****

**REPUBLIC OF KENYA**

**COMPETENCY BASED MODULAR CURRICULUM**

**FOR**

**WELDING TECHNOLOGY**

**KNQF LEVEL 5**

**PROGRAMME ISCED CODE: 0715 454A**

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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 AND ACRONYMS

AC Alternating Current

CPU Central Processing Unit

DC Direct Current

DVI Digital Visual Interface

FCAW Flux Cored Arc Welding

GMAW Gas Metal Arc Welding

HDMI High-Definition Multimedia Interface

KCSE Kenya Certificate of Secondary Education

KNQA Kenya National Qualifications Authority

MAG Metal Active Gas

MIG Metal Inert Gas

MMAW Manual Metal Arc Welding

NNP Nyeri National Polytechnic

PPE Personal Protective Equipment

RAM Random Access Memory

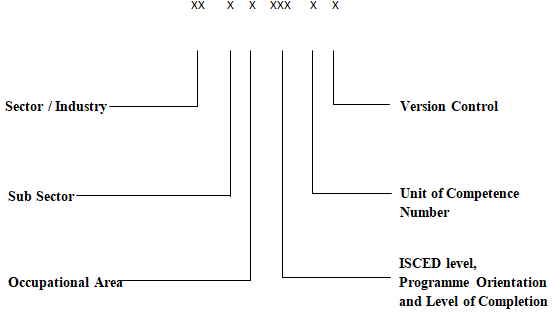
TIG Tungsten Inert Gas

TVETA Technical and Vocational Education and Training Authority

USB Universal Serial Bus

VGA Video Graphics Array

# KEY TO ISCED UNIT CODE



# COURSE OVERVIEW

Welding Technology Level 5 qualification consists of competencies that an individual must achieve to enable him/her to work in a welding establishment as a Welding Technician.

The curriculum consists of Basic, Common and Core Units of learning.

The Units of Learning comprising Welding Technology Level 5 include the following: Digital Literacy, Communication Skills, Work Ethics and Practices, Entrepreneurial Skills, Mathematics, Technical Drawings, Mechanical Science, Electrical and Electronics Principles, Metallurgy, Fabrication Processes I, Arc Welding Processes I, Gas welding, Soldering and brazing processes, Metal Inert Gas Welding, Tungsten Inert Gas Welding, Fabrication Processes II, Arc Welding Processes II and Gas Metal Arc Welding Operations.

**SUMMARY OF UNITS OF LEARNING**

|  |  |  |  |
| --- | --- | --- | --- |
| **Unit Code** | **Unit Title** | **Unit Duration (Hours)** | **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** |
|  | | | |
| **MODULE III** | | | |
| 0031 441 02A | Communication Skills | 40 | **4** |
| 0417 441 03A | Work Ethics and Practices | 40 | **4** |
| 0715 441 09A | Metallurgy | 80 | **8** |
| 0541 441 05A | Mathematics | 80 | **8** |
| 0715 451 16A | Arc Welding Processes II | 120 | **12** |
| 0715 451 15A | Fabrication Processes II | 120 | **12** |
| **MODULE IV** | | | |
| 0611 441 01A | Digital Literacy | 40 | **4** |
| 0413 441 04A | Entrepreneurial Skills | 40 | **4** |
| 0732 441 06A | Apply Technical Drawings | 80 | **8** |
| 0715 441 07A | Mechanical Science | 80 | **8** |
| 0713 441 08A | Electical & Electronics Principles | 80 | **8** |
| 0715 451 17A | Gas Metal Arc Welding Operations | 120 | **12** |
| **Institutional Hours** | | **1670** | **167** |
| Industrial Attachment | | 480 | 48 |
| **GRAND TOTAL** | | **2150** | **215** |

***Trainees enrolled for part qualification shall undertake the core unit of competency of choice***

**Entry Requirements**

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

1. Kenya Certificate of Secondary Education (KCSE) with a grade of D (Plain) or its equivalent.

OR

1. Possession of a KNQF Level 4 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 6 Welding qualification or its equivalent in Welding & Fabrication; and
2. License by TVETA

**Industry Training**

An individual enrolled in this course will be required to undergo Industry training for a minimum period of 480 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 for each unit of learning shall be as follows:
   1. 10:90 for the units in modules I and Module II; and
   2. 30:70 for the units in modules III and IV.
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 Technology Level 5** 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 451 01A | Fabrication Processes I | 150 | 15 |
| 0715 451 02A | Arc Welding Processes I | 100 | 10 |
| 0715 451 03A | Gas welding, Soldering and **B**razing Processes | 100 | 10 |
|  | **Total** | **350** | **35** |

## FABRICATION PROCESSES I

**Unit Code:** 0715 251 10A

**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 11A

**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 12A

**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** |
| 0715 451 04A | Metal Inert Gas Welding | 200 | 20 |
| 0715 451 05A | Tungsten Inert Gas Welding | 200 | 20 |
|  | **Total** | **400** | **40** |

## METAL INERT GAS WELDING

**Unit Code:** 0715 351 13A

**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 14A

**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 |

**MODULE III**

|  |  |  |  |
| --- | --- | --- | --- |
| **Unit Code** | **Unit Title** | **Unit Duration (Hours)** | **Credit**  **Factor** |
| 0031 441 02A | Communication Skills | 40 | 4 |
| 0417 441 03A | Work Ethics and Practices | 40 | 4 |
| 0715 441 09A | Metallurgy | 80 | 8 |
| 0541 441 05A | Mathematics | 80 | 8 |
| 0715 451 16A | Manual Metal Arc Welding Operations II | 120 | 12 |
| 0715 451 15A | Fabrication Processes II | 120 | 12 |
|  | **Total** | **480** | **48** |

## COMMUNICATION SKILLS

**UNIT CODE:** 0031 441 02A

**Relationship with Occupational Standards**

**This unit addresses the Unit of Competency:** Apply Communication Skills

**Duration of Unit:** 40 Hours

**Unit Description**

This unit of learning covers the learning outcomes, content, assessment methods, methods of delivery and resources required to train communication skills. The learning outcomes involve applying communication channels, written, non-verbal, oral, and group communication skills.

**Summary of Learning Outcomes**

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

|  |  |  |
| --- | --- | --- |
| **S/NO** | **Learning Outcomes** | **Duration (Hours)** |
|  | Apply communication channels. | 10 |
|  | Apply written communication skills. | 12 |
|  | Apply non-verbal skills. | 4 |
|  | Apply oral communication skills. | 4 |
|  | Apply group communication skills. | 10 |
| **Totals** | | **40** |

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

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1. Apply communication channels | * 1. Communication process   2. Principles of effective communication   3. Channels/medium/modes of communication   4. Factors to consider when selecting a channel of communication   5. Barriers to effective communication   6. Flow/patterns of communication   7. Sources of information   8. Organizational policies | * Oral questions * Written assessment * Observation * Portfolio of Evidence * Practical assessment * Third party report |
| 1. Apply written communication skills | * 1. Types of written communication   2. Elements of communication   3. Organization requirements for written communication | * Oral assessment * Written assessment * Observation * Portfolio of Evidence * Practical assessment * Third party report |
| 1. Apply non-verbal communication skills | * 1. Utilize body language and gestures   2. Apply body posture   3. Apply workplace dressing code | * Oral assessment * Written assessment * Observation * Portfolio of Evidence * Practical assessment * Third party report |
| 1. Apply oral communication skills | * 1. Types of oral communication pathways   2. Effective questioning techniques   3. Workplace etiquette   4. Active listening | * Oral assessment * Written assessment * Observation * Portfolio of Evidence * Practical assessment * Third party report |
| 1. Apply group discussion skills | * 1. Establishing rapport      1. Facilitating resolution of issues      2. Developing action plans      3. Group organization techniques      4. Turn-taking techniques      5. Conflict resolution techniques      6. Team-work | * Oral assessment * Written assessment * Observation * Portfolio of Evidence * Practical assessment |

**Suggested Methods of Instruction**

* Discussion
* Roleplaying
* Simulation
* Direct instruction
* Demonstration
* Field trips

**Recommended Resources for 30 trainees**

| **S/No.** | **Category/Item** | **Description/Specifications** | **Quantity** | **Recommended Ratio (Item: Trainee)** |
| --- | --- | --- | --- | --- |
| **A** | **Learning Materials** | | | |
|  | Textbooks | Comprehensive texts books on Communication Skills | 30 pcs | 1:1 |
|  | Mobile Phones | Smartphone for use by trainees | 30 pcs | 1:1 |
|  | Internet connection | Internet connection to aid communication between trainees |  |  |
|  | PowerPoint Presentations | For trainer’s use, covering course content and practical applications | 1 | 1:30 |
|  | Projector | Functional projector for displaying content during presentations | 1 | 1:30 |
|  | White board | Quality whiteboard of approximately 6 ft by 3 ft for writing during theory instruction | 1 | 1:30 |
|  | Printer | An ink-jet, laser-jet or toner-cartridge printer for printing notes, instructions and working drawings | 1 | 1:30 |
|  | Templates | Templates for creating various documents e.g. CV, Cover Letter, minutes, reports etc. | 30 | 1:1 |
| **B** | **Learning Facilities & Infrastructure** | | | |
|  | Lecture/Theory Room  /Learning Resource  Area\* | Spacious, equipped with projectors and Seats for 30 trainees, approximately 45 sqm (5 m x 9 m) | 1 | 1:30 |
|  | Computer Laboratory | Equipped with at least 30 functional computers with internet connectivity and the following software:   * + - Windows/ Linux/ Macintosh Operating System     - Microsoft Office Software     - Google Workspace Account     - Antivirus Software | 30 | 1:1 |
|  |  |  |  |  |
| **C** | **Consumable Materials** | | | |
|  | Printing Papers | A4 and A3 Printing papers suitable for the task | Enough |  |
|  | Flashcards | For carrying out various activities by trainees | Enough |  |
|  | Flipcharts | Sufficient for group work activities and displaying | Enough |  |
|  | Whiteboard Marker Pens | Dry-erase markers for trainers use. Assorted colors | Enough |  |

## WORK ETHICS AND PRACTICES

**UNIT CODE:** 0417 441 03A

**Relationship with Occupational Standards**

**This unit addresses the Unit of Competency:** Apply Work Ethics and Practices.

**Duration of Unit:** 40 Hours

**Unit Description**

This unit of learning covers the learning outcomes, content, assessment methods, methods of delivery and resources required to train work ethics and practices. The learning outcomes involve the ability to: conduct self-management, promote ethical work practices and values, promote teamwork, manage workplace conflicts, maintain professional and personal development, apply problem-solving, and promote customer care.

