

**REPUBLIC OF KENYA**

**COMPETENCY BASED MODULAR CURRICULUM**

**FOR**

**MECHANICAL PRODUCTION MACHINE OPERATION**

**KNQF LEVEL 4**

**PROGRAMME ISCED CODE: 0715 354A**

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**FOREWORD**

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

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

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

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

**PRINCIPAL SECRETARY**

**STATE DEPARTMENT FOR TVET**

**MINISTRY OF EDUCATION**

# PREFACE

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

TVET Act, CAP210A and the Sessional Paper No. 1 of 2019 on Reforming Education and Training in Kenya, emphasized the need toreform 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 Kenyan labour force.

This curriculum has been developed in adherence to the Kenya National Qualification Framework and CBETA standards and guidelines. The curriculum is designed and organized into Units of Learning with Learning Outcomes; suggested delivery methods, training/learning resources and methods of assessing the trainee’s achievement. The curriculum is competency-based and allows multiple entry and exit to the course.

I am grateful to the Council Members, Council Secretariat, Mechanical Engineering Production. NSSC, expert workers and all those who participated in the development of this curriculum.

# ACKNOWLEDGEMENT

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 was received from industry and various organizations.

I appreciate National role of Mechanical Engineering Sector Skills Committee who enabled the development of this curriculum. I recognize with appreciation the role of the SSC in ensuring that competencies required by the industry are addressed in this curriculum.

I also thank all stakeholders in the mechanical engineering sector for their valuable input and all those who participated in the process of developing this curriculum.

I am convinced that this curriculum will go a long way in ensuring that workers in construction sector will acquire competencies that will enable them perform their work more efficiently.

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# ACRONYMS

CAD Computer Aided Design

CBET Competency Based Education and Training

DC Direct Current

MMAW Manual metal arc welding

PPE Personal Protective Equipment

TVET Technical and Vocational Education and Training

TVETA Technical and Vocational Education and Training Authority

# KEY TO ISCED UNIT CODE



# COURSE OVERVIEW

Mechanical Production machine operation Level 4 qualification consists of competencies that an individual must achieve to enable him/her to work in a Production engineering establishment as a mechanical Production Technician. These competencies involve general fitting, welding operations, lathe operations and milling operations.

The curriculum is organized in modules comprising of Basic, Common and Core Units of Learning as applicable.

**SUMMARY OF UNITS OF LEARNING**

|  |  |  |  |
| --- | --- | --- | --- |
| **Unit Code** | **Unit Title** | **Unit Duration (Hours)** | **Credit Factor** |
| **MODULE I** | | | |
| 0715 351 01A | General fitting | 150 | 15 |
| 0715 351 02A | Welding Operations | 150 | 15 |
| **MODULE II** | | | |
| 0715 351 03A | Lathe Operations | 150 | 15 |
| 0715 351 04A | Milling Operations | 150 | 15 |
| Industrial Attachment | | 320 | 32 |
| **GRAND TOTAL** | | **920** | **92** |

**Entry Requirements**

1. An individual entering this course should have Kenya Certificate of Secondary Education (KCSE).

**Trainer qualification**

A trainer for this course must:

1. Have a minimum of KNQF level 5 qualifications or its equivalent in a related trade area.
2. Licensed by TVETA.
3. Registered by Engineer Board of Kenya (E.B.K) or Kenya Engineering Technology Registration Board (KETRB).

**Industry Training**

An individual enrolled in this course will be required to undergo Industry training for a minimum period of 240 hours in Mechanical engineering 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.

**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
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 a certificate of competency upon demonstration of competence in a unit of competency. To be awarded Kenya National Certificate in Mechanical Production Technology KNQF Level 5, the candidate must demonstrate competence in all the units of competency as given in 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 QAI.

# MODULE I

**GENERAL FITTING OPERATIONS**

**ISCED Unit Code: 0715 351** 01A

**Relationship to Occupational Standards:** Perform General Fitting Operations

**Duration of Unit**: 150 Hours

**Unit Description**

This unit describes the competencies required by a Mechanical Production Technician in order to perform general fitting operations. It includes carrying out general bench work operations, performing drilling operations, performing grinding operations, performing sawing operations, assembling parts, carrying out maintenance and housekeeping operations.

