | 10 |
| 0715 251 03A | Gas welding, Soldering and Brazing Processes | 100 | 10 |
| **MODULE II** | | | |
| 0715 351 04A | Metal Inert Gas Welding | 200 | 20 |
| 0715 351 05A | Tungsten Inert Gas Welding | 200 | 20 |
|  | **Industrial Attachment** | 320 | 32 |
|  | **TOTAL** | **1070** | **107** |

An individual entering this course should have any of the following minimum requirements:

1. Kenya Certificate of Secondary Education (KCSE) or its equivalent.

**Or**

1. Possession of a KNQF Level 3 qualification certificate in welding or any other related field.

**Trainer qualification**

Qualifications of a trainer for this course include:

1. Possession of at least level 5 Welding qualification or its equivalent in Welding & Fabrication; and
2. Licensed by TVETA.
3. Registered by Engineer Board of Kenya (E.B.K) or Kenya Engineering Technology Registration Board (KETRB).

**Industry Training**

An individual enrolled in this course will be required to undergo Industry training for a minimum period of 320 hours in Welding & Fabrication sector. The industrial training may be taken after completion of all units for those pursuing the full qualification or be distributed equally in each unit for those pursuing part qualification. In the case of dual training model, industrial training shall be as guided by the dual training policy.

**Competence Assessment**

1. An individual enrolled in this course shall be assessed for competence through formative and summative assessments.
2. During formative assessment all performance criteria shall be assessed based on performance criteria weighting.
3. Number of formative assessments shall minimally be equal to the number of elements in a unit of competency.
4. During summative assessment basic and common units may be integrated in the core units or assessed as discrete units.
5. Theoretical and practical weighting shall be 10:90 for all the units in modules I and Module II.
6. Formative and summative assessments shall be weighted at 60% and 40% respectively in the overall unit of learning score
7. For a candidate to be declared competent in a unit of competency, the candidate must meet the following conditions:
8. Obtained at least 40% in theory assessment in formative and summative assessments.
9. Obtained at least 60% in practical assessment in formative and summative assessment where applicable.
10. Obtained at least 50% in the weighted results between formative assessment and summative assessment where the former constitutes 60% and the latter 40% of the overall score.
11. Assessment performance rating for each unit of competency shall be as follows:

|  |  |
| --- | --- |
| **MARKS** | **COMPETENCE RATING** |
| 80 -100 | Attained Mastery |
| 65 - 79 | Proficient |
| 50 - 64 | Competent |
| 49 and below | Not Yet Competent |
| Y | Assessment Malpractice/irregularities |

1. Assessment for Recognition of Prior Learning (RPL) may lead to award of part and/or full qualification.

**Certification**

A candidate will be awarded with a Certificate of Competency upon demonstration of competence in a core Unit of Competency. To be awarded Kenya National TVET Certificate in Welding Level 4 the candidate must demonstrate competence in all the Units of Competency as given in the qualification pack. A Statement of Attainment certificate may be awarded upon demonstration of competence in a certifiable element within a unit.

The certificates shall be awarded by the Qualification Awarding Institution.

# MODULE I

|  |  |  |  |
| --- | --- | --- | --- |
| **Unit Code** | **Unit Title** | **Unit Duration (Hours)** | **Credit**  **Factor** |
| 0715 351 01A | Fabrication Processes I | 150 | 15 |
| 0715 351 02A | Arc Welding Processes I | 100 | 10 |
| 0715 351 03A | Gas welding, Soldering and Brazing Processes | 100 | 10 |
|  | **Total** | **350** | **35** |

# 

## FABRICATION PROCESSES I

**Unit Code:** 0715 251 01A

**Unit Duration:** 150 Hours

**Relationship to Occupational Standards**

**This unit addresses the Unit of Competency:** Perform Fabrication Processes I

**Unit Description**

This unit of learning covers the learning outcomes, content, assessment methods, methods of delivery and resources required to train fabrication processes I. The learning outcomes include carrying out bench work, sheet metal work, surface finishing operations and maintaining fabrication tools, machines and equipment.

**Summary of Learning Outcomes**

By the end of this unit of learning, the trainee will be able to:

|  |  |  |
| --- | --- | --- |
| **S/NO** | **Learning Outcomes** | **Duration (Hours)** |
|  | Carry out bench work | 60 |
|  | Carry out sheet metal work | 55 |
|  | Carry out surface finishing operations | 25 |
|  | Maintain fabrication tools, machines and equipment | 10 |
| **Totals** | | **150** |

**Learning Outcomes, Content and Suggested Assessment Methods**

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| * 1. Carry out bench work | * 1. Occupational health and safety standards      1. Benchwork hazards identification         1. Physical         2. Chemical         3. Biological         4. Psychological      2. Benchwork ergonomics      3. Workshop waste management      4. Workplace environmental safety      5. Benchwork safety   2. Emergency procedures in benchwork   3. Bench work tools and equipment      1. Types      2. Correct usage      3. Care and storage   4. Fabrication drawing interpretation      1. Dimensions   5. Material preparation in benchwork (metals up to 6 mm thickness)      1. Measuring      2. Marking out      3. Cutting      4. Edge preparation   6. Benchwork operations (metals up to 6 mm thickness)      1. Types         1. Filing         2. Grinding         3. Drilling         4. Reaming and tapping.         5. Sawing and cutting      2. Procedure and applications   7. Fitting and assembly in benchwork (up to 6 mm thickness)      1. Types and applications of fasteners         1. Bolts         2. Screws         3. Nuts         4. Rivets   **Practice**   * Filing of steel plates and pipes of up to 6 mm thickness * Grinding of metal plates and pipes of up to 6 mm thickness * Drilling of metal plates up to 6 mm thickness * Reaming and tapping of metal plates up to 6 mm thickness * Cutting of metal plates and pipes up to 6 mm thickness | * Practical test * Project work * Written tests * Portfolio of evidence |
| * 1. Carry out sheet metal work | * 1. Occupational health and safety standards in sheet metals   2. Sheet metal hazards identification      1. Physical      2. Chemical      3. Biological      4. Psychological   3. Sheet metal workshop Incident/Accident reporting   4. Sheet metal work ergonomics   5. Sheet metal workshop waste management   6. Personal Protective Equipment used in sheet metal work   7. Sheet metal work procedures   8. Roles and responsibilities in sheet metal workshop   9. Emergency procedures in sheet metal work   10. Housekeeping in sheet metal work       1. Cleaning       2. Waste management   11. Sheet metal work tools and equipment       1. Types       2. Correct usage       3. Care and storage   12. Material preparation in sheet metal work (up to 6 mm thickness)       1. Measuring       2. Marking out       3. Cutting       4. Edge preparation   13. Sheet metal work operations (up to 6 mm thickness)       1. Types          1. Filing          2. Grinding          3. Drilling          4. Reaming and tapping.          5. Sawing and cutting          6. Gas welding          7. Spot welding   14. Procedure and applications   15. Fitting and assembly in sheet metal work (up to 6 mm thickness)   16. Types and applications of fasteners in sheet metal work       1. Bolts       2. Screws       3. Nuts       4. Rivets   17. Sheet metal pattern development       1. Methods          1. Parallel line method   18. Sheet metal products       1. Types          1. Tanks          2. Panels          3. Cabinets and boxes          4. Drums          5. Tables and desks       2. Development and applications of sheet metal products   **Practice**  Carry out pattern development and produce:   * + - * Panels       * Cans | * Practical test * Project work * Written tests * Portfolio of evidence |
| * 1. Carry out surface finishing operations | * 1. Grinding   2. Surface polishing   3. Surface painting | * Practical test * Project work * Written tests * Portfolio of evidence |
| * 1. Maintain fabrication tools, machines and equipment | * 1. Fabrication tools repair      1. Handles      2. Heads      3. Jaws      4. Blades      5. Discs and wheels   2. Preventive maintenance of fabrication machines and equipment      1. Cleaning of the external surfaces of the machine      2. Inspecting cables, connectors and power sources      3. Lubricating of moving parts   **Practice**   * Clean external surfaces of machine, tools and equipment * Inspect cables, connectors and power sources * Lubricate moving parts | * Practical test * Project work * Written tests * Portfolio of evidence |