**Summary of Learning Outcomes**

By the end of thisunit of learning the trainee should be able to:

|  |  |  |
| --- | --- | --- |
| **S/NO** | **Learning Outcomes** | **Duration (Hours)** |
| **1.** | Apply self-management skills | 10 |
| **2.** | Promote ethical practices and values | 4 |
| **3.** | Promote Teamwork | 10 |
| **4.** | Maintain professional and personal development | 10 |
| **5.** | Apply Problem-solving skills | 4 |
|  | Promote Customer care. | 2 |
| **Totals** | | **40** |

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

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1. Apply self-management skills | * 1. Self-awareness   2. Formulating personal vision, mission, and goals   3. Healthy lifestyle practices   4. Strategies for overcoming work challenges   5. Emotional intelligence   6. Coping with Work Stress.   7. Assertiveness versus aggressiveness and passiveness      1. Developing and maintaining high self-esteem      2. Developing and maintaining positive self-image      3. Time management      4. Setting performance targets      5. Monitoring and evaluating performance targets | * Observation * Written assessment * Oral assessment * Third party reports * Portfolio of evidence * Project * Practical |
| 1. Promote ethical work practices and values | * 1. Integrity   2. Core Values, ethics and beliefs   3. Patriotism   4. Professionalism   5. Organizational codes of conduct   6. Industry policies and procedures | * Observation * Written assessment * Oral assessment * Third party reports * Portfolio of evidence * Project * Practical |
| 1. Promote Teamwork | * 1. Types of teams   2. Team building      1. Individual responsibilities in a team      2. Determination of team roles and objectives      3. Team parameters and relationships      4. Benefits of teamwork      5. Qualities of a team player      6. Leading a team      7. Team performance and evaluation   3. Conflicts and conflict resolution   4. Gender and diversity mainstreaming   5. Developing Healthy workplace relationships   6. Adaptability and flexibility   7. Coaching and mentoring skills | * Observation * Written assessment * Oral assessment * Third party reports * Portfolio of evidence * Project * Practical |
| 1. Maintain professional and personal development | * 1. Personal vs professional development and growth   2. Avenues for professional growth   3. Recognizing career advancement   4. Training and career opportunities      1. Assessing training needs      2. Mobilizing training resources   5. Licenses and certifications for professional growth and development   6. Pursuing personal and organizational goals   7. Managing work priorities and commitments   8. Dynamism and on-the-job learning | * Observation * Written assessment * Oral assessment * Third party reports * Portfolio of evidence * Project * Practical |
| 1. Apply Problem-solving skills | * 1. Causes of problems   2. Methods of solving problems   3. Problem-solving process   4. Decision making   5. Creative thinking and critical thinking process in development of innovative and practical solutions | * Observation * Written assessment * Oral assessment * Third party reports * Portfolio of evidence * Project * Practical |
| 1. Promote Customer Care | * 1. Identifying customer needs   2. Qualities of good customer service   3. Customer feedback methods   4. Resolving customer concerns   5. Customer outreach programs   6. Customer retention | * Observation * Written assessment * Oral assessment * Third party reports * Portfolio of evidence * Project * Practical |

**Suggested Methods of Instruction**

* Instructor lead facilitation of theory using active learning strategies.
* Demonstrations
* Simulation/Role play
* Group Discussion
* Presentations
* Projects
* Case studies
* Assignments

**Recommended Resources for 30 Trainees**

| **S/No.** | **Category/Item** | **Description/Specifications** | **Quantity** | **Recommended Ratio (Item: Trainee)** |
| --- | --- | --- | --- | --- |
| **A** | **Learning Materials** | | | |
|  | Textbooks | Comprehensive texts books on Work Ethics and Practices | 30 pcs | 1:1 |
|  | PowerPoint Presentations | For trainer’s use, covering course content and practical applications | 1 | 1:30 |
|  | Projector | Functional projector for displaying content during presentations | 1 | 1:30 |
|  | Media Resources | This include but are not limited to:   * Video Clips * Audio Clips * TV Sets * Radio Sets |  |  |
|  | White board | Quality whiteboard of approximately 6 ft by 3 ft for writing during theory instruction | 1 | 1:30 |
| **B** | **Learning Facilities & Infrastructure** | | | |
|  | Lecture/Theory Room  /Learning Resource  Area\* | Spacious, equipped with projectors and Seats for 30 trainees, approximately 45 sqm (5 m x 9 m) | 1 | 1:30 |
|  | Computer Laboratory | Equipped with at least 30 functional computers with internet connectivity and the following software:   * + - Windows/ Linux/ Macintosh Operating System     - Microsoft Office Software     - Google Workspace Account     - Antivirus Software | 30 | 1:1 |
|  |  |  |  |  |
| **C** | **Consumable Materials** | | | |
|  | Printing Papers | A4 and A3 Printing papers suitable for the task | Enough |  |
|  | Flashcards | For carrying out various activities by trainees | Enough |  |
|  | Charts | Sufficient for group work activities and displaying | Enough |  |
|  | Whiteboard Marker Pens | Dry-erase markers for trainers use. Assorted colors | Enough |  |

## METALLURGY

**Unit Code:** 0715 441 09A

**Unit Duration:** 80 Hours

**Relationship to Occupational Standards**

**This unit addresses the Unit of Competency:** Apply Metallurgy

**Unit Description**

This unit of learning covers the learning outcomes, content, assessment methods, methods of delivery and resources required to train metallurgy. The learning outcomes involve analyzing properties of engineering materials, using steel, aluminium, copper and its alloys, titanium and their alloys as well as performing metal testing.

**Summary of Learning Outcomes**

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

|  |  |  |
| --- | --- | --- |
| **S/NO** | **Learning Outcomes** | **Duration (Hours)** |
|  | Evaluate properties of engineering materials | 10 |
|  | Apply steel and its alloys | 20 |
|  | Apply aluminium and its alloys | 20 |
|  | Apply copper and its alloys | 10 |
|  | Apply titanium and its alloys | 10 |
|  | Perform metal testing | 10 |
| **Totals** | | **80** |

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

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1. Evaluate properties of engineering materials | * 1. Occupational health and safety standards      1. Workplace legislation and standards      2. Workplace hazard identification      3. Workshop waste management      4. Workshop safety         1. Regulations         2. Personal Protective Equipment      5. Workplace procedures         1. Roles and responsibilities         2. Documentation         3. Communication         4. Emergency procedures      6. Types of workplace hazards         1. Physical         2. Chemical         3. Biological         4. Environmental      7. Prevention and control   2. Metal properties      1. Physical         1. Color         2. Lustre         3. Opacity      2. Mechanical         1. Strength         2. Hardness         3. Ductility         4. Malleability         5. Toughness         6. Rigidity         7. Elasticity         8. Plasticity         9. Brittleness      3. Thermal         1. Melting point         2. Specific heat capacity         3. Linear expansivity   3. Forms of metal supply      1. Ingots      2. Bars      3. Plates      4. Pellets      5. Tubes      6. Pipes      7. Sheets      8. Strips      9. Wires   4. Applications of forms of supply   5. Mill Test Certificates      1. Interpretation      2. Usage   6. Types of metals      1. Ferrous         1. Steel         2. Cast Iron      2. Non ferrous         1. Aluminium         2. Copper         3. Titanium | * Written tests * Practical * Projects * Portfolio of Evidence |
| 1. Apply steel and its alloys | * 1. Steels up to 16 mm thickness      1. Low carbon steels      2. Medium carbon steels      3. High carbon steels      4. Mild steel   2. Properties and applications of steel   3. Steel alloys up to 16 mm thickness      1. Carbon steel alloys (series 10xx, 11xx, 12xx)      2. Alloy steel alloys (series 13xx, 14xx, 15xx, 16xx, 17xx)      3. Stainless steel alloys (series 2xxx, 3xxx, 4xxx, 5xxx, 6xxx, 7xxx)      4. Tool steel alloys (series T, O, W)   4. Properties and applications of alloy steels | * Written tests * Practical * Projects * Portfolio of Evidence |
| 1. Apply aluminium and its alloys | * 1. Aluminium and aluminium alloys up to 16 mm thickness      1. 1000 series (Pure aluminium)      2. 2000 series (Cooper alloy)      3. 3000 series (Manganese alloys)      4. 4000 series (Silicon alloys)      5. 5000 series (Magnesium alloys)      6. 6000 series (Magnesium and silicon alloys)      7. 7000 series (Zinc alloys)      8. 8000 series (Lithium alloys)   2. Properties and applications of aluminium and its alloys | * Written tests * Practical * Projects * Portfolio of Evidence |
| 1. Apply copper and its alloys | * 1. Copper and copper alloys up to 16 mm thickness      1. Copper-Alloy Series (C1xxx - Pure Copper)      2. Brass Alloys (C2xxx - Copper-Zinc Alloys)      3. Bronze Alloys (C6xxx - Copper-Tin Alloys)      4. Copper-Nickel Alloys (C7xxx - Copper-Nickel Alloys)      5. Aluminium Bronze Alloys (C8xxx - Copper-Aluminium Alloys)      6. Copper-Silver Alloys (C1xxx - Copper-Silver Alloys)      7. Beryllium Copper Alloys (C17200 - Copper-Beryllium Alloys)   2. Properties and applications of copper and its alloys | * Written tests * Practical * Projects * Portfolio of Evidence |
| 1. Apply titanium and its alloys | * 1. Titanium and titanium alloys up to 16 mm thickness      1. Unalloyed Titanium      2. Alpha Alloys (α)      3. Beta Alloys (β)      4. Alpha-Beta Alloys (α-β)      5. Titanium Alloys by UNS (Unified Numbering System)   2. Properties and applications of titanium and its alloys | * Written tests * Practical * Projects * Portfolio of Evidence |
| 1. Perform metal testing | * 1. Metal inspection machines, tools and equipment      1. Tools         1. Pneumatic tools         2. Gauges         3. Electromagnets      2. Use and care of tools      3. Machines         1. Universal testing machine         2. Ultrasonic testing machine         3. Radiography      4. Use and care of machines   2. Consumables      1. Films      2. Ferromagnetic Materials      3. Dyes   3. Non-destructive metal test parameters      1. Flaws      2. Pinholes      3. Penetration      4. Undercut   4. Weld Preparation procedure      1. Polishing      2. Grinding      3. Cleaning      4. Cutting   5. Non-destructive metal test      1. Visual inspection      2. Ultrasonic inspection      3. Magnetic particle induction      4. Radiography inspection      5. Dye penetrant      6. Eddy current testing   6. Applications and procedure of NDT   7. Destructive metal test parameters      1. Tensile strength      2. Yield strength      3. Hardness      4. Impact resistance   8. Destructive metal test      1. Tensile testing      2. Hardness testing      3. Impact test (Charpy and Izod)      4. Fatigue test      5. Creep test      6. Torsion test      7. Bend test      8. Fracture toughness test      9. Corrosion test Maintenance      10. Applications and procedure of DT   9. Maintenance      1. Lubrications      2. Belt adjustments      3. Scheduling      4. Record keeping | * Written tests * Practical * Projects * Portfolio of Evidence |

**Suggested Delivery Methods**

* Demonstration
* Group discussions
* Exercises
* Online materials
* Direct instructions
* Simulation