**Summary of Learning Outcomes**

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

|  |  |  |
| --- | --- | --- |
| **S/NO** | **Learning Outcomes** | **HOURS** |
|  | Carry out general bench work operations | 50 |
|  | Perform drilling operations | 10 |
|  | Perform grinding operations | 10 |
|  | Perform sawing operations | 10 |
|  | Assemble parts | 50 |
|  | Carry out maintenance and housekeeping operations | 10 |
| **TOTAL** | | **150 HRS** |

**Learning Outcomes, Content and suggested assessment methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcomes** | **Content** | **Suggested Assessment Method** |
| 1. Carry out general bench work operations | * 1. Bench work safety   2. Extraction of information      1. Dimensions      2. Tolerances      3. BS/ANSI drawing standards      4. Geometric ISO symbols & abbreviations   3. Fitting tools      1. Files      2. Taps and dies      3. Scrappers      4. Rivet sets      5. Riveting gun      6. Reamers   4. Marking out tools      1. Surface plate      2. V-blocks      3. Dial gauge      4. Engineer’s square   5. Measuring tools   6. Clamps   7. Assorted hand tools   8. Inspection tools and equipment   9. Jigs and fixtures   10. Bench operations       1. Filing       2. Threading          1. Taps          2. Dies       3. Scrapping       4. Riveting   11. Reaming |  |
| 1. Perform drilling operations | * 1. Drilling safety      1. Extraction of information      2. Dimensions      3. Tolerances      4. BS/ANSI drawing standards      5. Geometric ISO symbols & abbreviations   2. Drilling tools and accessories   3. Cutting fluids      1. Types of coolants      2. Composition of coolants      3. Selection of coolants      4. Uses of coolants      5. Advantages/disadvantages of coolants      6. Handling of coolants   4. Measuring and marking out tools   5. Types of drilling machines      1. Portable      2. Pillar      3. Bench      4. Radial   6. Mounting drilling tools   7. Drilling machine operations   8. Drilling      1. Boring      2. Spot facing      3. Tapping      4. Counter boring      5. Reaming      6. Counter sinking   9. Finishing | * Written Tests * Practical Tests * Projects * Portfolio of Evidence |
| 1. Perform grinding operations | * 1. Grinding safety   2. Grinding machine operation   3. Surface grinding operations   4. Grinding wheel      1. Types      2. Characteristics   5. Cutting fluids      1. Types of coolants      2. Composition of coolants      3. Selection of coolants      4. Uses of coolants      5. Advantages/disadvantages of coolants      6. Handling of coolants   6. Grinding machines      1. Pedestal grinder      2. Bench grinder      3. Hand grinder      4. Surface grinder   7. Finishing | * Written Tests * Practical Tests * Projects * Portfolio of Evidence |
| 1. Perform sawing operations | * 1. Sawing safety   2. Sawing methods   3. Cutting fluids      1. Types of coolants      2. Composition of coolants      3. Selection of coolants      4. Uses of coolants      5. Advantages/disadvantages of coolants      6. Handling of coolants   4. Types of sawing machines      1. Band saw      2. Reciprocating saw      3. Circular saw      4. Slitting saw   5. Types of sawing blades   6. Mounting sawing blades   7. Sawing machine operation   8. Sawing parameters      1. Speed      2. Feed rate | * Written Tests * Practical Tests * Projects * Portfolio of Evidence |
| 1. Assemble parts | * 1. Assembly safety   2. Mechanical fasteners      1. Temporary      2. Permanent   3. Functionality | * Written Tests * Practical Tests * Projects * Portfolio of Evidence |
| 1. Carry out maintenance and housekeeping operations | * 1. Troubleshooting      1. Faults diagnosis   2. Types of maintenance      1. Preventive maintenance      2. Corrective maintenance      3. Condition based maintenance      4. Predictive maintenance      5. Break down maintenance   3. Servicing of bench work tools and equipment   4. Inspection of bench work tools and equipment   5. Workshop waste sorting and disposal      1. Types of waste         1. General waste         2. Hazardous waste         3. Recyclable waste         4. Organic waste         5. e-waste      2. Waste sorting procedure         1. Designated bins for different types of waste         2. Sorting by material         3. Pre-sorting hazardous waste      3. Hazardous waste disposal         1. Chemical waste         2. Used oil and solvents   6. Cleaning and storing of tools and equipment | * Written Tests * Practical Tests * Projects * Portfolio of Evidence |