**Suggested Delivery Methods**

* Demonstration
* Group discussions
* Practical work.
* Exercises
* Industrial visits
* Online materials
* Direct instructions
* Simulation

**List of Recommended Resources**

**Recommended Resources for 25 trainees**

| **S/No.** | **Category/Item** | **Description/Specifications** | **Quantity** | **Recommended Ratio (Item: Trainee)** |
| --- | --- | --- | --- | --- |
| **A** | **Learning Materials** | | | |
|  | Textbooks | Comprehensive textbooks on Manual Metal Arc Welding (MMAW) | 25 | 1:1 |
|  | Drawing papers | A4, A3 and A2 size drawing papers for drafting of sketches and working drawings | 1 ream for each size |  |
|  | Projector | Functional projector for displaying content during presentations | 1 | 1:25 |
|  | Computer | Functional desktop computer with online instructional content | 1 | 1:25 |
|  | White board | Quality whiteboard of approximately 6 ft by 3 ft for writing during theory instruction | 1 | 1:25 |
|  | Printer | An ink-jet, laser-jet or toner-cartridge printer for printing notes, instructions and working drawings | 1 | 1:25 |
| **B** | **Learning Facilities & Infrastructure** | | | |
|  | Lecture/Theory Room | Spacious room with seats for 25 trainees, approximately 60 sqm | 1 | 1:25 |
|  | Workshop | Standard workshop with bench/fitting area and welding booths approximately 80 sqm | 1 | 1:25 |
| **C** | **Materials and Supplies** | | | |
|  | Dust coat/ overall | Shields skin and regular clothes from sparks | 25 | 1: |
|  | Gloves | Shields hands from sharp edges, heat, and chemical exposure | 25 | 1:1 |
|  | Safety boots | Protects feet from heavy objects, sharp materials, and impact. | 25 | 1:1 |
|  | Ear muffs/ ear plugs | Shields against prolonged exposure to high noise levels from machinery | 25 | 1:1 |
|  | Safety goggles | Protects eyes from flying metal particles, sparks, and dust | 25 | 1:1 |
|  | Raw materials | Steel  Plates   * 4mm thickness. * 6 mm thickness.   Pipes   * 4 mm thickness * 6 mm thickness   Sheets   * Below 4 mm thickness |  |  |
|  | First Aid kit | Fully equipped First Aid kit for use in case of accidents | 1 | 1:25 |
|  | Brooms and cleaning stuff | Hand brooms and mops for cleaning | 10 | 2:5 |
|  | Cotton waste | Absorbent cotton waste for cleaning of oils and other dirt on machines, tools and equipment |  |  |
|  | Cleaning detergents | General degreasers | 10 liters |  |
| Floor detergents | 10 liters |
| Hand detergents | 10 liters |
|  | Paints | Oil based paints | 10 liters |  |
| Water based paints | 10 liters |
|  | Coats | Undercoat | 5 liters |  |
| First coat | 5 liters |
| Second coat | 5 liters |
| Clear coat | 5 liters |
| **D** | **Tools and Equipment** | | | |
| **Measuring tools** | | | | |
|  | GAS  Welding/cutting outfit | -Welding Cylinders,  -1⁄4″ x 20-Ft. Twin Hose, | 5 | 1:5 |
|  | Cutting torch |  | 5 | 1:5 |
|  | Heating torches |  | 5 | 1:5 |
|  | LPG / Acetylene |  | 1 | 1:25 |
|  | LPG / Oxygen |  | 1 | 1:25 |
|  | Tip cleaners |  | 5 | 1:5 |
|  | Spark lighter |  | 2 | 1:12 |
|  | Spot welding machine |  | 3 | 1:8 |
|  | Steel rules | Calibrated steel rules for linear measurements | 20 | 4:5 |
|  | Vernier calipers | Calibrated vernier calipers for linear measurements | 20 | 4:5 |
|  | Tri squares | Properly aligned steel Tri-square for checking perpendicular edges | 5 | 1:5 |
|  | Vernier height gauge and surface plates | Calibrated vernier height gauges and surface plates for measurement of heights | 5 | 1:5 |
|  | Measuring tapes | Calibrated measuring tapes for linear measurements | 20 | 4:5 |
|  | Angle gauges | Calibrated steel rules for linear measurements | 5 | 1:5 |
| **Marking out tools** | | | | |
|  | Scribers | Quality steel pencil scribers for marking out lines on metal surfaces | 20 | 4:5 |
|  | Dot punches | Quality steel dot punches for marking out centers | 20 | 4:5 |
|  | Calipers | Quality steel calipers for marking out arcs on metal surfaces | 5 | 1:5 |
| **Cutting Tools** | | | | |
|  | Assorted hand files | Flat and round hand files for material preparation and finishing | 20 | 4:5 |
|  | Hacksaws | Hack saws with functional frames and blades for cutting metal plates and pipes | 20 | 4:5 |
|  | Tinsnips | Functional hand tinsnips for cutting metal sheets | 10 | 2:5 |
|  | Angle grinders | Portable angle grinders with cutting and grinding disks for cutting and grinding metal plates and pipes | 5 | 1:5 |
| **Work holding tools** | | | | |
|  | Work benches | Stable work benches for carrying out bench work | 5 | 1:5 |
|  | Bench vices | Functional bench vices/clamps for holding work pieces during bench work | 20 | 4:5 |
|  | Tongs | Functional pairs of tongs for holding hot pieces of metal during welding | 10 | 2:5 |
| **Finishing tools** | | | | |
|  | Wire brushes | To clean metal surfaces | 20 | 4:5 |
|  | File cards | Cleaning tool used to maintain files | 5 | 1:5 |
| **E** | **Machines and Equipment** | | | |
|  | Guillotine machines | Used for cutting large sheets of metal into smaller pieces with precision | 1 | 1:25 |
|  | Firefighting equipment | for ensuring safety in fabrication workshops where fire hazards are present, such as sparks | 3 |  |
|  | Rolling machines | used to bend and shape metal sheets into curved shapes, cylinders, or tubes | 1 | 1:25 |
|  | Bending machine | used to bend metal sheets or bars into angles and specific shapes. | 1 | 1:25 |
| **F** | **Reference Materials** | | | |
|  | Working drawings | Technical welding drawings giving the specifications of the welding to be carried out | 25 | 1:1 |
|  | Operation sheets | Operation sheets describing the procedures to be followed in carrying out welding | 25 | 1:1 |
|  | Welding Procedure Specifications (WPS) | WPS to guide on the procedure and standards to be used to achieve specific types of welds | 25 | 1:1 |
|  | Training Presentations/Slides | Digital format for shared access among trainees | 1 | 1:25 |
|  | Practical Assessment Guides | Worksheets for practical assessments | 25 | 1:1 |

## ARC WELDING PROCESSES I

**Unit Code:** 0715 251 02A

**Unit Duration:** 100 Hours

**Relationship to Occupational Standards**

**This unit addresses the Unit of Competency**: Perform Arc Welding Processes I

**Unit Description**

This unit of learning covers the learning outcomes, content, assessment methods, methods of delivery and resources required to train arc welding processes. The learning outcomes involve carrying out manual metal arc welding, arc cutting process and maintaining arc welding machines, tools and equipment.