**List of Recommended Resources**

**Recommended Resources for 30 trainees**

| **S/No.** | **Category/Item** | **Description/Specifications** | **Quantity** | **Recommended Ratio (Item: Trainee)** |
| --- | --- | --- | --- | --- |
| **A** | **Learning Materials** | | | |
|  | Textbooks | Textbooks on Materials Testing | 30 | 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 | 1:30 |
|  | Computer | Functional desktop computer with online instructional content | 1 | 1:30 |
|  | White board | Quality whiteboard of approximately 6 ft by 3 ft for writing during theory instruction | 1 | 1:30 |
|  | Printer | An ink-jet, laser-jet or toner-cartridge printer for printing notes, instructions and working drawings | 1 | 1:30 |
| **B** | **Learning Facilities & Infrastructure** | | | |
|  | Lecture/Theory Room | Spacious room with seats for 25 trainees, approximately 60 sqm | 1 | 1:30 |
|  | Workshop | Standard workshop with bench/fitting area and welding booths approximately 80 sqm | 1 | 1:30 |
| **C** | **Materials and Supplies** | | | |
|  | Dust coat/ overall | Shields skin and regular clothes from sparks | 30 | 1: |
|  | Gloves | Shields hands from sharp edges, heat, and chemical exposure | 30 | 1:1 |
|  | Safety boots | Protects feet from heavy objects, sharp materials, and impact. | 30 | 1:1 |
|  | Ear muffs/ ear plugs | Shields against prolonged exposure to high noise levels from machinery | 30 | 1:1 |
|  | Safety goggles | Protects eyes from flying metal particles, sparks, and dust | 30 | 1:1 |
|  | Raw materials | Steel, aluminum, copper and titanium  Plates   * 4mm thickness. * 6 mm thickness. * 9 mm thickness. * 12 mm thickness. * 16 mm thickness   Pipes   * 4 mm thickness * 6 mm thickness * 9 mm thickness * 12 mm thickness * 16 mm thickness   Sheets   * Below 4mm thickness |  |  |
|  | Liquid dyes and developers | For liquid penetrant test | Enough |  |
|  | First Aid kit | Fully equipped First Aid kit for use in case of accidents | 1 | 1:30 |
|  | Brooms and cleaning stuff | Hand brooms and mops for cleaning | 10 | 1:3 |
|  | 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 |
| **D** | **Tools and Equipment** | | | |
| **Measuring tools** | | | | |
|  | Steel rules | Calibrated steel rules for linear measurements | 20 | 2:3 |
|  | Vernier calipers | Calibrated vernier calipers for linear measurements | 20 | 2:3 |
|  | Tri squares | Properly aligned steel Tri-square for checking perpendicular edges | 6 | 1:5 |
|  | Vernier height gauge and surface plates | Calibrated vernier height gauges and surface plates for measurement of heights | 6 | 1:5 |
|  | Measuring tapes | Calibrated measuring tapes for linear measurements | 20 | 2:3 |
|  | Angle gauges | Calibrated steel rules for linear measurements | 6 | 1:5 |
| **Marking out tools** | | | | |
|  | Scribers | Quality steel pencil scribers for marking out lines on metal surfaces | 20 | 2:3 |
|  | Dot punches | Quality steel dot punches for marking out centres | 20 | 2:3 |
|  | Calipers | Quality steel calipers for marking out arcs on metal surfaces | 6 | 1:5 |
| **Cutting Tools** | | | | |
|  | Assorted hand files | Flat and round hand files for material preparation and finishing | 20 | 2:3 |
|  | Hacksaws | Hack saws with functional frames and blades for cutting metal plates and pipes | 20 | 2:3 |
|  | Tinsnips | Functional hand tinsnips for cutting metal sheets | 10 | 1:3 |
|  | 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 | 6 | 1:5 |
|  | Bench vices | Functional bench vices/clamps for holding work pieces during bench work | 20 | 2:3 |
|  | Tongs | Functional pairs of tongs for holding hot pieces of metal during welding | 10 | 1:3 |
| **Finishing tools** | | | | |
|  | Wire brushes | To clean metal surfaces | 20 | 2:3 |
|  | File cards | Cleaning tool used to maintain files | 6 | 1:5 |
| **E** | **Machines and Equipment** | | | |
|  | Universal testing machine | Functional machine for carrying out hardness test, tensile test, torsion test | 1 | 1:30 |
|  | Bend test machine | Functional machine for carrying out bend test | 1 | 1:30 |
|  | Ultrasonic testing machine | Functional machine for carrying out ultrasonic test | 1 | 1:30 |
|  | Hardness testing machine | Functional machine for carrying out hardness test | 1 | 1:30 |
|  | X-ray machine | Functional machine for carrying out X-ray test | 1 | 1:30 |
|  | 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 | 1:30 |
|  | Bending machine | used to bend metal sheets or bars into angles and specific shapes. | 1 | 1:30 |
|  | Bench shears |  | 6 | 1:5 |
| **F** | **Reference Materials** | | | |
|  | Operation sheets | Operation sheets describing the procedures to be followed in carrying out testing | 30 | 1:1 |
|  | Training Presentations/Slides | Digital format for shared access among trainees | 1 | 1:30 |
|  | Practical Assessment Guides | Worksheets for practical assessments | 30 | 1:1 |

## MATHEMATICS

**Unit Code:** 0541 441 05A

**Relationship with Occupational Standards**

**This unit addresses the Unit of Competency:** Apply Mathematics

**Unit Duration:** 80 Hours

**Unit Description**

This unit of learning covers the learning outcomes, content, assessment methods, methods of delivery and resources required to train mathematics. The learning outcomes involve those required in order to apply algebra, trigonometric functions, coordinate geometry, statistics, vector theorem, matrices and to carry out mensuration.

**Summary of Learning Outcomes**

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

|  |  |  |
| --- | --- | --- |
| **S/No.** | **Learning Outcomes** | **Duration (Hours)** |
|  | Apply algebra | 20 |
|  | Apply trigonometric functions | 20 |
|  | Carry out mensuration | 20 |
|  | Apply statistics and probability | 20 |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| * + - 1. Apply algebra | * 1. Indices      1. Power zero      2. Negative powers      3. Fractional powers      4. Laws of indices         1. Addition         2. Subtraction         3. Division         4. Multiplication   2. BODMAS   3. Roots      1. Square roots      2. Cube roots      3. nth roots   4. Logarithms      1. Laws of Logarithms         1. Product Law         2. Quotient Law         3. Power Law   5. Use of scientific calculator      1. Power ON/OFF      2. Mode         1. Degree         2. Radian         3. Gradient         4. SD      3. Clear      4. Save      5. Shift   6. Simultaneous equations   (up to 3 equations)   * + 1. Elimination     2. Substitution     3. Reduction     4. Graphical   1. Quadratic equations      1. Factorization      2. Quadratic formula      3. Completing the square      4. Graphical | * Written tests |
| * + - 1. Apply trigonometric functions | * 1. Angles      1. Acute      2. Obtuse      3. Reflex      4. Right angle   2. Triangles      1. Isosceles      2. Equilateral      3. Right angled      4. Scalene   3. Trigonometric Ratios      1. Sine      2. Cosine      3. Tangent      4. Cosecant      5. Secant      6. Cotangent   4. Trigonometric Identities      1. Proof of identities      2. Pythagorean identities   5. Solve trigonometric equations   6. Hyperbolic functions      1. Sinh x      2. Cosh x      3. Cosech x      4. Tanh x      5. Sech x | * Written tests |
| * + - 1. Carry out mensuration | * 1. Units and symbols of measurement      1. Mass      2. Distance      3. Speed      4. Temperature      5. Time   2. Imperial and metric units      1. Conversions   3. Perimeter      1. Regular shapes   4. Area      1. Regular shapes   5. Volume      1. Regular shapes | * Written tests |
| * + - 1. Apply statistics and probability | * 1. Data presentation      1. Continuous variables         1. Histogram         2. Line      2. Discrete variable         1. Bar graph         2. Pie graph      3. Grouped data         1. Histogram         2. Bar         3. Cumulative frequency         4. ogive      4. Ungrouped data         1. Line         2. Cumulative frequency   2. Measures of central tendency      1. Mean         1. Grouped data         2. Ungrouped data      2. Mode         1. Grouped data         2. Ungrouped data      3. Medium         1. Grouped data         2. Ungrouped data   3. Measures of dispersion      1. Standard deviation         1. Grouped data         2. Ungrouped data      2. Variance         1. Grouped data         2. Ungrouped data   4. Probability      1. With replacement      2. Without replacement   5. Probability distribution functions      1. Binomial distribution      2. Poisson distribution   6. Normal distribution | * Written tests |

* Demonstration
* Group discussions
* Exercises
* Online materials
* Direct instructions
* Simulation

**Recommended Resources for 30 trainees**

| **S/No.** | **Category/Item** | **Description/Specifications** | **Quantity** | **Recommended Ratio (Item: Trainee)** |
| --- | --- | --- | --- | --- |
| **A** | **Learning Materials** | | | |
|  | Textbooks | Comprehensive textbooks on Engineering Mathematics | 30 | 1:1 |
|  | Graph books | For graphical representation of solutions | 30 | 1:1 |
|  | Projector | Functional projector for displaying content during presentations | 1 | 1:30 |
|  | Computer | Functional desktop computer with online instructional content | 1 | 1:30 |
|  | White board | Quality whiteboard of approximately 6 ft by 3 ft for writing during theory instruction | 1 | 1:30 |
|  | Printer | An ink-jet, laser-jet or toner-cartridge printer for printing notes, instructions and working drawings | 1 | 1:30 |
| **B** | **Learning Facilities & Infrastructure** | | | |
|  | Lecture/Theory Room | Spacious room with seats for 25 trainees, approximately 60 sqm | 1 | 1:30 |
| **C** | **Materials and Supplies** | | | |
|  | First Aid kit | Fully equipped First Aid kit for use in case of accidents | 1 | 1:30 |
| **D** | **Tools and Equipment** | | | |
|  | Set of Mathematical instruments | For constructions and measurements | 30 | 1:1 |
|  | Scientific Calculator | For Calculations | 30 | 1:1 |
|  | Firefighting extinguishers | Water, carbon dioxide and chemical powder fire extinguishers for fire fighting | 1 | 1:30 |
| **E** | **Reference Materials** | | | |
|  | Training Presentations/Slides | Digital format for shared access among trainees | 1 | 1:30 |
|  | Standard Mathematical Tables | For reference on formulae, identities, laws and principles | 30 | 1:1 |

## ARC WELDING PROCESSES II

**Unit Code:** 0715 451 16A

**Unit Duration:** 120 Hours

**Relationship to Occupational Standards**

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

**Unit Description**

This unit of learning covers the learning outcomes, content, assessment methods, methods of delivery and resources required to train MMAW operations. The learning outcomes involve carrying out manual metal arc welding, gouging and maintaining 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)** |
| 1. | Carry out manual metal arc welding (MMAW) | 50 |
| 2. | Carry out gouging | 50 |
| 3. | Maintain welding machines, tools and equipment | 20 |
| **Totals** | | **150** |