**Suggested Delivery Methods**

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

**List of recommended resources (for 25 trainees)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning materials** | | | |
|  | Textbooks | Reference | 5 pcs | 1:5 |
|  | Charts | Display | Adequate |  |
|  | PowerPoint Presentations | For trainer’s use | Adequate |  |
|  | Overhead Projector | Display | 1 | 1:25 |
| **B** | **Learning facilities & infrastructure** | | | |
|  | Lecture/theory room | 15m by 10m | 1 | 1:25 |
|  | Workshop | 20m by 15m | 1 | 1:25 |
|  | Work benches | Bench work Operations | 8 | 1:4 |
| **C** | **Consumable materials** | | | |
|  | First aid kit | First aid | 1 | 1:25 |
|  | Ream of printing papers | Printing | Adequate |  |
|  | Cleaning detergents | Cleaning | Adequate |  |
|  | Cotton wool waste | Cleaning | Adequate |  |
|  | Grinding wheel | Grinding | Adequate |  |
|  | Assorted Flat bars | Work piece materials | Adequate |  |
|  | Assorted drill bits | For drilling | Adequate |  |
| **D** | **Tools and equipment** | | | |
|  | Hacksaws | Metal cutting | 25 pcs | 1:1 |
|  | Measuring tools   * Vanier calliper * Tape measure | Measurement | 5pcs  5pcs | 1:5 |
|  | Marking out tools | Marking out | 5 pcs | 1:5 |
|  | Pedestal grinding machine | Grinding | Adequate |  |
|  | Bench vices | Work holding | 10 | 1:2 |
|  | File card | File cleaning | 5 pcs | 1:5 |
|  | Firefighting equipment | Firefighting | Adequate |  |
|  | Inspection tools   * Vanier calliper * Tape measure | For inspection | 5pcs  5pcs | 1:5 |
|  | Pliers | Work holding/cutting | Adequate |  |
|  | Drilling machines | For drilling | Adequate |  |
|  | V-blocks | Supporting cylindrical work | 5 | 1:5 |
|  | Surface plates | Reference Surface | 2 | 2:25 |
|  | Angle grinders | Grinding | 5 | 1:5 |
|  | Assorted files | Filling | 10 | 2:5 |
|  | Clamps | Work clamping | 5 | 1:5 |
|  | Power hand tools | Metal cutting | 5 | 1:5 |
|  | Assorted hammers | Hammering | 5 | 1:5 |
|  | Jigs and fixture | Tool, work holding and guiding | Adequate |  |
|  | Saws | Metal cutting | 10 | 2:5 |

**WELDING OPERATIONS**

**UNIT CODE:** 0715 451 02A

**Relationship to Occupational Standards**:

This unit addresses the unit of competency: Join parts by welding

**Duration of Unit: 150 HRS**

**Unit Description**

This unit covers the competencies required in joining parts by welding. It involves carrying out manual metal arc welding, gas welding, brazing and soldering, MIG welding, TIG welding and maintaining welding equipment.

**Summary of Learning Outcomes**

By the end of the unit the student should be able to:

|  |  |  |
| --- | --- | --- |
| **S/NO** | **Learning Outcomes** | **Hours** |
|  | Carry out manual metal arc welding | 40 |
|  | Carry out gas welding, brazing and soldering | 40 |
|  | Carry out metal inert gas welding (MIG) | 30 |
|  | Carry out tungsten inert gas welding (TIG) | 30 |
|  | Maintain welding tools and equipment | 10 |
| **TOTAL** | | **150 HRS** |