**Summary of Learning Outcomes**

By the end of this unit of learning, the trainee should be able to:

|  |  |  |
| --- | --- | --- |
| **S/NO** | **Learning Outcomes** | **Duration (Hours)** |
|  | Carry out manual metal arc welding (MMAW) | 70 |
|  | Carry out arc cutting process | 20 |
|  | Maintain welding machines, tools and equipment | 10 |
| **Totals** | | **100** |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Carry out Manual Metal Arc Welding (MMAW) | * 1. Occupational health and safety standards      1. Welding workshop safety      2. Welding workshop rules and regulations      3. Personal protective equipment in welding   2. Hazards in welding      1. Types of hazards      2. Hazard control   3. Welding machines and tools safety      1. Types      2. Use      3. Care   4. Housekeeping in welding      1. Tools and materials storage      2. Workshop cleaning      3. Waste handling and disposal   5. MMAW machines, tools, equipment      1. Types      2. Use      3. Care   6. MMAW parameters      1. Setting         1. Current         2. Arc length         3. Arc force         4. Polarity   7. Materials used in welding      1. Welding Electrodes         1. Types         2. Flux coating         3. Coding         4. Applications   8. Forms of material supply      1. Types         1. Steel plates up to 6 mm thickness         2. Steel pipes up to 6 mm thickness      2. Applications   9. Welding drawing interpretation      1. Dimensions      2. Tolerances      3. Welding symbols and notations      4. Parts list   10. Material preparation in MMAW   (up to 6 mm thickness)   * + 1. Measuring     2. Marking out     3. Cutting     4. Edge preparation   1. Weld joints in MMAW      1. Types         1. Butt joint         2. Lap joint         3. Corner joint         4. T-joint         5. Cruciform joint      2. Geometry and applications   2. Welding positions in MMAW      1. Types         1. Flat         2. Horizontal      2. Description and applications   3. Weld defects in MMAW      1. Types         1. Porosity         2. Undercut         3. Incomplete penetration         4. Slag inclusion         5. Reinforcement         6. Spatters         7. Weld craters         8. Weld cracks         9. Distortion      2. Causes and prevention   4. Arc welded product finishing processes      1. Methods         1. Grinding         2. Varnishing         3. Oil blacking         4. Painting      2. Applications of MMAW finishing processes   **Practice**   * Arc weld mild steel plates and pipes of up to 6 mm thickness in: * Flat position * Horizontal position | * Practical test * Project work * Written tests Portfolio of evidence |
| 1. Carry out arc cutting process | * 1. Arc cutting parameters      1. Setting         1. Current         2. Electrodes   2. Arc cutting process   (up to 6 mm thickness)   * + 1. Procedure     2. Applications   1. Edge finishing after arc cutting   (up to 6 mm thickness)   * + 1. Type     2. Procedure     3. Application   **Practice**   * Arc cut mild steel plates and pipes of: * 4 mm thickness in flat position | * Practical test * Project work * Written tests Portfolio of evidence |
| 1. Maintain welding machines, tools and equipment | * 1. Welding tools repair      1. Handles      2. Heads      3. Jaws      4. Blades      5. Discs and wheels   3.2 Preventive maintenance of fabrication machines and equipment   * + 1. Cleaning of the external surfaces of the machine     2. Inspecting cables, connectors and power sources     3. Lubricating of moving parts   **Practice**   * Clean external surfaces of machine * Inspect cables, connectors and power sources * Lubricate moving parts | * Practical test * Project work * Written tests Portfolio of evidence |

**Suggested Delivery Methods**

* Demonstration
* Group discussions
* Practical work
* Exercises
* Direct instructions
* Industrial visits
* Online materials
* Simulation

**List of Recommended Resources**

**Recommended Resources for 25 trainees**

| **S/No.** | **Category/Item** | **Description/Specifications** | **Quantity** | **Recommended Ratio (Item: Trainee)** |
| --- | --- | --- | --- | --- |
| **A** | **Learning Materials** | | | |
| 1. | Textbooks | Textbooks on Manual Metal Arc Welding (MMAW) | 25 | 1:1 |
|  | Drawing papers | A4, A3 and A2 size drawing papers for drafting of sketches and working drawings | 1 ream |  |
|  | Projector | Functional projector for displaying content during presentations | 1 | 1:25 |
|  | Computer | Functional desktop computer with online instructional content | 1 | 1:25 |
|  | White board | Quality whiteboard of approximately 6 ft by 3 ft for writing during theory instruction | 1 | 1:25 |
|  | Printer | An ink-jet, laser-jet or toner-cartridge printer for printing notes, instructions and working drawings | 1 | 1:25 |
| **B** | **Learning Facilities & Infrastructure** | | | |
|  | Lecture/Theory Room | Spacious room with seats for 25 trainees, approximately 60 sqm | 1 | 1:25 |
|  | Workshop | Standard workshop with bench/fitting area and welding booths approximately 80 sqm | 1 | 1:25 |
| **C** | **Materials and Supplies** | | | |
|  | PPEs | Quality PPE for personal protection during welding and fabrication: |  |  |
| Dust coats | 25 | 1:1 |
| Leather aprons | 25 | 1:1 |
| Face shield | 25 | 1:1 |
| Overalls | 25 | 1:1 |
| Leather gloves | 25 | 1:1 |
| Safety boots | 25 | 1:1 |
| Goggles | 25 | 1:1 |
|  | Raw materials | Steel and aluminum  Plates   * 4mm thickness. * 6 mm thickness. * 9 mm thickness. * 12 mm thickness.   Pipes   * 4 mm thickness * 6 mm thickness * 9 mm thickness |  |  |
|  | First Aid kit | Fully equipped First Aid kit for use in case of accidents | 1 | 1:25 |
|  | Brooms and cleaning stuff | Hand brooms and mops for cleaning | 10 | 2:5 |
|  | Cotton waste | Absorbent cotton waste for cleaning of oils and other dirt on machines, tools and equipment | Enough |  |
|  | Cleaning detergents | General degreasers | 10 litres |  |
| Floor detergents | 10 litres |
| Hand detergents | 10 litres |
|  | Electrodes | 2.5 mm and 3.2 mm rutile (fill-freeze) electrodes | 50 pkts |  |
| **D** | **Tools and Equipment** | | | |
| **Measuring tools** | | | | |
|  | Steel rules | Calibrated steel rules for linear measurements | 20 | 4:5 |
|  | Vernier calipers | Calibrated vernier calipers for linear measurements | 20 | 4:5 |
|  | Tri squares | Properly aligned steel Tri-square for checking perpendicular edges | 5 | 1:5 |
|  | Vernier height gauge and surface plates | Calibrated vernier height gauges and surface plates for measurement of heights | 5 | 1:5 |
|  | Measuring tapes | Calibrated measuring tapes for linear measurements | 20 | 4:5 |
|  | Angle gauges | Calibrated steel rules for linear measurements | 5 | 1:5 |
| **Marking out tools** | | | | |
|  | Scribers | Quality steel pencil scribers for marking out lines on metal surfaces | 20 | 4:5 |
|  | Dot punches | Quality steel dot punches for marking out centres | 20 | 4:5 |
|  | Calipers | Quality steel calipers for marking out arcs on metal surfaces | 5 | 1:5 |
| **Cutting Tools** | | | | |
|  | Assorted hand files | Flat and round hand files for material preparation and finishing | 20 | 4:5 |
|  | Hacksaws | Hack saws with functional frames and blades for cutting metal plates and pipes | 20 | 4:5 |
|  | Angle grinders | Portable angle grinders with cutting and grinding disks for cutting and grinding metal plates and pipes | 5 | 1:5 |
| **Work holding tools** | | | | |
|  | Work benches | Stable work benches for carrying out bench work | 5 | 1:5 |
|  | Bench vices | Functional bench vices/clamps for holding work pieces during bench work | 20 | 4:5 |
|  | Tongs | Functional pairs of tongs for holding hot pieces of metal during welding | 10 | 2:5 |
| **Finishing tools** | | | | |
|  | Wire brushes | Steel wire brushes for cleaning metal surfaces and welds | 20 | 4:5 |
|  | Chipping hammers | Metal chipping hammers for removing spatters and slags from welds | 10 | 2:5 |
|  | File cards | High grade hardened steel file cards for cutting and smoothing metal edges and surfaces | 5 | 1:5 |
| **E** | **Machines and Equipment** | | | |
|  | Arc welding machines | DC welding machine | 10 | 2:5 |
|  | Firefighting extinguishers | Water, carbon dioxide and chemical powder fire extinguishers for fire fighting | 1 | 1:25 |
|  | Electrode cabinet/oven | Functional electrode oven and cabinet for baking and storage of electrodes | 1 | 1:25 |
|  | Welding fixtures | Steel welding fixtures/magnets for securing workpieces during welding | 10 | 2:5 |
| **F** | **Reference Materials** | | | |
|  | Working drawings | Technical welding drawings giving the specifications of the welding to be carried out | 25 | 1:1 |
|  | Operation sheets | Operation sheets describing the procedures to be followed in carrying out welding | 25 | 1:1 |
|  | Welding Procedure Specifications (WPS) | WPS to guide on the procedure and standards to be used to achieve specific types of welds | 25 | 1:1 |
|  | Training Presentations/Slides | Digital format for shared access among trainees | 1 | 1:25 |
|  | Practical Assessment Guides | Worksheets for practical assessments | 25 | 1:1 |