**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. Workplace legislation and standards      2. Risk Assessment      3. Workshop Incident/Accident         1. Nature         2. Causes         3. Prevention         4. Report      4. Workplace ergonomics and work design      5. Workplace environmental safety         1. Impact of waste and by-products         2. Workshop waste management            1. Housekeeping activities            2. Sorting            3. Disposal      6. Workshop safety         1. Layout      7. Workplace procedures         1. Compliance         2. Documentation         3. Communication         4. Emergency procedures   2. Working drawing interpretation      1. Dimensions      2. Tolerances      3. Symbols and notations   3. Manual Metal Arc Welding (MMAW) machines/equipment, tools and materials      1. Machines         1. AC machine         2. DC machine         3. AC/DC machine         4. Diesel generators      2. Tools         + 1. Driers           2. Welding screens           3. Fire extinguishers           4. Welding jigs and fixtures      3. Materials         1. Electrodes            1. Types            2. Coding            3. Applications         2. Plates         3. Pipes         4. Tubes      4. Uses      5. Care and storage   4. MMAW parameters      1. Current      2. Arc length      3. Arc force      4. Polarity   5. Metals up to 16 mm thickness      1. Plates         1. Steel         2. Copper         3. Aluminium      2. Pipes         1. Steel         2. Copper         3. Aluminium   6. MMAW material preparation   (up to 16 mm thickness)   * + 1. Measuring     2. Marking out     3. Cutting     4. Edge preparation   1. Welding positions      1. Types         1. Flat         2. Horizontal         3. Vertical         4. Overhead   2. Welded joints      1. Types   3. Weld defects      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. Types         1. Buffing         2. Polishing         3. Grinding         4. Varnishing         5. Painting      2. Procedure and applications   **Practice**   * Arc weld metal plates and pipes of 9-16 mm thickness in: * Flat position * Horizontal position * Vertical position * Overhead position | * Practical test * Project work * Portfolio of evidence * Written tests |
| 2. Carry out gouging | * 1. Gouging parameters      1. Setting parameters         1. Current         2. Arc force   2. Electrodes      1. Graphite electrode selection   3. Gouging procedure   (up to 16 mm thickness)  **Practice**   * Arc cut steel, aluminium, copper and titanium plates and pipes of 9-16 mm thickness in: * Flat position * Horizontal position * Vertical position * Overhead position | * Written tests * Practical test * Project work * Portfolio of evidence |
| 3. Maintain welding machines, tools and equipment | * 1. Repair of welding tools parts      1. Handles      2. Heads      3. Jaws      4. Blades      5. Discs and wheels   3.2 Preventive maintenance of welding machines and equipment   * + 1. Cleaning external surfaces of machine     2. Inspecting cables, connectors and power sources     3. Lubricating moving parts   1. Preventive maintenance report      1. Report preparation      2. Uses      3. Storage   **Practice**   * Clean external surfaces of machine * Inspect cables, connectors and power sources * Lubricate moving parts * Report writing. | * Written tests * Practical test * Project work * Portfolio of evidence |

**Suggested Delivery Methods**

* Demonstration
* Group discussions
* Practical work
* Exercises
* Direct instructions
* Industrial visits/Excursion
* 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** | | | |
|  | 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, aluminum, copper and titanium  Plates   * 4mm thickness. * 6 mm thickness. * 9 mm thickness. * 12 mm thickness. * 16 mm thickness   Pipes   * 4 mm thickness * 6 mm thickness * 9 mm thickness * 12 mm thickness * 16 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 pcs | 1:1 |

## FABRICATION PROCESSES II

**Unit Code:** 0715 451 17A

**Unit Duration:** 120Hours

**Relationship to Occupational Standards**

**This unit addresses the Unit of Competency:** Carry out Fabrication Processes II

**Unit Description**

This unit of learning covers the learning outcomes, content, assessment methods, methods of delivery and resources required to train fabrication processes. The learning outcomes involve carrying out bench work, sheet metal work 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)** |
| 1. | Carry out bench work | 50 |
| 2. | Carry out sheet metal work | 50 |
| 3. | Maintain fabrication tools, machines and equipment | 20 |
| **Totals** | | **120** |

**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. Workshop legislation and standards      2. Risk Assessment      3. Workshop Incident/Accident reporting      4. Workshop ergonomics and work design      5. Workshop safety         1. Layout      6. Workplace procedures         1. Compliance         2. Documentation         3. Communication         4. Emergency procedures   2. Fabrication drawing interpretation      1. Tolerances      2. Symbols and notations   3. Material preparation   (metals up to16 mm thickness)   * + 1. Measuring     2. Marking out     3. Cutting     4. Edge preparation   1. Benchwork operations on metals (0.1-12 mm thickness)      1. Types         1. Filing         2. Grinding         3. Drilling Operations            1. Counter boring            2. Counter sinking            3. Spot facing            4. Reaming         4. Hand threading procedure            1. External threads            2. Internal threads   2. Fitting and assembly of metal parts up to 16 mm thickness      1. Types and applications of fasteners         1. Bolts         2. Flanges         3. Straps         4. Hooks         5. Turnbuckles         6. Slings         7. Chains         8. Screws         9. Nuts         10. Riveting             1. Methods             2. Types             3. Joints             4. Tools   1.7 Joint functionality and quality  1.8 Securing components using adhesives, welds, and press-fits.  **Practice**   * Filing of metal plates and pipes   + 9 mm thickness   + 12 mm thickness   + 16 mm thickness * Grinding of metal plates and pipes   + 9 mm thickness   + 12 mm thickness   + 16 mm thickness * Drilling of metal pates   + 9 mm thickness   + 12 mm thickness   + 16 mm thickness * Reaming and tapping of metal pates   + 9 mm thickness   + 12 mm thickness   + 16 mm thickness * Cutting of metal plates and pipes   + 9 mm thickness   + 12 mm thickness   + 16 mm thickness * Riveting of metal sheets * Fabricate metallic frames, doors and windows | * Practical test * Project work * Portfolio of evidence * Written tests |
| 1. Carry out sheet metal work | * 1. Pattern development      1. Methods         1. Parallel line method         2. Triangulation         3. Radial line      2. Procedure and applications   2. Sheet metal products      1. Types         1. Tanks         2. Gutters         3. Cabinets and boxes         4. Drums         5. Tables and desks         6. Guardings/enclosures         7. Troughs      2. Development and applications   **Practice**   * Develop the following sheet metal products: * Tanks * Gutters * Cabinets and boxes * Drums * Tables and desks * Guardings/enclosures * Troughs | * Practical test * Project work * Portfolio of evidence * Written tests |
| 1. Maintain fabrication tools, machines and equipment | * 1. Fabrication tools repair      1. Handles      2. Heads      3. Jaws      4. Blades      5. Discs and wheels   3.2 Preventive maintenance of welding fabrication tools, machines and equipment   * + 1. Cleaning of the external surfaces of the machine     2. Inspecting cables, connectors and power sources     3. Lubricating of moving parts   1. Preventive maintenance report   **Practice**   * Clean external surfaces of machine * Inspect cables, connectors and power sources * Lubricate moving parts * Report writing | * Practical test * Project work * Portfolio of evidence * Written tests |

**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 Fabrication Processes | 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** | | | |
|  | 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, aluminum, copper and titanium  Plates   * 4mm thickness. * 6 mm thickness. * 9 mm thickness. * 12 mm thickness. * 16 mm thickness   Pipes   * 4 mm thickness * 6 mm thickness * 9 mm thickness * 12 mm thickness * 16 mm thickness   Sheets   * Below 4mm 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 |
| **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 | 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 |

# MODULE IV

|  |  |  |  |
| --- | --- | --- | --- |
| **Unit Code** | **Unit Title** | **Unit Duration (Hours)** | **Credit**  **Factor** |
| 0611 441 01A | Digital Literacy | 40 | 4 |
| 0413 441 04A | Entrepreneurial Skills | 40 | 4 |
| 0732 441 06A | Apply Technical Drawings | 80 | 8 |
| 0715 441 07A | Mechanical Science | 80 | 8 |
| 0713 441 08A | Electical & Electronics Principles | 80 | 8 |
| 0715 451 17A | Gas Metal Arc Welding Operations | 120 | 12 |
|  | **Total** | **480** | **48** |

## DIGITAL LITERACY

**UNIT CODE:** 0611 441 01A

**Relationship with Occupational Standards**

**This unit addresses the Unit of Competency:** Apply Digital Literacy

**Duration of Unit:** 40 Hours

**Unit Description**

This unit of learning covers the learning outcomes, content, assessment methods, methods of delivery and resources required to train digital literacy. The learning outcomes involve operating computer devices, solving tasks using the Office suite, managing data and information, performing online communication and collaboration, applying cybersecurity skills and job entry techniques, and performing jobs online.

**Summary of Learning Outcomes**

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

|  |  |  |
| --- | --- | --- |
| **S/No.** | **Learning Outcomes** | **Duration (Hours)** |
|  | Operate Computer Devices | 6 |
|  | Solve Tasks Using Office Suite | 14 |
|  | Manage Data and Information | 6 |
|  | Perform Online Communication and Collaborations | 4 |
|  | Apply Cybersecurity Skills | 4 |
|  | Perform Online Jobs | 4 |
|  | Apply job entry techniques. | 2 |
| **Totals** | | **40** |