**Learning Outcomes, Content and suggested assessment methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested**  **Assessment**  **Methods** |
| 1. Carry out manual metal arc welding | * 1. Safety      1. Personal protective equipment (PPE)         1. Head protection         2. Eye/ mouth protection         3. Body protection         4. Hand protection         5. Foot protections      2. Safe workplace         1. Workshop rules and regulations         2. Welding hazards            1. Electric shock            2. Fumes            3. Confined space      3. Machine safety         1. Equipment and accessories are in good Working conditions      4. House keeping         1. Cleaning, Organizing, and Storing MMAW Tools, Equipment, and Materials         2. Storage of Electrodes as per Stores Procedures         3. Store Records Types and Update Procedures         4. Cleaning of the MMAW Work Area         5. Waste Segregation and Disposal   2. Interpretation of working drawing      1. Definition of terms         1. Working drawing         2. Interpretation         3. Dimensions         4. Tolerance      2. Dimensions and Tolerances      3. International drawing standards         1. British Standard (BS)         2. American National and International Standards (ANSI)         3. International organization standards (ISO)         4. Welding drawings         5. Welding symbols and abbreviations      4. Free hand sketching         1. Use of drawing instruments/CAD   3. Machines, tools and equipment      1. Electrodes      2. Welding machine      3. Chipping hammer      4. Wire brush      5. Working table      6. Power supply.   4. Storage of electrodes      1. Dry and well-ventilated environment.      2. Air tight containers.   5. Workpiece preparation.      1. measurement      2. Material cutting.      3. Marking out.      4. alignment   6. welding symbols and weld positions      1. welding symbols         1. fillet         2. spot         3. butt         4. bevel      2. welding positions         1. flat position         2. horizontal position         3. vertical position         4. overhead position   7. Finishing of arc welded product      1. Buffing      2. Grinding      3. Polishing      4. Plating.      5. Electro-Coating.      6. Blasting      7. Brushing   8. Inspection of MMAW welding      1. Visual      2. Bending      3. Measuring. | * Written Tests * Practical tests * Portfolio of Evidence |
| 1. Carry out gas welding, brazing and soldering | * 1. Assembly of machine tools and equipment.      1. Parts of Oxyacetylene accessories.      2. Setting the oxyacetylene welding machine.   2. Workpiece preparation.      1. measurement      2. Material cutting.      3. Marking out.      4. alignment   3. Gas welding equipment      1. Gas hose pipes      2. Gas cylinders      3. Welding torch      4. Mixing chamber.   4. Gas welding operation on a 4mm thickness workpiece.      1. Types of flames         1. Oxidizing flames.         2. Carburizing flames.         3. Neutral flame.      2. Welding technique         1. Rightwards         2. Leftwards      3. Types of joints         1. Tee joint         2. Butt joint         3. Lap joint         4. Overlap joint      4. Welding defects         1. Spatters         2. Distortion         3. Cracks         4. Porosity      5. Welding procedure.   5. Gas cutting operation.      1. Machine parameters         1. Ratio of oxygen and acetylene.         2. Pressure.         3. Material thickness.   6. Perform brazing operation of material up to 4mm thick.      1. Brazing tools and equipment         1. Types         2. Uses         3. Care and storage      2. Brazing materials   (Types and applications)   * + - 1. Fluxes       2. Spelter     1. Brazing parameters   (Setting)   * + - 1. Flame       2. Working pressure     1. Brazing process        1. Procedure        2. Applications   1. Soldering operation of steel and copper up to 4mm thickness      1. Soldering tools and equipment         1. Types         2. Uses         3. Care and storage      2. Soldering materials   (Types and applications)   * + - 1. Fluxes       2. Solder     1. Soldering parameters   (Setting)   * + - 1. Temperature       2. Pressure     1. Soldering process        1. Procedure        2. Applications   1. Finishing operations   2. Inspection of the welded component | * Written Tests * Practical tests * Project Work * Portfolio of Evidence |
| 1. Carry out metal inert gas welding (MIG) | * 1. MIG welding equipment and accessories   (Types, uses and care)   * + 1. Inert gas cylinders     2. MIG welding torch     3. MIG welding tools     4. Fire extinguishers     5. Welding jigs and fixtures     6. Nozzle cleaners   1. Welding material preparation   (up to 12 mm thickness)   * + 1. Measuring     2. Marking out     3. Cutting     4. Edge preparation   1. MIG weldingparameters (Setting)      1. Working pressure      2. Current      3. Wire speed      4. Wire gauge   2. Materials   (up to 12 mm thickness)   * + 1. Plates     2. Steel     3. Aluminum   1. Welding positions (Description and Applications)      1. Flat      2. Horizontal      3. Vertical      4. Overhead   2. Types of joints   (Geometry and Applications)   * + 1. Butt joint     2. Lap joint     3. Corner joint     4. T-joint   1. Weld defects   (Types, causes and prevention)   * + 1. Porosity     2. Undercut     3. Incomplete penetration     4. Reinforcement     5. Spatters     6. Weld craters     7. Weld cracks     8. Distortion   1. Finishing processes (Procedure and applications)      1. Buffing      2. Polishing      3. Grinding      4. Deburring      5. Electroplating      6. Painting | * Written Tests * Practical tests * Project Work * Portfolio of Evidence |
| 1. Carry out tungsten inert gas welding (TIG) | * 1. TIG welding equipment and accessories   (Types, usage, care and storage)   * + 1. TIG torch     2. Tungsten electrode     3. Filler wire   1. Materials   (Types and usage)   * + 1. Filler rod     2. TIG process     3. (metals up to 16 mm thickness)     4. Procedure     5. Applications | * Written Tests * Practical tests * Project Work * Portfolio of Evidence |
| 1. Maintain welding tools and equipment | 1. Maintenance schedule is prepared as per manufacturers manual.    1. Cleaning of the external surfaces of the machine    2. Inspecting cables, connectors and power sources    3. Lubricating of moving parts 2. Welding Machines, tools and equipment are cleaned and lubricated as per the Manual. 3. Welding Machines, tools and equipment are inspected as per the Manual. 4. Faults on welding Machines, tools and equipment are identified and reported/rectified and as per sops.   Maintenance report is prepared as per the organization policy. | * Written Tests * Practical tests * Project Work * Portfolio of Evidence |