## GAS WELDING, SOLDERING AND BRAZING

**Unit Code**: 0715 251 03A

**Unit Duration:** 100 Hours

**Relationship to Occupational Standards**

**This unit addresses the Unit of Competency:** Perform Gas Welding, Soldering and Brazing

**Unit Description**

This unit of learning covers the learning outcomes, content, assessment methods, methods of delivery and resources required to train gas welding. The learning outcomes involve applying communication skills, carrying out gas welding, gas cutting, brazing, soldering and maintaining gas welding machines, tools and equipment.

**Summary of Learning Outcomes**

By the end of this unit of learning, the trainee should be able to:

|  |  |  |
| --- | --- | --- |
| **S/No.** | **Learning Outcomes** | **Duration (Hours)** |
|  | Carry out gas welding | 40 |
|  | Carry out gas cutting | 10 |
|  | Carry out brazing | 20 |
|  | Carry out soldering | 20 |
|  | Maintain gas welding machines, tools and equipment | 10 |
| **Totals** | | **100** |

**Learning Outcomes, Content and Suggested Assessment Methods**

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| * + 1. Apply communication skills | * 1. Principles of effective communication in welding:      1. Courtesy      2. Correctness      3. Consideration      4. Clarity      5. Completeness   2. Communication barriers in welding:      1. Language      2. Physical      3. Channel   3. Flow of communication in welding workplace:      1. Downward      2. Upward   4. Sources of information in welding workplace:      1. Employee      2. Customers’ feedback      3. Organization documents   5. Welding drawing interpretation      1. Dimensions      2. Tolerances      3. Welding symbols and notations      4. Parts list   6. Digital communication      1. E-Portfolio      2. Communication to clients   7. Basic Costing      1. Materials      2. Labour   Product pricing | * Written assessment * Oral assessment * Observation * Portfolio of evidence |
| * + 1. Carry out gas welding | * 1. Occupational health and safety standards Workshop safety      1. Workshop rules and regulations      2. Personal protective equipment in gas welding   2. Gas welding hazards      1. Types of hazards      2. Hazard control   3. Gas welding machines and tools safety   4. Housekeeping in gas welding      1. Tools and materials storage      2. Workshop cleaning      3. Waste handling and disposal   5. Gas welding equipment and accessories      1. Equipment and accessories         1. Oxygen cylinders         2. Acetylene cylinder         3. Propane cylinder         4. Welding torch         5. Regulators         6. Hoses         7. Jigs and fixtures      2. Use and care   6. Gas welding tools      1. Types         1. Nozzle cleaner         2. Lighter      2. Use and care   7. Welding material preparation   (steel up to 6 mm thickness)   * + 1. Measuring     2. Marking out     3. Cutting     4. Edge preparation   1. Gas weldingparameters      1. Setting         1. Working pressure         2. Oxygen-fuel ratio   2. Materials   (Steel up to 6 mm thickness)   * + - 1. Plates       2. Pipes   1. Welding positions      1. Types         1. Flat         2. Horizontal      2. Description and applications   2. Weld joints      1. Types         1. Butt joint         2. Lap joint         3. Corner joint         4. T-joint         5. Cruciform joint      2. Geometry and applications   3. Gas welding faults      1. Types         1. Flash back         2. Back fire         3. Leakages      2. Causes and prevention   4. Gas welding defects      1. Types         1. Porosity         2. Undercut         3. Incomplete penetration         4. Reinforcement         5. Spatters         6. Weld craters         7. Weld cracks         8. Distortion      2. Causes and prevention   5. Finishing processes in gas welding      1. Methods         1. Polishing         2. Grinding         3. Varnishing         4. Oil blacking         5. Deburring         6. Painting      2. Procedure and application   **Practice**   * Gas weld mild steel plates and pipes of up to 6 mm thickness * Flat position * Horizontal position | * Practical test * Project work * Written tests * Portfolio of evidence |
| * + 1. Carry out gas cutting | * 1. Gas cutting tools and equipment      1. Cutting torch         1. Use         2. Care   2. Fuel gas in gas cutting      1. Types      2. Applications   3. Gas cutting material preparation   (steel up to 6 mm thickness)   * + 1. Measuring     2. Marking out   1. Gas cutting process on steel up to 6 mm thickness      1. Procedure      2. Applications   **Practice**   * Gas cut mild steel plates and pipes of: * Up to 6 mm thickness in flat position | * Practical test * Project work * Written tests * Portfolio of evidence |
| * + 1. Carry out brazing | * 1. Brazing tools and equipment      1. Types      2. Uses      3. Care   2. Types and uses of brazing materials      1. Fluxes      2. Spelter   3. Brazing parameters      1. Setting         1. Working pressure         2. Oxy-fuel ratio   4. Brazing process      1. Procedure      2. Applications   **Practice**   * Braze mild steel sheet metal, plates and pipes of: * Up to 4 mm thickness in flat position | * Practical test * Project work * Written tests * Portfolio of evidence |
| 1. Carry out soldering | * 1. Soldering tools and equipment      1. Types      2. Uses      3. Care and storage   2. Applications of soldering materials      1. Fluxes      2. Solder   3. Setting soldering parameters      1. Temperature      2. Pressure   4. Soldering process      1. Procedure      2. Types of soldering operations      3. Applications   **Practice**   * Solder steel, aluminium, copper and titanium plates and pipes of up to 4 mm thickness in: * Flat position   1. Horizontal position | * Practical test * Project work * Written tests * Portfolio of evidence |
| 1. Maintain gas welding machines, tools and equipment | * 1. Welding tools repair      1. Heads      2. Handles      3. Jaws      4. Blades      5. Discs and wheels   2. Preventive maintenance of fabrication machines and equipment      1. Cleaning of the external surfaces of the machine      2. Inspecting cables, connectors and power sources      3. Lubricating of moving parts   **Practice**   * Clean external surfaces of machine, tools and equipment * Inspect cables, connectors and power sources * Lubricate moving parts | * Practical test * Project work * Written tests * Portfolio of evidence |