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

| **Learning Outcome** | **Content** | **Suggested**  **Assessment Methods** |
| --- | --- | --- |
| 1. Operate computer devices | * 1. Meaning and importance of digital literacy   2. Functions and Uses of Computers   3. Classification of computers   4. Components of a computer system   5. Computer Hardware      1. The System Unit E.g. Motherboard, CPU, casing      2. Input Devices e.g. Pointing, keying, scanning, voice/speech recognition, direct data capture devices.      3. Output Devices e.g. hardcopy output and softcopy output      4. Storage Devices e.g. main memory e.g. RAM, secondary storage (Solid state devices, Hard Drives, CDs & DVDs, Memory cards, Flash drives      5. Computer Ports e.g. HDMI, DVI, VGA, USB type C etc.   6. Classification of computer software   7. Operating system functions   8. Procedure for turning/off a computer   9. Mouse use techniques   10. Keyboard Parts and Use Techniques   11. Desktop Customization   12. File and Files Management using an operating system   13. Computer Internet Connection Options       1. Mobile Networks/Data Plans       2. Wireless Hotspots       3. Cabled (Ethernet/Fiber)       4. Dial-Up       5. Satellite   14. Computer external devices management       1. Device connections       2. Device controls (volume controls and display properties) | * Observation * Written assessment * Oral assessment * Practical assessment |
| 1. Solve tasks using Office suite | * 1. Meaning and Importance of Word Processing   2. Examples of Word Processors   3. Working with word documents      1. Open and close word processor      2. Create a new document      3. Save a document      4. Switch between open documents   4. Enhancing productivity      1. Set basic options/preferences      2. Help resources      3. Use magnification/zoom tools      4. Display, hide built-in tool bar      5. Using navigation tools   5. Typing Text   6. Document editing (copy, cut, paste commands, spelling and Grammar check)   7. Document formatting      1. Formatting text      2. Formatting paragraph      3. Formatting styles      4. Alignment      5. Creating tables      6. Formatting tables   8. Graphical objects      1. Insert object (picture, drawn object)      2. Select an object      3. Edit an object      4. Format an object   9. Document Print setup      1. Page layout,      2. Margins set up      3. Orientation.   10. Word Document Printing   11. Meaning & Importance of electronic spreadsheets   12. Components of Spreadsheets   13. Application areas of spreadsheets   14. Using spreadsheet application       1. Parts of Excel screen: ribbon, formula bar, active cell, name box, column letter,row number, Quick Access Toolbar.       2. Cell Data Types       3. Block operations       4. Arithmetic operators (formula bar (-, +, \*, /).       5. Cell Referencing   15. Data Manipulation       1. Using Functions (Sum, Average, SumIF, Count, Max, Max, IF, Rank, Product, mode etc)       2. Using Formulae       3. Sorting data       4. Filtering data       5. Visual representation using charts   16. Worksheet printing   17. Electronic Presentations   18. Meaning and Importance of electronic presentations   19. Examples of Presentation Software   20. Using the electronic presentation application       1. Parts of the PowerPoint screen (slide navigation pane, slide pane, notes, the ribbon, quick access toolbar, and scroll bars).       2. Open and close presentations       3. Creating Slides (Insert new slides, duplicate, or reuse slides.)       4. Text Management (insert, delete, copy, cut and paste, drag and drop, format, and use spell check).       5. Use magnification/zoom tools       6. Apply or change a theme.       7. Save a presentations       8. Switch between open presentations   21. Developing a presentation       1. Presentation views       2. Slides       3. Master slide   22. Text       1. Editing text       2. Formatting       3. Tables   23. Charts       1. Using charts       2. Organization charts   24. Graphical objects       1. Insert, manipulate       2. Drawings   25. Prepare outputs       1. Applying slide effects and transitions       2. Check and deliver          1. Spell check a presentation          2. Slide orientation          3. Slide shows, navigation   26. Print presentations (slides and handouts) | * Observation * Portfolio of Evidence * Project * Written assessment * Practical assessment * Oral assessment |
| 1. Manage Data and Information | * 1. Meaning of Data and information   2. Importance and Uses of data and information   3. Types of internet services      1. Communication Services      2. Information Retrieval Services      3. File Transfer      4. World Wide Web Services      5. Web Services      6. Automatic Network Address Configuration      7. News Group      8. Ecommerce   4. Types of Internet Access Applications   5. Web browsing concepts      1. Key concepts      2. Security and safety   6. Web browsing      1. Using the web browser      2. Tools and settings      3. Clearing Cache and cookies      4. URIs      5. Bookmarks      6. Web outputs   7. Web based information      1. Search      2. Critical evaluation of information      3. Copyright, data protection   8. Downloads Management   9. Performing Digital Data Backup (Online and Offline)   10. Emerging issues in internet | * Observation * Portfolio of Evidence * Project * Written assessment * Practical assessment * Oral assessment |
| 1. Perform online communication and collaboration | * 1. Netiquette principles   2. Communication concepts      1. Online communities      2. Communication tools      3. Email concepts   3. Using email      1. Sending email      2. Receiving email      3. Tools and settings      4. Organizing email   4. Digital content copyright and licenses   5. Online collaboration tools      1. Online Storage (Google Drive)      2. Online productivity applications (Google Docs & Forms)      3. Online meetings (Google Meet/Zoom)      4. Online learning environments      5. Online calendars (Google Calendars)      6. Social networks (Facebook/Twitter - Settings & Privacy)   6. Preparation for online collaboration      1. Common setup features      2. Setup   7. Mobile collaboration      1. Key concepts      2. Using mobile devices      3. Applications      4. Synchronization | * Observation * Portfolio of Evidence * Project * Written assessment * Practical assessment * Oral assessment |
| 1. Apply cybersecurity skills | * 1. Data protection and privacy      1. Confidentiality of data/information      2. Integrity of data/information      3. Availability of data/information   2. Internet security threats      1. Malware attacks      2. Social engineering attacks      3. Distributed denial of service (DDoS)      4. Man-in-the-middle attack (MitM)      5. Password attacks      6. IoT Attacks      7. [Phishing Attacks](https://onlinedegrees.sandiego.edu/top-cyber-security-threats/#phishing-attacks)      8. [Ransomware](https://onlinedegrees.sandiego.edu/top-cyber-security-threats/#ransomware)   3. Computer threats and crimes   4. Cybersecurity control measures      1. Physical Controls      2. Technical/Logical Controls (Passwords,PINs, Biometrics)      3. Operational Controls   5. Laws governing protection of ICT in Kenya      1. The Computer Misuse and Cybercrimes Act No. 5 of 2018      2. The Data Protection Act No. 24 of 2019 | * Observation * Portfolio of Evidence * Project * Written assessment * Practical assessment * Oral assessment |
| 1. Perform Online Jobs | * 1. Introduction to online working   2. Types of online Jobs   3. Online job platforms      1. Remotask      2. Data annotation tech      3. Cloud worker      4. Upwork      5. Oneforma      6. Appen   4. Online account and profile management   5. Identifying online jobs/job bidding   6. Online digital identity   7. Executing online tasks   8. Management of online payment accounts. | * Observation * Portfolio of Evidence * Project * Written assessment * Practical assessment * Oral assessment |
| 1. Apply job entry techniques | * 1. Types of job opportunities      1. Self-employment      2. Service provision      3. product development      4. salaried employment         1. Sources of job opportunities   2. Resume/ curriculum vitae      1. What is a CV      2. How long should a CV be      3. What to include in a CV      4. Format of CV      5. How to write a good CV      6. Don’ts of writing a CV   3. Job application letter      1. What to include      2. Addressing a cover letter      3. Signing off a cover letter   4. Portfolio of Evidence      1. Academic credentials      2. Letters of commendations      3. Certification of participations      4. Awards and decorations   5. Interview skills      1. Listening skills      2. Grooming      3. Language command      4. Articulation of issues      5. Body language      6. Time management      7. Honesty   6. Generally knowledgeable in current affairs and technical area | * + Observation   + Oral assessment   + Portfolio of evidence   + Third party report * Written assessment |

**Suggested Methods of Instruction**

* + Instructor-led facilitation using active learning strategies
  + Demonstration by trainer
  + Practical work by trainees
  + Viewing of related videos
  + Group discussions
  + Project
  + Role play
  + Case study

**Recommended Resources for 30 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/Specifications** | **Quantity** | **Recommended Ratio (Item: Trainee)** |
| **A** | **Learning Materials** | | | |
|  | Textbooks | Comprehensive texts books on Digital Literacy | 30 pcs | 1:1 |
|  | Installation Manuals | Detailed guides for equipment and software installation and troubleshooting | 5 pcs | 1:5 |
|  | PowerPoint Presentations | For trainer’s use, covering course content and practical applications | 1 | 1:30 |
|  | Projector | Functional projector for displaying content during presentations | 1 | 1:30 |
|  | White board | Quality whiteboard of approximately 6 ft by 3 ft for writing during theory instruction | 1 | 1:30 |
|  | Printer | An ink-jet, laser-jet or toner-cartridge printer for printing notes, instructions and working drawings | 1 | 1:30 |
|  | Templates | Templates for creating various documents e.g. CV, Cover Letter, etc. | 30 | 1:1 |
| **B** | **Learning Facilities & Infrastructure** | | | |
|  | Lecture/Theory Room  /Learning Resource  Area\* | Spacious, equipped with projectors and Seats for 30 trainees, approximately 45 sqm (5 m x 9 m) | 1 | 1:30 |
|  | Computer Laboratory | Equipped with at least 30 functional computers with internet connectivity and the following software:   * + - Windows/ Linux/ Macintosh Operating System     - Microsoft Office Software     - Google Workspace Account     - Antivirus Software | 30 | 1:1 |
|  |  |  |  |  |
| **C** | **Consumable Materials** | | | |
|  | Printing Papers | A4 and A3 Printing papers suitable for the task | Enough |  |
|  | Whiteboard Marker Pens | Dry-erase markers for trainers use. Assorted colors | Enough |  |
|  | Storage devices | Any of the following storage devices:   * USB Flash Drive * USB Hard Drive * Compact Disks (CDs) * Digital Versatile Disks (DVDs) | Enough |  |

**ENTREPRENEURIAL SKILLS**

**UNIT CODE:** 0413 441 04A

**Relationship with occupational standards**

**This unit addresses the unit of competency:** Apply Entrepreneurial Skills.

**Duration of unit:** 40 Hours

**Unit Description:**

This unit of learning covers the learning outcomes, content, assessment methods, methods of delivery and resources required to train entrepreneurial skills. The learning outcomes involve demonstrating an understanding of financial literacy, applying entrepreneurial concepts identifying entrepreneurship opportunities, applying business legal aspects, and developing business innovative strategies and business plans.

**Summary of Learning Outcomes**

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

|  |  |  |
| --- | --- | --- |
| **S/NO** | **Learning Outcomes** | **Duration (Hours)** |
| 1. | Apply financial literacy | 6 |
| 2. | Apply the entrepreneurial concept | 4 |
| 3. | Identify entrepreneurship opportunities | 6 |
| 4. | Apply business legal aspects | 6 |
| 5. | Innovate Business Strategies | 6 |
| 6. | Develop business plan | 12 |
| **Totals** | | **40** |

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

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1. Apply financial literacy | * 1. Personal finance management   2. Balancing between needs and wants   3. Budget Preparation   4. Saving management   5. Factors to consider when deciding where to save   6. Debt management   7. Factors to consider before taking a loan   8. Investment decisions   9. Types of investments   10. Factors to consider when investing money   11. Insurance services   12. insurance products available in the market   13. Insurable risks | * Observation * Project * Written assessment * Oral assessment * Third party report * Interviews |
| 1. Apply entrepreneurial concept | * 1. Difference between Entrepreneurs and Business persons   2. Types of entrepreneurs   3. Ways of becoming an entrepreneur   4. Characteristics of Entrepreneurs   5. salaried employment and self-employment   6. Requirements for entry into self-employment   7. Roles of an Entrepreneur in an enterprise   8. Contributions of Entrepreneurship | * Observation * Project * Written assessment * Oral assessment * Third party report |
| 1. Identify entrepreneurship opportunities | * 1. Sources of business ideas   2. Factors to consider when evaluating business opportunity   3. Business life cycle | * Observation * Project * Written assessment * Oral assessment * Third party report |
| 1. Apply business legal aspects | * 1. Forms of business ownership   2. Business registration and licensing processing   3. Types of contracts and agreements   4. Employment laws   5. Taxation laws | * Observation * Project * Written assessment * Oral assessment * Third party report |
| 1. Innovate business Strategies | * 1. Creativity in business   2. Innovative business strategies   3. Entrepreneurial Linkages   4. ICT in business growth and development | * Observation * Project * Written assessment * Oral assessment * Third party report |
| 1. Develop Business Plan | * 1. Business description   2. Marketing plan   3. Organizational/Management   4. plan   5. Production/operation plan   6. Financial plan   7. Executive summary   8. Business plan presentation   9. Business idea incubation | * Observation * Written assessment * Project * Oral assessment * Third party report |

**Suggested Methods of Instruction**

* Direct instruction with active learning strategies
* Project (Business plan)
* Case studies
* Field trips
* Group Discussions
* Demonstration
* Question and answer
* Problem solving
* Experiential
* Team training
* Guest speakers