**Suggested Delivery Methods**

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

**Recommended Resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/Specifications** | **Quantity** | **Recommended Ratio (Item: Trainee)** |
| **A** | **Learning Materials** | | | |
|  | Textbooks | Comprehensive textbook on Welding and Fabrication | 1 | 1:25 |
|  | Drawing papers | A4, A3 and A2 size drawing papers for drafting of sketches and working drawings | Adequate |  |
|  | 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 * 12 mm thickness   Sheets   * Up to gauge 18 | Adequate |  |
|  | Tungsten electrodes | Electrodes used in TIG welding | Adequate |  |
|  | Electrodes | 2.5 mm and 3.2 mm rutile (fill-freeze) electrodes | Adequate |  |
|  | MIG welding wire | Acts as both the electrode and the filler material | Adequate |  |
|  | TIG welding wire | Used as filler rods | Adequate |  |
|  | Gas welding equipment | Oxygen cylinder | 3 | 3:25 |
| Acetylene cylinders | 3 | 3:25 |
| Set of hose pipes | 3 | 3:25 |
| Set of regulators | 3 | 3:25 |
| Spark lighter | 3 | 3:25 |
| spelters | 3 | 3:25 |
| solders | 3 | 3:25 |
| fluxes | 3 | 3:25 |
| Filler rod | 3 | 3:25 |
| Welding torch | 3 | 3:25 |
| Brazing torch | 3 | 3:25 |
| Soldering gun | 3 | 3:25 |
| Cutting torch | 3 | 3:25 |
| Welding tips | 3 | 3:25 |
|  | Arc welding machines and accessories | DC welding machines | 3 | 3:25 |
| AC welding machines | 3 | 3:25 |
| Electrode holder | 3 | 3:25 |
| Clamp holder | 3 | 3:25 |
| Single phase Electrode cables | 3 | 3:25 |
| 3 phase electrode cables | 3 | 3:25 |
|  | Grinding machine and accessories. | Grinding machine | 3 | 3:25 |
| Grinding disc | Adequate |  |
| Cutting disc | Adequate |  |
|  | Brooms and cleaning stuff | Hand brooms and mops for cleaning | Adequate |  |
|  | Cotton waste | Absorbent cotton waste for cleaning of oils and other dirt on machines, tools and equipment | Adequate |  |
|  | Cleaning detergents | General degreasers | Adequate |  |
| Floor detergents | Adequate |
| Hand detergents | Adequate |
| **D** | **Tools and Equipment** | | | |
| **Measuring tools** | | | | |
|  | Steel rules | Calibrated steel rules for linear measurements | 10 | 2:5 |
|  | Vernier calipers | Calibrated vernier calipers for linear measurements | 10 | 2:5 |
|  | 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 | 1 | 25 |
|  | Measuring tapes | Calibrated measuring tapes for linear measurements | 5 | 1:5 |
|  | Angle gauges | Calibrated angle gauges for angular measurements | 5 | 1:5 |
| **Marking out tools** | | | | |
|  | Scribers | Quality steel pencil scribers for marking out lines on metal surfaces | 10 | 2:5 |
|  | Dot punches | Quality steel dot punches for marking out centres | 10 | 2:5 |
|  | 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 | 10 | 2:5 |
|  | Hacksaws | Hack saws with functional frames and blades for cutting metal plates and pipes | 10 | 2:5 |
|  | 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 |
|  | 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 | 1 | 1:25 |
|  | TIG welding equipment | Functional welding equipment | 1 | 1:25 |
|  | Fire extinguisher | for ensuring safety in fabrication workshops where fire hazards are present, such as sparks | 5 | 1:5 |
|  | First Aid kit | Fully equipped First Aid kit for use in case of accidents | 5 | 1:5 |
|  | Welding gun | Feeds the filler wire into the weld pool | 5 | 1:5 |

**MODULE II**

**CONVENTIONAL LATHE MACHINE OPERATIONS**

**UNIT CODE :** 0715 351 03A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Operate Conventional Lathe Machine

**Duration of Unit: 150 HRS**

**Unit Description**

This unit covers the competencies required in operating a conventional lathe machine. It involves preparing working drawing, lathe operation plan and lathe cutting tools, setting up lathe machine, producing parts by lathe operations, inspecting finished work and maintaining lathe machine and tools.