**Suggested Delivery Methods**

* Demonstration
* Group discussions
* Practical work.
* Exercises
* Industrial visits
* Online materials
* Direct instructions
* Simulation

**List of Recommended Resources**

**Recommended Resources for 25 trainees**

| **S/No.** | **Category/Item** | **Description/Specifications** | **Quantity** | **Recommended Ratio (Item: Trainee)** |
| --- | --- | --- | --- | --- |
| **A** | **Learning Materials** | | | |
|  | Textbooks | Texts books on Gas Welding processes | 5 | 1:5 |
|  | Installation Manuals | Detailed guides for equipment installation and troubleshooting | 5 | 1:5 |
|  | PowerPoint Presentations | For trainer’s use, covering course content and practical applications | 1 | 1:25 |
|  | Drawing papers | A4, A3 and A2 size drawing papers for drafting of sketches and working drawings | 1 ream of each size |  |
|  | Working drawings | Printed per project | 25 | 1:1 |
|  | Operation sheets | Per project | 25 | 1:1 |
|  | Projector | Functional projector for displaying content during presentations | 1 | 1:25 |
|  | Computer | Functional desktop computer with online instructional content | 1 | 1:25 |
|  | White board | Quality whiteboard of approximately 6 ft by 3 ft for writing during theory instruction | 1 | 1:25 |
|  | Printer | An ink-jet, laser-jet or toner-cartridge printer for printing notes, instructions and working drawings | 1 | 1:25 |
|  | Templates | Per project | 5 | 1:5 |
| **B** | **Learning Facilities & Infrastructure** | | | |
|  | Lecture/Theory Room  /Learning Resource  Area\* | Spacious, equipped with projectors and Seats for 25 trainees, approximately 45 sqm (5 m x 9 m) | 1 | 1:25 |
|  | Standard workshop | Hands-on training area with workbenches, tools, and safety equipment, approximately 80 sqm | 1 | 1:25 |
|  | Grinding Booth\* | 2 m x 1.5 m | 1 |  |
|  | Materials/Preparation  Area\* | 2 m x 2 m | 1 |  |
|  | Bench work Area\* | 1.5 m x 2.5 m | 1 |  |
|  | Wash Area /Comfort  Room *(male & female)*\* | 2.5 m x 4 m | 1 |  |
|  | Tool Room & S/M  Storage Area\* | 4 m x 5 m | 1 |  |
|  |  |  |  |  |
| **C** | **Consumable Materials** | | | |
|  | Pipes | Steel pipes of 4, 6 mm thickness | Enough |  |
|  | Plates | Steel plates 4, 6 mm thickness | Enough |  |
|  | Sheets | Up to gauge 18 | Enough |  |
|  | Dark glass | For gas welding | 3 | 1: 8 |
|  | Cut off disc | 3/32” x 5/8" x 4" dia. | 25 | 1:1 |
|  | Filler (alloy) rod | 1.6/2.4 mm dia. | Enough |  |
|  | Insulation Tapes | For securing connections and insulation, assorted colors | 25 | 1:1 |
|  | Cotton waste | For cleaning | Enough |  |
|  | Cleaning detergents | General degreasers  Floor detergents  Hand detergents | Enough |  |
|  | Spelter | General Brazing  Silver Brazing (brass/stainless) | Enough |  |
|  | Solders | Soft Solders  Hard solders | Enough |  |
|  | Fluxes | Corrosive  Non-corrosive | Enough |  |
|  | Electrodes | 2.5 mm and 3.2 mm rutile (fill-freeze) electrodes | 50 pkts |  |
| **D** | **Tools and Equipment** | | | |
|  | GAS  Welding/cutting outfit | -Welding Cylinders,  -1⁄4″ x 20-Ft. Twin Hose, | 5 | 1:5 |
|  | Arc welding machines | DC welding machine | 10 | 2:5 |
|  | Spot welding machine |  | 3 | 1:8 |
|  | Tape Measures | 5 m tape measures for accurate measurement | 5 | 1:5 |
|  | Cutting torch |  | 5 | 1:5 |
|  | Heating torches |  | 5 | 1:5 |
|  | Welding tips |  | 15 |  |
|  | First Aid kit |  | 1 |  |
|  | Portable disc Grinder/angle grinders |  | 5 | 1:5 |
|  | Exhaust fan |  | 1 | 1:25 |
|  | Work bench | W/Bench Vice On 4 Corners | 4 | 1:6 |
|  | LPG / Acetylene |  | 1 | 1:25 |
|  | LPG / Oxygen |  | 1 | 1:25 |
|  | Pipe beveling machine |  | 1 | 1:25 |
|  | Fire-fighting equipment |  | 3 |  |
|  | Tip cleaners |  | 5 | 1:5 |
|  | Spark lighter |  | 2 | 1:12 |
|  | Jigs and fixtures |  | 5 | 1:5 |
|  | Screwdrivers |  | 5 | 1:5 |
|  | Pliers /Cutters |  | 5 | 1:5 |
|  | Chipping Hammer |  | 5 | 1:5 |
|  | Steel Brush |  | 5 | 1:5 |
|  | Files Bastard |  | 5 | 1:5 |
|  | Scribers |  | 5 | 1:5 |
|  | Dot Punches |  | 5 | 1:5 |
|  | Try Square |  | 5 | 1:5 |
|  | Steel Rule | 300 mm long | 20 | 2:5 |
|  | Filler Gauge |  | 5 | 1:5 |
|  | Wire Cutter |  | 5 | 1:5 |
|  | Hand Hacksaw |  | 20 | 2:5 |
|  | Measuring Tapes |  | 20 | 2:5 |
| **E** | **PPE (Personal Protective Equipment)** | | | |
|  | Leather apron/jacket | Body protection | 25 | 1:1 |
|  | Helmets | Head protection | 25 | 1:1 |
|  | Gloves | Hand protection | 25 | 1:1 |
|  | Safety goggles wide vision | Face /Eye protection | 25 | 1:1 |
|  | Safety shoes | Foot protection | 25 | 1:1 |
| **F** | **Reference Materials** | | | |
|  | Welding blueprint /drawings and standards | Reference on industry standards (e.g., BS/ANSI/AWS etc) | 5 | 1:5 |
|  | Training Presentations/Slides | Digital format for shared access among trainees | 1 | 1:25 |
|  | Multimedia Learning Modules | Digital licenses for videos and tutorials | 25 | 1:1 |
|  | Practical Assessment Guides | Worksheets for practical assessments | 25 | 1:1 |