**Recommended Resources for 30 Trainees**

| **S/No.** | **Category/Item** | **Description/Specifications** | **Quantity** | **Recommended Ratio (Item: Trainee)** |
| --- | --- | --- | --- | --- |
| **A** | **Learning Materials** | | | |
|  | Textbooks | Comprehensive texts books on Entrepreneurial Skills | 30 pcs | 1:1 |
|  | PowerPoint Presentations | For trainer’s use, covering course content and practical applications | 1 | 1:30 |
|  | Projector | Functional projector for displaying content during presentations | 1 | 1:30 |
|  | Media Resources | These include but are not limited to:   * Video Clips * Audio Clips * TV Sets * Radio Sets * Newspapers * Business Journals * Case studies |  |  |
|  | Templates | Templates for creating various documents e.g. business plan, invoices etc. | 30 | 1:1 |
|  | White board | Quality whiteboard of approximately 6 ft by 3 ft for writing during theory instruction | 1 | 1:30 |
| **B** | **Learning Facilities & Infrastructure** | | | |
|  | Lecture/Theory Room  /Learning Resource  Area\* | Spacious, equipped with projectors and Seats for 30 trainees, approximately 45 sqm (5 m x 9 m) | 1 | 1:30 |
|  | Computer Laboratory | Equipped with at least 15 functional computers with internet connectivity and the following software:   * + - Windows/ Linux/ Macintosh Operating System     - Microsoft Office Software     - Google Workspace Account     - Antivirus Software | 1 | 1:1 |
|  |  |  |  |  |
| **C** | **Consumable Materials** | | | |
|  | Writing Materials | Writing materials for note taking | Enough |  |
|  | Flashcards | For carrying out various activities by trainees | Enough |  |
|  | Charts | Sufficient for group work activities and displaying | Enough |  |
|  | Whiteboard Marker Pens | Dry-erase markers for trainers use. Assorted colors | Enough |  |

## TECHNICAL DRAWING

**UNIT CODE:** 0732 441 06A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Apply technical drawing

**Duration of Unit:** 80 hours

**Unit Description**

This unit covers the competences required to apply technical drawings. It involves using technical drawing tools, equipment and materials, producing plane geometry drawings, orthographic drawings of components, solid geometry drawings, isometric drawings and assembly drawings.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/NO** | **Learning Outcomes** | **Duration (Hours)** |
| **1.** | Use technical drawing tools, equipment and materials | 10 |
| **2.** | Produce plane geometry drawings | 10 |
| **3.** | Produce orthographic drawings of components | 20 |
| **4.** | Produce solid geometry drawings | 10 |
| **5.** | Produce Isometric drawings | 20 |
| **6.** | Produce assembly drawings | 10 |
| **Total** | | **80** |

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

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| * + - 1. Use and maintain drawing equipment and materials | * 1. Drawing equipment      1. T square      2. Set square      3. Protractor      4. Engineering drawing set   2. Drawing materials      1. Drawing papers      2. Maskin tape      3. Clips      4. Drawing board      5. Clutch pencils   3. Use and maintenance of drawing equipment | * Practical Tests * Written tests |
| * + - 1. Produce plane geometry drawings | * 1. Types of lines in drawings      1. Boarder lines      2. Faint continuous lines      3. Broken lines      4. Chain lines      5. Centre lines      6. Cutting lines   2. Construction of angles      1. Acute angles      2. Right angles      3. Reflex angles      4. Obtuse angles      5. Straight angles   3. Bisection of angles      1. Acute angles      2. Right angles      3. Reflex angles      4. Obtuse angles   4. Measurement of angles      1. Acute angles      2. Right angles      3. Reflex angles      4. Obtuse angles      5. Straight angles   5. Construction of plane geometric forms      1. Triangles      2. Quadrilaterals      3. Polygons      4. Circles and tangents   6. Construction of scales      1. Plane scales      2. Diagonal scale      3. Reducing and enlargement scales | * Practical tests * Written Tests |
| 1. Produce orthographic drawings of components | * 1. Orthographic drawings      1. First angle projection      2. Third angle projection   2. Dimensioning   3. Sectional views   4. Free hand sketches      1. Geometric forms      2. Tools      3. Equipment      4. Mechanical components | * Practical tests * Written Tests |
| 1. Produce solid geometry drawings | * 1. Sketches and drawings of patterns      1. Cylinders      2. Prisms      3. pyramids   2. solids drawings      1. Prisms      2. Cones      3. Cylinders   3. Development and interpenetrations of solids      1. cylinder to cylinder      2. cylinder to prisms      3. prism to prism   4. Different symbols and abbreviations   5. Auxiliary views and true shapes of truncated solids      1. Truncated cylinder      2. Truncated prism      3. Truncated pyramid | * Practical tests * Written Tests |
| 1. Produce isometric drawings | * 1. Isometric sketches and drawings of components   2. Isometric curves and circles   3. Oblique sketches of components | * Practical tests * Written Tests |
| 1. Produce assembly drawings | * 1. Orthographic views of assembly drawings      1. First angle projection      2. Third angle projection   2. Sectional views   3. Parts list | * Practical tests * Written Tests |

**Suggested Methods of Delivery**

* Projects
* Demonstration by trainer
* Practice by the trainee
* Discussions

**Recommended Resources for 30 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| S/No. | Category/Item | Description/Specifications | Quantity | Recommended Ratio (Item: Trainee) |
| A | Learning Materials |  |  |  |
|  | Textbooks | Comprehensive texts books on Technical Drawing | 25 pcs | 1:1 |
|  | PowerPoint Presentations | For trainer’s use, covering course content and practical applications | 1 | 1:25 |
|  | Working drawings | Working drawings giving a detailed overview of the task at hand |  |  |
|  | Projector | Functional projector for displaying content during presentations | 1 | 1:25 |
|  | White board | Quality whiteboard of approximately 6 ft by 3 ft for writing during theory instruction | 1 | 1:25 |
| B | Learning Facilities & Infrastructure |  |  |  |
|  | Drawing Room  /Learning Resource  Area\* | Spacious, equipped with a projector and drawing tables for 25 trainees, approximately 45 sqm (5 m x 9 m) | 1 | 1:25 |
| C | Consumable Materials |  |  |  |
|  | Drawing papers | A4, A3 and A2 size drawing papers for drafting of sketches and working drawings | 1 ream | 1:25 |
|  | Drawing Pencils | For drawing   * HB * 2H/3H * 2B | Enough |  |
|  | Eraser | Dustless eraser for pencil stains | 30 |  |
|  | Masking Tape | For attaching the drawing paper to the drawing board | Enough |  |
| D | Tools and Equipment |  |  |  |
|  | Drawing Instruments | The include:   * T-squares * 30-60 degree set squares * 45 degree set square * Protractor * Compass set | 25 sets | 1:1 |
|  | Pencil Sharpener | For creating sharp pencil tips | 25 pcs | 1:1 |
|  | Drawing Tables | For drawing | 25 pcs | 1:1 |
| E | Reference Materials |  |  |  |
|  | Welding /blueprint /drawing Standards | Reference on industry standards (e.g., BS/ANSI/AWS etc) | 5 pcs | 1:5 |
|  | Multimedia Learning Modules | Videos and tutorials | 25 pcs | 1:1 |

## MECHANICAL SCIENCE

**UNIT CODE:** 0715 441 07A

**Relationship with Occupational Standards**: Apply Mechanical Science

**Duration of Unit**: 80 Hours

**Unit Description**

This unit of learning covers the learning outcomes, content, assessment methods, methods of delivery and resources required to train mechanical science. The learning outcomes involve resolving forces, determining effects of loads in mechanical systems, analysing properties of materials, determining the nature of friction in mechanical systems and solving problems related to motion.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/NO** | **Learning Outcomes** | **Duration (Hours)** |
| **1.** | Resolve forces | 10 |
| **2.** | Determine effects of loads in mechanical systems. | 20 |
| **3.** | Analyze properties of materials. | 10 |
| **4.** | Determine the nature of friction in mechanical systems | 20 |
| **5.** | Solve problems related to motion | 20 |
| **Total** | | **80** |

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

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1. Resolve forces | * 1. Definition of force   2. Types of force systems      1. Collinear      2. Coplanar      3. Concurrent   3. Theorems of forces      1. Triangle      2. Parallelogram      3. Polygon   4. Resolution of forces      1. Analysis      2. Graphical Method | * Written Tests * Portfolio of Evidence |
| 1. Determine effects of loads in mechanical systems. | * 1. Types of Forces      1. Friction      2. Centrifugal      3. Centripetal      4. Gravitational      5. Inertia   2. Moments      1. Definition      2. Calculations of moment of force about an axis   3. Principles of Moments      1. Clockwise and anticlockwise moments   4. Application of Moments of Forces in Engineering      1. Simply supported beams having point loads   5. Determination of moment couples      1. Simply supported beams with couples | * Written Tests * Portfolio of Evidence |
| 1. Analyze properties of materials | * 1. Mechanical Properties of Materials:      1. Strength (Compressive, Shear. And Tensile)      2. Brittleness      3. Hardness      4. Malleability      5. Plasticity      6. Elasticity      7. Toughness   2. Mechanical Materials Properties Tests      1. Tensile Test      2. Hardness Test   3. Direct Stresses      1. Define Stress      2. Types of Stress:         1. Tensile stress         2. Compressive stress      3. Calculate Stress   4. Selection of Materials      1. Factors to Consider in Materials Selection | * Written Tests * Portfolio of Evidence |
| 1. Determine the nature of friction in mechanical systems | * 1. Friction      1. Definition      2. Advantages and disadvantages of friction   2. Laws of Friction:      1. Laws of static friction      2. Laws of dynamic friction   3. Effects of Friction   4. Applications of Friction      1. Lubrication      2. Tyre Traction      3. Braking Systems      4. Bearing and Bushings      5. Grinding of Tools      6. Transmission Systems | * Written Tests * Portfolio of Evidence |
| 1. Solve problems related to motion. | * 1. Definition of terms      1. Distance      2. Displacement      3. Time      4. Speed      5. Velocity      6. Acceleration   2. Laws of Motion      1. Newton’s First Law of Motion      2. Newton’s Second Law of Motion      3. Newton’s Third Law of Motion   3. Calculating Parameters of Motion      1. Equations of linear and angular motion      2. Calculations         1. Displacement         2. Speed         3. Velocity         4. Acceleration   4. Linear and Angular Motion      1. Converting         1. Angular to Linear Motion         2. Linear to angular motion   5. Motion Graphs      1. Displacement/Time Graphs      2. Velocity/Time Graphs | * Written Tests * Portfolio of Evidence |

**Suggested Delivery Methods**

* Group discussions
* Demonstration by the trainer
* Online video clips
* Power point presentation

**Recommended Resources for 30 Trainees**

| **S/No.** | **Category/Item** | **Description/Specifications** | **Quantity** | **Recommended Ratio (Item: Trainee)** |
| --- | --- | --- | --- | --- |
| **A** | **Learning Materials** | | | |
|  | Textbooks | Comprehensive textbooks on Engineering Mathematics | 30 | 1:1 |
|  | Graph books | For graphical representation of solutions | 30 | 1:1 |
|  | Projector | Functional projector for displaying content during presentations | 1 | 1:30 |
|  | Computer | Functional desktop computer with online instructional content | 1 | 1:30 |
|  | White board | Quality whiteboard of approximately 6 ft by 3 ft for writing during theory instruction | 1 | 1:30 |
|  | Printer | An ink-jet, laser-jet or toner-cartridge printer for printing notes, instructions and working drawings | 1 | 1:30 |
| **B** | **Learning Facilities & Infrastructure** | | | |
|  | Lecture/Theory Room | Spacious room with seats for 25 trainees, approximately 60 sqm | 1 | 1:30 |
| **C** | **Materials and Supplies** | | | |
|  | First Aid kit | Fully equipped First Aid kit for use in case of accidents | 1 | 1:30 |
| **D** | **Tools and Equipment** | | | |
|  | Set of Mathematical instruments | For constructions and measurements | 30 | 1:1 |
|  | Scientific Calculator | For Calculations | 30 | 1:1 |
| **E** | **Reference Materials** | | | |
|  | Training Presentations/Slides | Digital format for shared access among trainees | 1 | 1:30 |
|  | Standard Mathematical Tables | For reference on formulae, identities, laws and principles | 30 | 1:1 |

## ELECTRICAL AND ELECTRONICS PRINCIPLES

**UNIT CODE:** 0713 441 08A

**Relationship with Occupational Standards**

**This unit addresses the unit of competency:** Apply Electrical and Electronics principles.

**Unit Duration:** 80 Hours

**Unit Description**

This unit of learning covers the learning outcomes, content, assessment methods, methods of delivery and resources required to train electrical and electronics principles. The learning outcomes involve applying basic concepts of electrical quantities, cells and batteries, magnetism and electromagnetism, basic electrical machines and electronics principles.