**Summary of Learning Outcomes**

B**y** the end of the unit the learner should be able to

|  |  |  |
| --- | --- | --- |
| S/NO | **Learning Outcomes** | Hours |
|  | Interpret working drawings | 20 |
|  | Set Work piece and tool(s) on lathe machine | 20 |
|  | Setup lathe machine | 20 |
|  | Produce parts by lathe machine operations | 80 |
|  | Carry out Lathe maintenance | 10 |
| **TOTAL** | | **150 HRS** |

**Learning Outcomes, Content and suggested assessment methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **content** | **Suggested assessment methods** |
| 1. Interpret Working drawings | * 1. Extraction of information      1. Dimensions      2. Tolerances      3. BS/ANSI drawing standards      4. Geometric ISO symbols & abbreviations   2. Free hand sketching   3. Forms of supply of engineering materials   4. Definition of operation plan      1. Structure of an operation plan   5. Types of lathe machines   6. Parts of a lathe machine   7. Lathe machine operations      1. Knurling      2. reaming      3. Threading      4. Turning      5. Facing      6. Boring      7. Taper turning      8. Grooving      9. Parting off      10. Chamfering      11. Drilling   8. Machining parameters      1. Feed rate      2. Material removal rate      3. Spindle speed      4. Cutting speed      5. Depth of cut      6. Finishing allowance   9. Tools and accessories      1. Lathe Cutting tools      2. Measuring tools      3. Marking out tools      4. Lathe centres      5. Work holding devices   10. Workpiece materials       1. Mild steel bars and shafts       2. Nylon and ptfe round bars       3. Stainless bars and shafts       4. Brass round bars | * Written Tests * Practical tests * Project Work * Portfolio of Evidence |
| **2.** setWork piece and tool(s) on lathe machine | * 1. Lathe cutting tools      1. Knurling tools      2. Reamer      3. Thread cutting tools      4. Turning tools      5. Boring tools      6. Parting off tools      7. Drilling bits      8. Chamfering tools      9. Facing tools   2. Tool sharpening by grinding   3. Selection and mounting of Tool inserts      1. Threading insert      2. Turning insert      3. Boring insert      4. Parting insert | * Written Tests * Practical tests * Project Work * Portfolio of Evidence |
| 1. Setup lathe machine | * 1. Safety      1. PPE      2. Safe workplace      3. Machine safety         1. Machine Guard         2. Emergency buttons and foot brakes         3. Good Working condition   2. Workpiece preparation      1. Measuring and marking out      2. Cutting of work piece   3. Mounting of lathe machine accessories      1. Steady rest      2. Face plate      3. Travelling steady      4. Lathe dog      5. Mandrel      6. Chuck      7. Catch plate   4. Lathe machine attachments      1. Taper turning attachment      2. Grinding attachment      3. Copying attachment      4. Milling attachment   5. Mounting of workpiece      1. Truing   6. Tool setting on lathe machine      1. Tool centering   7. Coolants      1. Soluble oil      2. Importance      3. Composition | * Written Tests * Practical tests * Project Work * Portfolio of Evidence |
| 1. Produce parts by lathe machine operations | * 1. Trial testing      1. For wobble      2. Centering   2. Lathe machine operations      1. Knurling      2. Reaming      3. Threading      4. Turning      5. Facing      6. Boring      7. Taper turning      8. Grooving      9. Parting off      10. Chamfering      11. Drilling   3. Surface Finishing      1. Chamfering      2. Knurling      3. Grooving      4. Polishing   4. Inspection      1. Tools and equipment      2. Dimensional tolerances      3. Surface finish      4. Discrepancies         1. Rough surface         2. Chatter marks         3. Tears and grooves         4. Out of roundness         5. Incorrect thread pitch   5. Functionality | * Written Tests * Practical tests * Project Work * Portfolio of Evidence |
| 1. Carry out lathe maintenance | * 1. Types of maintenance      1. Preventive      2. Scheduled      3. Routine   2. Trouble shooting      1. Fault diagnosis   3. Servicing of lathe machine and accessories      1. Inspection      2. Storage      3. Lubrication      4. Alignment and adjustment   4. Maintenance report and logs   5. House keeping      1. Record keeping      2. Cleaning of work environment (waste sorting and disposal)   6. Cleaning and storage of finished work, tools and equipment | * Written Tests * Practical tests * Project Work * Portfolio of Evidence |