*\* This area can also be used by other welding courses.*

# MODULE II

|  |  |  |  |
| --- | --- | --- | --- |
| **Unit Code** | **Unit Title** | **Unit Duration (Hours)** | **Credit**  **Factor** |
| 0715 351 04A | Metal Inert Gas Welding | 200 | 20 |
| 0715 351 05A | Tungsten Inert Gas Welding | 200 | 20 |
|  | **Total** | **400** | **40** |

## METAL INERT GAS WELDING

**Unit Code:** 0715 351 04A

**Unit Duration:** 200 Hours

**Relationship to Occupational Standards**

**This unit addresses the Unit of Competency:** Perform Metal Inert Gas (MIG) Welding

**Unit Description**

This unit of learning covers the learning outcomes, content, assessment methods, methods of delivery and resources required to train MIG welding. The learning outcomes involve drafting working drawing, carrying out metal inert gas (MIG) welding and maintaining MIG welding machines, tools and equipment

**Summary of Learning Outcomes**

By the end of this unit of learning, the trainee should be able to:

|  |  |  |
| --- | --- | --- |
| **S/NO** | **Learning Outcomes** | **Duration (Hours)** |
|  | Draft working drawing | 40 |
|  | Carry out Metal Inert Gas (MIG) welding | 140 |
|  | Maintain MIG welding machines, tools and equipment | 20 |
| **Total** | | **200** |

1. Draft working drawing
2. Carry out Metal Inert Gas (MIG) welding
3. Maintain MIG welding machines, tools and equipment

**Learning Outcomes, Content and Suggested Assessment Methods**

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1. Draft working drawing | * 1. Drawing interpretation      1. Dimensions         1. Linear         2. Angular      2. Tolerances      3. Symbols and notations      4. Views/Elevations         1. First angle         2. Third angle      5. Scale      6. Measurement of angles      7. Sketching of plane geometric forms         1. Triangles         2. Quadrilaterals         3. Polygons         4. Circles and tangents      8. Solids sketches         1. Prisms         2. Cones         3. Cubes         4. Cuboids   Cylinders   * 1. Draft work drawings      1. Drawing dimension      2. Welding symbols and notations   2. Operation procedure      1. Development      2. Use   **Practice**   * Draft working drawing * Prepare operation plan | * Written tests * Practical test * Project work Portfolio of evidence |
| 1. Carry out Metal inert Gas (MIG) welding | * 1. Occupational health and safety standards      1. Workshop safety      2. Personal protective equipment      3. Workplace procedures   2. Welding hazards      1. Types      2. Prevention and control   3. Safe handling of equipment   4. Housekeeping      1. Cleaning      2. Waste Management   5. Interpretation of working drawing      1. Symbols and notations      2. Abbreviations      3. Parts list   6. MIG welding equipment and accessories      1. Types         1. Inert gas cylinders         2. MIG welding machine            1. MIG wire            2. MIG torch      2. Use and care   7. MIG welding tools      1. Types         1. Fire extinguishers         2. Welding jigs and fixtures         3. Nozzle cleaner         4. Wire brush      2. Use and care   8. Welding material preparation   (steel up to 10 mm thickness)   * + 1. Measuring     2. Marking out     3. Cutting     4. Edge preparation   1. MIG weldingparameters      1. Setting         1. Pre-operation checks         2. Working pressure         3. Current         4. Torch angle         5. Wire speed         6. Wire gauge/diameter   2. Modes of metal transfer      1. Short circuit      2. Globular      3. Spray arc      4. Pulsed   3. Metallic Materials (up to 10 mm thickness)      1. Plates      2. Pipes   4. Welding positions      1. Types         1. Flat         2. Horizontal         3. Vertical      2. Applications   5. Types of joints      1. Types         1. Butt joint         2. Edge joint         3. Plug joint         4. Lap joint         5. Corner joint         6. T-joint         7. Cruciform joint      2. Geometry and applications   6. Weld defects      1. Types         1. Porosity         2. Undercut         3. Incomplete penetration         4. Reinforcement         5. Spatters         6. Weld craters         7. Weld cracks         8. Distortion      2. Causes and prevention   7. Finishing processes      1. Types         1. Polishing         2. Grinding         3. Blueing         4. Varnishing         5. Oil blacking         6. Deburring         7. Painting      2. Procedure and applications   **Practice**   * MIG weld metallic materials up to 10 mm thickness in: * Flat position * Horizontal position * Vertical position | * Practical test * Project work * Written tests * Portfolio of evidence |
| 1. Maintain MIG welding machines, tools and equipment | * 1. Welding tools repair      1. Heads      2. Handles      3. Jaws      4. Blades      5. Discs and wheels   3.2 Preventive maintenance of fabrication machines and equipment   * + 1. Cleaning of the external surfaces of the machine     2. Inspecting cables, connectors and power sources     3. Lubricating of moving parts   **Practice**   * Clean external surfaces of machines, tools and equipment * Inspect cables, connectors and power sources * Lubricate moving parts | * Practical test * Project work * Written tests * Portfolio of evidence |

**Suggested Delivery Methods**

* Demonstration
* Group discussions
* Practical work.
* Exercises
* Industrial visits
* Online materials
* Direct instructions
* Simulation