**Summary of Learning Outcomes**

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

|  |  |  |
| --- | --- | --- |
| **S/NO** | **Learning Outcomes** | **Duration (Hours)** |
| 1. | Apply basic concepts of electrical quantities | 10 |
| 2. | Apply DC and AC circuits | 10 |
| 3. | Apply the concept of cells and batteries | 10 |
| 4. | Apply magnetism and electromagnetism | 10 |
| 5. | Apply basic electrical machines | 20 |
| 6. | Apply electronics components | 20 |
| **Total** | | **80** |

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

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1. Use the concept of basic Electrical quantities | * 1. Basic SI Units      1. Overview of SI Units         1. Power (Watts, W)         2. Current (Amperes, A)         3. Resistance (Ohms, Ω)         4. Voltage (Volts, V)   2. Conductors and Insulators      1. Identification and Characteristics         1. Metals vs. non-metals         2. Applications in electrical circuits   3. Electrical Quantities      1. Charge, Force, Work, and Power      2. Definitions and units      3. Calculations involving Electrical quantities   4. Ohm’s Law      1. Understanding Ohm's Law      2. Practical applications and calculations   5. Basic Electrical and Electronic Measurements      1. Measurement Techniques      2. Use of Multimeters, oscilloscopes, and ammeters      3. Measurement accuracy and calibration | * Portfolio of evidence * Practical test * Third party report * Written tests * Project work |
| 1. Apply DC and AC circuits | * 1. Introduction to Electrical Circuits      1. Introduction to electricity:      2. Voltage, current, and power.      3. Overview of DC and AC circuits.      4. Basic circuit elements: Resistors, capacitors, and inductors.   2. DC Circuit Analysis      1. Series and parallel circuits.      2. Voltage and current division principles.      3. Kirchhoff's Voltage Law (KVL) and Kirchhoff's Current Law (KCL).      4. Analysis of complex circuits using KVL and KCL.      5. Hands-on lab: Building and testing DC circuits.   3. AC circuits analysis      1. Introduction to AC: Sinusoidal waveforms, frequency, and period.      2. RMS values, peak values, and average values.      3. AC voltage and current sources.      4. Phasor representation of AC quantities.      5. Impedance and admittance.      6. Series and parallel AC circuits.      7. Resonance in RLC circuits.      8. Practical analysis of AC circuits using phasors.      9. Power in AC Circuits         1. Power factor and power factor correction.         2. Real, reactive, and apparent power.         3. AC power calculations for single-phase and three-phase circuits.         4. Energy consumption and efficiency.         5. Applications of AC power in household and industrial settings.   4. Practical Activity:      1. Connection in series and Parallel Simulation | * Oral questioning * Portfolio of evidence * Practical test * Third party report * Written tests * Project work |
| 1. Apply the concept of cells and batteries | * 1. Introduction to Cells and Batteries   2. Overview of energy storage and electrochemical cells.   3. Basic concepts: Voltage, current, capacity, and energy density.   4. e.m.f and internal resistance of cells   5. Electrochemical principles: Redox reactions and electrode potentials.   6. Components of a cell: Anode, cathode, electrolyte, and separator.   7. Types of cells: Primary vs. secondary cells (non-rechargeable vs. rechargeable).   8. Primary Cells (Non-Rechargeable)      1. Zinc-Carbon Cells: Construction, chemistry, and applications.      2. Alkaline Cells: Advantages over zinc-carbon, usage, and performance characteristics.      3. Comparison of common primary cells (e.g., lithium primary cells).      4. Performance limitations and efficiency of primary cells.      5. Environmental impact and disposal considerations for non-rechargeable batteries.      6. Hands-on lab: Testing the performance of different primary cells.   9. Secondary Cells (Rechargeable)      1. Lead-Acid Batteries: Chemistry, construction, and applications (e.g., automotive).      2. Nickel-Cadmium (NiCd) and Nickel-Metal Hydride (NiMH): Differences, pros, and cons.      3. Charging and discharging cycles of rechargeable cells.      4. Lithium-Ion Batteries: Working principles, construction, and applications.      5. Advantages of lithium-ion technology over older battery types.      6. Safety considerations: Overcharging, thermal runaway, and battery management systems.      7. Emerging Technologies: Solid-state batteries, lithium-sulphur, and other advancements.      8. Energy density and power density considerations in modern applications.      9. Batteries maintenance      10. Hands-on lab: Disassembling and examining a rechargeable battery.   10. Battery Performance and Characteristics       1. Battery capacity: Ampere-hour (Ah) ratings and energy content.       2. Factors affecting battery life: Temperature, charge/discharge rates, and cycling.       3. Internal resistance and its effect on performance.       4. Battery efficiency and energy losses.       5. State of charge (SOC) and depth of discharge (DOD).       6. Battery degradation and aging mechanisms.       7. Measuring battery parameters (voltage, current, capacity).       8. Testing techniques for battery health and performance.       9. Hands-on lab: Performance testing of different battery types.   11. Applications of Batteries       1. Batteries in consumer electronics (e.g., smartphones, laptops).       2. Automotive applications: Starting, lighting, and ignition (SLI) batteries.       3. Electric vehicles (EVs) and hybrid electric vehicles (HEVs): Battery requirements and challenges.       4. Industrial and grid storage applications.       5. Renewable energy integration: Solar and wind energy storage solutions.       6. Specialized applications: Medical devices, aerospace, and military.       7. Case studies on battery failure and safety incidents.       8. Discussion on regulations and standards for battery use.   12. Environmental Impact and Recycling       1. Environmental impact of battery production and disposal.       2. Strategies for reducing the ecological footprint of battery technologies.       3. Recycling processes for different types of batteries.       4. Government policies and regulations regarding battery disposal.       5. Advances in battery recycling technologies.   13. Hands-on lab: Exploring the recycling process and evaluating eco-friendly battery alternatives. | * Portfolio of evidence * Practical test * Third party report * Written tests * Project work |
| 1. Apply magnetism and electromagnetism | * 1. Magnetic Circuits and Devices      1. Introduction to magnetic circuits.      2. Magnetic flux, magnetic field density, magnetic field strength, Reluctance, magnetomotive force (MMF), and magnetic flux.      3. Calculations involving magnetic circuits      4. Analogies between electric and magnetic circuits.      5. Magnetic materials in electrical devices (soft and hard magnetic materials).   2. Electromagnetic Induction      1. Faraday’s Law of electromagnetic induction.      2. Lenz's Law: Direction of induced EMF.      3. Practical applications: Electric generators and transformers.      4. Induced EMF in different configurations (moving conductors, changing magnetic fields).      5. Self-induction and mutual induction.      6. Transformers: Working principles, construction, and applications.      7. Step up and step-down transformers      8. Power losses in transformers.      9. Calculations involving transformers      10. Energy stored in magnetic fields. | * Oral questioning * Portfolio of evidence * Practical test * Third party report * Written tests * Project work |
| 1. Apply basic electrical machines | * 1. DC Machines      1. DC machine construction and types (motors and generators).      2. Working principle of DC generators and back EMF.      3. Types of DC generators: Series, shunt, and compound.      4. Working principle of DC motors.      5. Types of DC motors: Series, shunt, and compound.      6. Speed-torque characteristics of DC motors.      7. Performance analysis and efficiency of DC machines.      8. Starting methods for DC motors.      9. Hands-on lab: Testing and operating a DC motor/generator.   2. Induction Motors (AC Machines)      1. Introduction to induction motors: Construction and working principles.      2. Types of induction motors: Squirrel cage and wound rotor.      3. Rotating magnetic fields and slip in induction motors.      4. Equivalent circuit model of an induction motor.      5. Torque-speed characteristics.      6. Methods of starting and speed control.      7. Performance analysis of induction motors.      8. Losses and efficiency considerations.   3. Hands-on lab: Testing and operating an induction motor. | * Portfolio of evidence * Practical test * Third party report * Written tests * Project work |
| 1. Apply electronics components | * 1. Introduction to Electronic Components      1. Overview of electronics: What are electronic components?      2. Classification of components: Passive, active, and electromechanical.      3. Introduction to circuit symbols and schematic diagrams.      4. Basic electrical quantities and units (voltage, current, resistance).      5. Understanding datasheets and component specifications.      6. Overview of testing and measurement tools (multimeters, oscilloscopes).   2. Passive Components      1. Resistors: Types, color codes, power ratings, and applications.      2. Capacitors: Types (ceramic, electrolytic, film), capacitance value, and working voltage.      3. Charging and discharging of capacitors in DC circuits.      4. Applications of capacitors in filtering, timing, and energy storage.      5. Inductors: Types, inductance value, and applications.      6. Inductor behavior in DC and AC circuits.      7. Introduction to filters: RC, RL, and RLC circuits.   3. Semiconductor Devices      1. Diodes: Introduction to PN junctions, characteristics, and types (LEDs, Zener diodes, Schottky diodes).      2. Applications of diodes in rectification, voltage regulation, and signal clipping.      3. Transistors: Types (BJT and MOSFET), characteristics, and configurations.      4. Basic transistor circuits: Switches and amplifiers.      5. Hands-on lab: Building and testing simple diode and transistor circuits.      6. Special semiconductor devices: Thyristors, TRIACs, and optoelectronic devices.      7. Characteristics and applications in switching and control.   4. Integrated Circuits (ICs)      1. Overview of integrated circuits: Analog vs. digital ICs.      2. Operational amplifiers (Op-Amps): Characteristics and basic configurations.      3. Applications of Op-Amps in signal processing.      4. Timers and oscillators: 555 timer IC and its applications.      5. Voltage regulators: Linear and switching regulators.      6. Introduction to data converters (ADC and DAC).      7. Digital ICs: Logic gates and flip-flops.      8. Applications of digital ICs in basic logic circuits.      9. Hands-on lab: Building circuits using Op-Amps, timers, and logic gates.   5. Electromechanical and Specialized Components      1. Relays: Types, operation, and applications in switching.      2. Switches and connectors: Types and usage in electronic circuits.      3. Transformers: Basic operation, step-up/step-down functions, and isolation.      4. Displays: LED, LCD, and seven-segment displays.      5. Circuit Design and Practical Applications      6. Basic circuit design principles: Bread boarding, PCB layout, and soldering.      7. Introduction to circuit simulation tools (e.g., Multisim, LTSpice).      8. Testing and troubleshooting techniques.      9. Real-world applications of electronic components.      10. Building practical projects: Power supplies, audio amplifiers, and sensor-based circuits.      11. Hands-on lab: Final project assembly and testing. | * Portfolio of evidence * Practical test * Third party report * Written tests * Project work |