**Suggested Delivery Methods**

* Demonstration by trainer
* Group discussions
* Practical work by trainee(s)
* Industrial visits
* YouTube for teaching/learning and inspiration
* Simulation

**Recommended Resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** |  |  |  |
|  | Textbooks | For reference purpose | 1pc |  |
|  | Installation manuals | For reference purpose | 1pc | 1:25 |
|  | Charts | For illustration purpose | Adequate |  |
|  | Computer | Instruction | 10 | 1:5 |
| **B** | **Learning Facilities & Infrastructure** | | | |
|  | Lecture/theory room | 9 m ×12 m | 1 | 1:25 |
| Workshop | 20 m × 20 m | 1 | 1:25 |
| Laboratory | 9 m × 12 m | 1 | 1:25 |
| **Safety** | | | |
| Safety goggles | safety | 25 pcs | 1:1 |
| Leather glove | safety | 25 pcs | 1:1 |
| Helmet | safety | 25 pcs | 1:1 |
| Ear muffs | safety | 25 pcs | 1:1 |
| Overall | safety | 25 pcs | 1:1 |
| Safety boots | safety | 25 pcs | 1:1 |
| Dust mask | safety | 25 pcs | 1:1 |
| Face shield | safety | 25 pcs | 1:1 |
| **C** | **Consumable Materials** | | | |
|  | First aid kit | For first aid | 1 | 1:25 |
|  | Fire extinguisher | Fire fighting | Adequate |  |
|  | Ream of Drawing papers | drawing | Adequate |  |
|  | Cleaning detergents | Cleaning | adequate |  |
|  | Cutting fluid | For cooling the cutting and drilling tool | adequate |  |
|  | Machine oil as per machine manual | For lubrication of the machine | adequate |  |
|  | Cotton wool waste | For cleaning | adequate |  |
|  | soft brush | For cleaning | 25 pcs | 1:1 |
|  | **Raw material** | | | |
|  | Mild steel bar | Assorted | adequate |  |
|  | Round bar plastic | Assorted | adequate |  |
| **E** | **Tools and Equipment** | | | |
| 1 | **Measuring Tools** |  |  |  |
|  | Steel rule | For short length measurement | 25 pcs | 1:1 |
|  | Micrometer screw gauge | For measuring external diameters | 25 pcs | 1:1 |
|  | Vanier callipers | For measuring internal and external diameters | 25 pcs | 1:1 |
|  | Combination set | For angle measurements | 2pcs | 2:25 |
|  | Dial gauge indicator | For measuring of internal diameters | 3pcs | 3:25 |
|  | **Marking Out Tools** | | | |
|  | Vanier height gauge | For measuring of height of short objects | 2 pcs | 2:25 |
|  | Surface plate | For marking out | 2pcs | 2:25 |
|  | Angle plate | For marking out | 2pcs | 2:25 |
|  | Scribers | For marking out | 5 pcs | 1:5 |
|  | Divider | For marking out | 13pcs | 1:2 |
|  | V block | For placing of work pieces during measurements | 5 pcs | 1:5 |
|  | **lathe Cutting Tools** |  | | |
|  | Assorted Twist drills | For drilling | adequate |  |
|  | Turning tool | Turning operation | 8 | 8:25 |
|  | Threading tool | Threading operation | 8 | 8:25 |
|  | Facing tool | For work facing | 8 | 8:25 |
|  | knurling | For knurling operation | 8 | 8:25 |
|  | boring | For boring operation | 8 | 8:25 |
|  | grooving | For grooving operation | 8 | 8:25 |
|  | parting | For parting operation | 8 | 8:25 |
|  | reaming | For reaming operation | 8 | 8:25 |
|  | Centre drill | For drilling operation | 8 | 8:25 |
|  | **Power cutting tools** | | | |
|  | Reciprocating saw | Cutting | 1pc | 1:25 |
|  | Band saw | cutting |  |  |
|  | Hand grinder | grinding | 2 | 2:25 |