**List of Recommended Resources**

**Recommended Resources for 25 trainees**

| **S/No.** | **Category/Item** | **Description/Specifications** | **Quantity** | **Recommended Ratio (Item: Trainee)** |
| --- | --- | --- | --- | --- |
| **A** | **Learning Materials** | | | |
|  | Textbooks | Textbooks on Welding and Fabrication | 25 | 1:1 |
|  | Drawing papers | A4, A3 and A2 size drawing papers for drafting of sketches and working drawings | 1 ream for each size |  |
|  | Projector | Functional projector for displaying content during presentations | 1 | 1:25 |
|  | Computer | Functional desktop computer with online instructional content | 1 | 1:25 |
|  | White board | Quality whiteboard of approximately 6 ft by 3 ft for writing during theory instruction | 1 | 1:25 |
|  | Printer | An ink-jet, laser-jet or toner-cartridge printer for printing notes, instructions and working drawings | 1 | 1:25 |
| **B** | **Learning Facilities & Infrastructure** | | | |
|  | Lecture/Theory Room | Spacious room with seats for 25 trainees, approximately 60 sqm | 1 | 1:25 |
|  | Workshop | Standard workshop with bench/fitting area and welding booths approximately 80 sqm | 1 | 1:25 |
| **C** | **Materials and Supplies** | | | |
|  | Dust coat/ overall | Shields skin and regular clothes from sparks | 25 | 1: |
|  | Gloves | Shields hands from sharp edges, heat, and chemical exposure | 25 | 1:1 |
|  | Safety boots | Protects feet from heavy objects, sharp materials, and impact. | 25 | 1:1 |
|  | Welding helmets | Protecting the eyes while providing a clear view of the weld. | 25 | 1:1 |
|  | Ear muffs/ ear plugs | Shields against prolonged exposure to high noise levels from machinery | 25 | 1:1 |
|  | Safety goggles | Protects eyes from flying metal particles, sparks, and dust | 25 | 1:1 |
|  | Raw materials | Metallic materials  Plates   * 4mm thickness. * 6 mm thickness. * 9 mm thickness. * 12 mm thickness.   Pipes   * 4 mm thickness * 6 mm thickness * 9 mm thickness * 12 mm thickness |  |  |
|  | Tungsten electrodes | Electrodes used in TIG welding | 20 packets |  |
|  | First Aid kit | Fully equipped First Aid kit for use in case of accidents | 1 | 1:25 |
|  | Brooms and cleaning stuff | Hand brooms and mops for cleaning | 10 | 2:5 |
|  | Cotton waste | Absorbent cotton waste for cleaning of oils and other dirt on machines, tools and equipment | Enough |  |
|  | Cleaning detergents | General degreasers | 10 liters |  |
| Floor detergents | 10 liters |
| Hand detergents | 10 liters |
| **D** | **Tools and Equipment** | | | |
| **Measuring tools** | | | | |
|  | Steel rules | Calibrated steel rules for linear measurements | 20 | 4:5 |
|  | Vernier calipers | Calibrated vernier calipers for linear measurements | 20 | 4:5 |
|  | Tri squares | Properly aligned steel Tri-square for checking perpendicular edges | 5 | 1:5 |
|  | Vernier height gauge and surface plates | Calibrated vernier height gauges and surface plates for measurement of heights | 5 | 1:5 |
|  | Measuring tapes | Calibrated measuring tapes for linear measurements | 20 | 4:5 |
|  | Angle gauges | Calibrated steel rules for linear measurements | 5 | 1:5 |
| **Marking out tools** | | | | |
|  | Scribers | Quality steel pencil scribers for marking out lines on metal surfaces | 20 | 4:5 |
|  | Dot punches | Quality steel dot punches for marking out centres | 20 | 4:5 |
|  | Calipers | Quality steel calipers for marking out arcs on metal surfaces | 5 | 1:5 |
| **Cutting Tools** | | | | |
|  | Assorted hand files | Flat and round hand files for material preparation and finishing | 20 | 4:5 |
|  | Hacksaws | Hack saws with functional frames and blades for cutting metal plates and pipes | 20 | 4:5 |
|  | Tinsnips |  | 10 | 2:5 |
|  | Angle grinders | Portable angle grinders with cutting and grinding disks for cutting and grinding metal plates and pipes | 5 | 1:5 |
| **Work holding tools** | | | | |
|  | Work benches | Stable work benches for carrying out bench work | 5 | 1:5 |
|  | Collet | Hold the tungsten electrode in place | 5 | 1:5 |
|  | Bench vices | Functional bench vices/clamps for holding work pieces during bench work | 20 | 4:5 |
|  | Tongs | Functional pairs of tongs for holding hot pieces of metal during welding | 10 | 2:5 |
| **Finishing tools** | | | | |
|  | Wire brushes | To clean metal surfaces | 20 | 4:5 |
|  | MIG welding wire | Acts as both the electrode and the filler material | 2000kg | 80:1 |
|  | File cards | Cleaning tool used to maintain files | 5 | 1:5 |
| **E** | **Machines and Equipment** | | | |
|  | MIG/ MAG welding machine | Uses a continuous wire feed as an electrode | 5 | 1:5 |
|  | Firefighting equipment | For ensuring safety in fabrication workshops where fire hazards are present, such as sparks | 3 |  |
|  | Welding gun | Feeds the filler wire into the weld pool | 5 | 1:5 |
| **F** | **Reference Materials** | | | |
|  | Working drawings | Technical welding drawings giving the specifications of the welding to be carried out | 25 | 1:1 |
|  | Operation sheets | Operation sheets describing the procedures to be followed in carrying out welding | 25 | 1:1 |
|  | Welding Procedure Specifications (WPS) | WPS to guide on the procedure and standards to be used to achieve specific types of welds | 25 | 1:1 |
|  | Training Presentations/Slides | Digital format for shared access among trainees | 1 | 1:25 |
|  | Practical Assessment Guides | Worksheets for practical assessments | 25 | 1:1 |

## TUNGSTEN INERT GAS WELDING

**Unit Code:** 0715 351 05A

**Unit Duration:** 200 Hours

**Relationship to Occupational Standards**

**This unit addresses the Unit of Competency:** Perform Tungsten Inert Gas Welding

**Unit Description**

This unit of learning covers the learning outcomes, content, assessment methods, methods of delivery and resources required to train TIG welding. The learning outcomes involve drafting working drawing, carrying out Tungsten Inert Gas (TIG) welding, and maintaining gas metal arc welding equipment

**Summary of Learning Outcomes**

By the end of this learning unit, the trainee should be able to:

|  |  |  |
| --- | --- | --- |
| **S/NO** | **Learning Outcomes** | **Duration (Hours)** |
|  | To draft working drawing | 40 |
|  | To Carry out Tungsten Inert Gas (TIG) welding | 140 |
|  | To Maintain TIG welding machines, tools and equipment | 20 |
| **Totals** | | **200** |

**Learning Outcomes, Content and Suggested Assessment Methods**

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1. Draft working drawing | * 1. Drawing interpretation      1. Dimensions         1. Linear         2. Angular      2. Tolerances      3. Symbols and notations      4. Views/Elevations         1. First angle         2. Third angle      5. Scale      6. Measurement of angles      7. Sketching of plane geometric forms         1. Triangles         2. Quadrilaterals         3. Polygons         4. Circles and tangents      8. Solids sketches         1. Prisms         2. Cones         3. Cubes         4. Cuboids   Cylinders   * 1. Draft work drawings      1. Drawing dimension      2. Welding symbols and notations   2. Operation procedure      1. Development      2. Use   **Practice**   * Draft working drawing * Prepare operation plan | * Written tests * Practical test * Project work * Portfolio of evidence |
| 1. Carry out Tungsten Inert Gas (TIG) welding | * 1. Occupational health and safety standards      1. Personal protective equipment      2. Workshop safety      3. Workplace procedures      4. Welding hazards         1. Types         2. Prevention and control      5. Safe handling of equipment   2. Housekeeping      1. Cleaning      2. Waste management   3. Interpretation of working drawing      1. Symbols and notations      2. Abbreviations      3. Parts list   4. TIG welding equipment and accessories      1. Types         1. TIG torch         2. Inert gas cylinders         3. Tungsten electrode         4. Filler rods      2. Uses and care   5. Welding material preparation   (up to 10 mm thickness)   * + 1. Measuring     2. Marking out     3. Cutting     4. Edge preparation   1. TIG welding parameters      1. Setting         1. Current         2. Arc force         3. Voltage         4. Gas pressure   2. MIG welding tools      1. Types         1. Fire extinguishers         2. Welding jigs and fixtures         3. Nozzle cleaner      2. Use and care   3. TIG welding process      1. Procedure      2. Applications   4. Metallic Materials (up to 10 mm thickness)      + 1. Plates        2. Pipes   5. Welding positions      1. Types         1. Flat         2. Horizontal         3. Vertical      2. Applications   6. Types of joints      1. Types         1. Butt joint         2. Lap joint         3. Corner joint         4. T-joint         5. Cruciform joint      2. Geometry and applications   7. Weld defects      1. Types         1. Porosity         2. Undercut         3. Incomplete penetration         4. Reinforcement         5. Spatters         6. Weld craters         7. Weld cracks         8. Distortion      2. Causes and prevention   8. Finishing processes      1. Types         1. Polishing         2. Grinding         3. Blueing         4. Varnishing         5. Oil blacking         6. Deburring         7. Painting      2. Procedure and applications   **Practice**   * TIG weld metallic materials plates and pipes of up to 10 mm thickness in: * Flat position * Horizontal position * Vertical position | * Practical test * Project work * Written tests * Portfolio of evidence |
| 1. Maintain TIG welding machines, tools and equipment | * 1. Welding tools repair      1. Heads      2. Handles      3. Jaws      4. Blades      5. Discs and wheels   3.2 Preventive maintenance of fabrication machines and equipment   * + 1. Cleaning of the external surfaces of the machine     2. Inspecting cables, connectors and power sources     3. Lubricating of moving parts   **Practice**   * Clean external surfaces of machine, tools and equipment * Inspect cables, connectors and power sources * Lubricate moving parts | * Practical test * Project work * Written tests * Portfolio of evidence |