**Suggested Methods of Instruction**

* Demonstration by trainer
* Practice by the trainee
* Field trips
* Discussions

**Recommended Resources for 30 trainees**

| **S/No.** | **Category/Item** | **Description/Specifications** | **Quantity** | **Recommended Ratio (Item: Trainee)** |
| --- | --- | --- | --- | --- |
| **A** | **Learning Materials** | | | |
|  | Textbooks | Comprehensive texts on electrical and control principle. | 6 pcs | 1:5 |
|  | Charts | Visual aids covering electrical theories and safety protocols | 10 pcs | 1:3 |
|  | PowerPoint Presentations | For trainer’s use, covering course content and practical applications | 1 | 1:30 |
| **B** | **Learning Facilities & Infrastructure** | | | |
|  | Lecture/Theory Room | Equipped with projectors and seating for 25 trainees, ~60 sqm | 1 | 1:30 |
|  | Workshop | Hands-on training area with workbenches, tools, and safety equipment, ~80 sqm | 1 | 1:30 |
|  | Computer Laboratory | Equipped with testing setups for electrical experiments, ~50 sqm.  Equipped with computers installed with Circuit simulation software. | 30 | 1:1 |
|  |  |  |  |  |
| **C** | **Consumable Materials** | | | |
|  | Electrical Wires | Assorted sizes and color-coded (e.g., 1.5mm², 2.5mm², 4mm²) | 6 rolls | 1:5 |
|  | Insulation Tapes | For securing connections and insulation, assorted colors | 30 pcs | 1:1 |
|  | Breadboard | For prototyping and testing circuits | 6 pcs | 1:5 |
|  | Sensors | Assorted types (temperature, pressure, proximity) | 10 pcs | 1:3 |
|  | Signal generators | For generating AC signals | 6 pcs | 1:5 |
|  | Transducers | Assorted | 10 pcs | 1:3 |
|  | Electronic components | Resistors, transistors, capacitors, relays, transformers. Integrated IC, OPAM. | 120 pcs | 4:1 |
|  |  |  |  |  |
| **D** | **Tools and Equipment** | | | |
|  | Screwdrivers | Assorted sets for various applications | 3 sets | 1:10 |
|  | Side Cutters | For cutting wires and cables | 6 pcs | 1:5 |
|  | Pliers | For gripping and bending wires | 3 pcs | 1:10 |
|  | Stripping Knives | For stripping insulation from wires | 5 pcs | 1:6 |
|  | Computers | Equipped with electrical and electronics simulation software | 6 pcs | 1:5 |
|  | Multimeters | For measuring voltage, current, and resistance | 6 pcs | 1:5 |
|  | Clamp Meters | For measuring current flow in circuits | 6 pcs | 1:5 |
|  | Oscilloscope | For observing waveforms and signals | 1 | 1:30 |
|  | Voltmeter | For measuring voltage | 1 | 1:30 |
|  | Ammeter | For measuring current | 1 | 1:30 |
|  | Signal Generator | For generating electrical signals for testing | 1 | 1:30 |
|  | Soldering gun | For soldering | 10 | 1:3 |
|  | Soldering wire | For making joints in electrical circuits | 10 | 1:3 |
|  | PLC | For program practice | 6 | 1:5 |
|  | Cells and batteries | For learning | 6 | 1:5 |
|  |  |  |  |  |
| **E** | **PPE (Personal Protective Equipment)** | | | |
|  | PPE Sets | Includes helmets, gloves, safety goggles, shoes, and harnesses | 30 sets | 1:1 |
|  | Safety Signs and Barriers | For simulating safety zones and hazards | 10 sets | 1:3 |
|  | Earthing Test Kits | For ground testing and demonstrating earthing procedures | 6 pcs | 1:5 |
|  | Electrical Test Benches | For hands-on testing of functionality and circuit design | 6 pcs | 1:5 |
|  |  |  |  |  |
| **F** | **Reference Materials** | | | |
|  | Industrial Automation Manuals | Covering principles and practices in automation | 30 pcs | 1:1 |
|  | Electrical Standards | Reference on industry standards (e.g., IEEE Guidelines) | 6 pcs | 1:5 |
|  | Technical Handbooks | On motors, drives, and wiring systems | 30 pcs | 1:1 |
|  | Training Presentations/Slides | Digital format for shared access among trainees | 1 | 1:30 |
|  | Multimedia Learning Modules | Digital licenses for videos and tutorials | 30 pcs | 1:1 |
|  | Practical Assessment Guides | Worksheets for practical assessments | 30 pcs | 1:1 |

## GAS METAL ARC WELDING OPERATIONS

**Unit Code:** 0715 451 17A

**Unit Duration:** 120 Hours

**Relationship to Occupational Standards**

**This unit addresses the Unit of Competency:** Carry out Gas Metal Arc Welding Operations

**Unit Description**

This unit of learning covers the learning outcomes, content, assessment methods, methods of delivery and resources required to train GMAW operations. The learning outcomes involve carrying out metal inert gas welding, metal active gas welding, flux- cored arc welding, tungsten inert gas welding, and maintaining gas metal arc welding 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)** |
| 1. | Carry out Metal inert Gas (MIG) welding | 30 |
| 2. | Carry out Metal Active Gas (MAG) welding | 20 |
| 3. | Carry out Flux Cored Arc Welding (FCAW) | 30 |
| 4. | Carry out Tungsten Inert Gas (TIG) welding | 30 |
| 5. | Maintain Gas Metal Arc Welding (GMAW) equipment | 10 |
| **Totals** | | **120** |

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

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1. Carry out Metal inert Gas (MIG) welding | 1.1 Occupational health and safety standards   * + 1. Workplace legislation and standards     2. Workplace hazard identification     3. Risk Assessment     4. Workshop Incident/Accident reporting     5. Workplace ergonomics and work design     6. Workshop waste management     7. Workplace environmental safety     8. Workshop safety        1. Regulations        2. Personal Protective Equipment        3. Layout     9. Workplace procedures        1. Roles and responsibilities        2. Compliance        3. Documentation        4. Communication        5. Emergency procedures     10. Welding hazards         1. Fire/Burns         2. Cuts         3. Fumes         4. Noise         5. Gas explosion     11. Housekeeping         1. Cleaning         2. Waste management   1. Drawing interpretation      1. Dimensions      2. Tolerances      3. Symbols and notations   2. MIG welding equipment and accessories      1. Types         1. Inert gas cylinders         2. MIG welding torch         3. MIG wire         4. MIG welding tools         5. Fire extinguishers         6. Welding jigs and fixtures         7. Nozzle cleaner      2. Use and care   3. Welding material preparation   (0.1-16 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 feed speed         6. Wire gauge/diameter   2. Modes of metal transfer      1. Short circuit      2. Globular      3. Spray arc      4. Pulsed   3. Shielding gases      1. Argon      2. Helium   4. Metallic Materials   (0.1-16 mm thickness)   * + 1. Plates     2. Pipes   1. Welding positions      1. Types         1. Flat         2. Horizontal         3. Vertical         4. Overhead      2. Applications   2. Weld joints      1. Types         1. Butt joint         2. Lap joint         3. Edge joint         4. Plug joint         5. Corner joint         6. T-joint         7. Cruciform joint      2. Geometry and application   3. 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   4. Finishing processes      1. Methods         1. Buffing         2. Polishing         3. Grinding         4. Varnishing         5. Deburring         6. Electroplating         7. Painting      2. Applications   **Practice**   * MIG weld Metallic materials plates and pipes of 4-16 mm thickness in: * Flat position * Horizontal position * Vertical position * Overhead position | * Written tests * Practical test * Project work * Portfolio of evidence |
| 1. Carry out Metal Active Gas (MAG) welding | * 1. MAG welding equipment and accessories      1. Active gas cylinders         1. Applications         2. Care   2. Shielding gas      1. Carbon IV Oxide   3. MAG welding process      1. Procedure      2. Applications   **Practice**   * MAG weld metallic materials plates and pipes of 4-16 mm thickness in: * Flat position * Horizontal position * Vertical position * Overhead position | * Written tests * Practical test * Project work * Portfolio of evidence |
| 1. Carry out Flux Cored Arc Welding (FCAW) | * 1. Flux Cored Arc Welding (FCAW) machines, tools and equipment      1. Types      2. Usage      3. Care and storage   2. Types of FCAW processes      1. Gas shielded      2. Self-shielded   3. FCAW parameters      1. Setting         1. Current         2. Shielding gas type         3. Shielding gas pressure         4. Arc force   4. FCAW process      1. Procedure      2. Applications   **Practice**   * FCAW weld Metallic materials plates and pipes of 4-16 mm thickness in: * Flat position * Horizontal position * Vertical position * Overhead position | * Written tests * Practical test * Project work * Portfolio of evidence |
| 1. Carry out Tungsten Inert Gas (TIG) welding | * 1. TIG welding equipment and accessories      1. Types         1. TIG torch         2. Tungsten electrode         3. Filler wire      2. Use and care   2. Use and care of materials      1. Filler rod   3. Shielding gases      1. Argon      2. Helium   4. TIG process   (metals up to 16 mm thickness)   * + 1. Procedure     2. Applications   **Practice**   * TIG weld metallic materials plates and pipes of 4-16 mm thickness in: * Flat position * Horizontal position * Vertical position * Overhead position | * Written tests * Practical test * Project work * Portfolio of evidence |
| 1. Maintain Gas Metal Arc Welding (GMAW) equipment | * 1. GMAW tools repair      1. Handles      2. Heads      3. Jaws      4. Blades      5. Discs and wheels   2. Preventive maintenance of GMAW machines and equipment      1. Cleaning of the external surfaces of the machine      2. Inspecting cables, connectors and power sources      3. Lubricating of moving parts   3. Preventive maintenance report      1. Content      2. Usage and storage   **Practice**   * Clean external surfaces of machine * Inspect cables, connectors and power sources * Lubricate moving parts * Report writing. | * Written tests * Practical test * Project work * 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 Welding and Fabrication | 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** | | | |
|  | 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. * 16 mm thickness   Pipes   * 4 mm thickness * 6 mm thickness * 9 mm thickness * 12 mm thickness * 16 mm thickness |  |  |
|  | Tungsten electrodes | Electrodes used in TIG welding | Enough |  |
|  | FCAW electrodes | Electrodes used in FCAW welding | Enough |  |
|  | 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 |
|  | 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** | | | |
|  | MIG/ MAG welding machine | uses a continuous wire feed as an electrode | 5 | 1:5 |
|  | MAG welding machine | Uses a non-consumable tungsten electrode | 5 | 1:5 |
|  | TIG welding equipment | Functional welding equipment | 5 | 1:5 |
|  | FCAW equipment | Functional welding equipment | 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 |