**Suggested Delivery Methods**

* Demonstration
* Group discussions
* Practical work.
* Exercises
* Industrial visits
* Online materials
* Direct instructions
* Simulation

**List of Recommended Resources**

**Recommended Resources for 25 trainees**

| **S/No.** | **Category/Item** | **Description/Specifications** | **Quantity** | **Recommended Ratio (Item: Trainee)** |
| --- | --- | --- | --- | --- |
| **A** | **Learning Materials** | | | |
|  | Textbooks | Textbooks on Welding and Fabrication | 25 | 1:1 |
|  | Drawing papers | A4, A3 and A2 size drawing papers for drafting of sketches and working drawings | 1 ream for each size |  |
|  | Projector | Functional projector for displaying content during presentations | 1 | 1:25 |
|  | Computer | Functional desktop computer with online instructional content | 1 | 1:25 |
|  | White board | Quality whiteboard of approximately 6 ft by 3 ft for writing during theory instruction | 1 | 1:25 |
|  | Printer | An ink-jet, laser-jet or toner-cartridge printer for printing notes, instructions and working drawings | 1 | 1:25 |
| **B** | **Learning Facilities & Infrastructure** | | | |
|  | Lecture/Theory Room | Spacious room with seats for 25 trainees, approximately 60 sqm | 1 | 1:25 |
|  | Workshop | Standard workshop with bench/fitting area and welding booths approximately 80 sqm | 1 | 1:25 |
| **C** | **Materials and Supplies** | | | |
|  | Dust coat/ overall | Shields skin and regular clothes from sparks | 25 | 1: |
|  | Gloves | Shields hands from sharp edges, heat, and chemical exposure | 25 | 1:1 |
|  | Safety boots | Protects feet from heavy objects, sharp materials, and impact. | 25 | 1:1 |
|  | Welding helmets | Protecting the eyes while providing a clear view of the weld. | 25 | 1:1 |
|  | Ear muffs/ ear plugs | Shields against prolonged exposure to high noise levels from machinery | 25 | 1:1 |
|  | Safety goggles | Protects eyes from flying metal particles, sparks, and dust | 25 | 1:1 |
|  | Raw materials | Metallic Materials  Plates   * 4mm thickness. * 6 mm thickness. * 9 mm thickness. * 12 mm thickness.   Pipes   * 4 mm thickness * 6 mm thickness * 9 mm thickness * 12 mm thickness |  |  |
|  | Tungsten electrodes | Electrodes used in TIG welding | 20 packets |  |
|  | First Aid kit | Fully equipped First Aid kit for use in case of accidents | 1 | 1:25 |
|  | Brooms and cleaning stuff | Hand brooms and mops for cleaning | 10 | 2:5 |
|  | Cotton waste | Absorbent cotton waste for cleaning of oils and other dirt on machines, tools and equipment | Enough |  |
|  | Cleaning detergents | General degreasers | 10 liters |  |
| Floor detergents | 10 liters |
| Hand detergents | 10 liters |
| **D** | **Tools and Equipment** | | | |
| **Measuring tools** | | | | |
|  | Steel rules | Calibrated steel rules for linear measurements | 20 | 4:5 |
|  | Vernier calipers | Calibrated vernier calipers for linear measurements | 20 | 4:5 |
|  | Tri squares | Properly aligned steel Tri-square for checking perpendicular edges | 5 | 1:5 |
|  | Vernier height gauge and surface plates | Calibrated vernier height gauges and surface plates for measurement of heights | 5 | 1:5 |
|  | Measuring tapes | Calibrated measuring tapes for linear measurements | 20 | 4:5 |
|  | Angle gauges | Calibrated steel rules for linear measurements | 5 | 1:5 |
| **Marking out tools** | | | | |
|  | Scribers | Quality steel pencil scribers for marking out lines on metal surfaces | 20 | 4:5 |
|  | Dot punches | Quality steel dot punches for marking out centers | 20 | 4:5 |
|  | Calipers | Quality steel calipers for marking out arcs on metal surfaces | 5 | 1:5 |
| **Cutting Tools** | | | | |
|  | Assorted hand files | Flat and round hand files for material preparation and finishing | 20 | 4:5 |
|  | Hacksaws | Hack saws with functional frames and blades for cutting metal plates and pipes | 20 | 4:5 |
|  | Tinsnips |  | 10 | 2:5 |
|  | Angle grinders | Portable angle grinders with cutting and grinding disks for cutting and grinding metal plates and pipes | 5 | 1:5 |
| **Work holding tools** | | | | |
|  | Work benches | Stable work benches for carrying out bench work | 5 | 1:5 |
|  | Collet | Hold the tungsten electrode in place | 5 | 1:5 |
|  | Bench vices | Functional bench vices/clamps for holding work pieces during bench work | 20 | 4:5 |
|  | Tongs | Functional pairs of tongs for holding hot pieces of metal during welding | 10 | 2:5 |
| **Finishing tools** | | | | |
|  | Wire brushes | To clean metal surfaces | 20 | 4:5 |
|  | TIG welding wire | Used as filler rods | 200kg | 8:1 |
|  | File cards | Cleaning tool used to maintain files | 5 | 1:5 |
| **E** | **Machines and Equipment** | | | |
|  | TIG welding machine | Uses a non-consumable tungsten electrode | 5 | 1:5 |
|  | Firefighting equipment | for ensuring safety in fabrication workshops where fire hazards are present, such as sparks | 3 |  |
|  | Welding gun | Feeds the filler wire into the weld pool | 5 | 1:5 |
| **F** | **Reference Materials** | | | |
|  | Working drawings | Technical welding drawings giving the specifications of the welding to be carried out | 25 | 1:1 |
|  | Operation sheets | Operation sheets describing the procedures to be followed in carrying out welding | 25 | 1:1 |
|  | Welding Procedure Specifications (WPS) | WPS to guide on the procedure and standards to be used to achieve specific types of welds | 25 | 1:1 |
|  | Training Presentations/Slides | Digital format for shared access among trainees | 1 | 1:25 |
|  | Practical Assessment Guides | Worksheets for practical assessments | 25 | 1:1 |