**MILLING OPERATIONS**

**UNIT CODE** : 0715 351 04A

**Relationship to Occupational Standards:**

This unit addresses the unit of competency: Operate Conventional Milling Machine

**Duration of Unit: 150 HRS**

**Unit Description**

This unit covers the competencies required in operating conventional milling machine. It involves preparing working drawing, preparing milling operation plan, preparing milling cutting tools, setting up milling machine, producing parts by milling operations, inspecting finished work and maintaining milling machine and tools

**Summary of Learning Outcomes**

By the end of the unit the student should be able to:

|  |  |  |
| --- | --- | --- |
| **S/NO** | **Learning Outcomes** | **Hours** |
|  | Interpret Working drawings interpretation | 20 |
|  | Set work piece and tool(s) on milling machine | 20 |
|  | Set up Milling machine | 20 |
|  | Produce parts by Milling machine operations | 80 |
|  | Carry out Milling machine maintenance | 10 |
| **TOTAL** | | **150 HRS** |

**Learning Outcomes, Content and suggested assessment methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested**  **Assessment Methods** |
| 1. Interpret Working drawings | * 1. Reading and extraction of information      1. Dimensions      2. Tolerances      3. BS/ANSI drawing standards      4. Geometric ISO symbols & abbreviations   2. Free hand sketching   3. Milling cutters and accessories   4. Types of milling machine      1. Vertical      2. Horizontal      3. Universal   5. Advantages and disadvantage of milling machines   6. Parts of the milling machine      1. Functions of each part   7. Milling machine operations      1. Face milling      2. Progressive milling      3. Profile milling      4. End milling      5. Form milling      6. Gang milling      7. Slot milling      8. Angular milling      9. Slitting      10. Slab milling      11. Straddle milling      12. Gear milling   8. Definition of operation plan      1. Structure of an operation plan   9. Milling operation sequence      1. Procedure   10. Milling parameters       1. Cutting speed       2. Feed rate       3. Material removal rate       4. Depth of cut   11. Milling machine tools and accessories       1. Work holding devices       2. Angular table       3. Rotary table       4. Dividing head       5. Plain table       6. clamps   12. Materials       1. Types       2. Mild steel       3. Brass       4. Aluminium   13. Forms of supply       1. Bars       2. Plates       3. shaft | * Written Tests * Practical tests * Project Work * Portfolio of Evidence |
| 1. Set work piece and tool(s) on milling machine | * 1. Safety      1. PPE      2. Safe workplace      3. Machine safety         1. Machine Guard         2. Emergency buttons and foot brakes      4. machine Working condition      5. Housekeeping operations         1. Record keeping         2. Cleaning of work environment (waste sorting and disposal)         3. Cleaning and storing of finished work, tools and equipment   2. Types of milling cutters   3. Grinding of milling cutters   4. Selection and mounting of Tool inserts      1. Types of inserts         1. Surface cutter insert         2. T slot cutter         3. Face cutter inserts         4. Slot milling inserts      2. Application of inserts | * Written Tests * Practical tests * Project Work * Portfolio of Evidence |
| 1. Set up Milling machine | * 1. Check the machine conditions      1. Functioning of control buttons      2. Oil level      3. Cutting fluid level      4. Machine is ready to use   2. Selection of Machine tools and accessories   3. Setting the milling machine tool and accessories   4. Mounting of work piece      1. Setting the work at the centre   5. Cutting fluids      1. Types      2. Composition      3. Selection and application      4. Importance   6. Setting the milling machine parameters      1. Feed rate      2. Depth of cut      3. Spindle speed | * Written Tests * Practical tests * Project Work * Portfolio of Evidence |
| 1. Produce parts by Milling machine operations | * 1. Safety during milling operation   2. Milling operation procedure   3. Milling machine parameters   4. Check and rectify the dimension discrepancies   5. Inspection      1. Tools and equipment      2. Dimension tolerances      3. Surface finish         1. visual inspection      4. Discrepancies   6. Functionality **test** | * Written Tests * Practical tests * Project Work * Portfolio of Evidence |
| 1. Carry out Milling machine maintenance | * 1. Types of maintenance      1. Preventive      2. Scheduled      3. Routine   2. Trouble shooting      1. Fault diagnosis   3. Servicing of milling machine, tools and accessories      1. Inspection      2. Storage      3. Lubrication      4. Alignment and adjustment   4. Maintenance report and logs | * Written Tests * Practical tests * Project Work   Portfolio of Evidence |

**Suggested Delivery Methods**

* Demonstration by trainer
* Discussions
* Practical work by trainee(s)
* Exercises
* Industrial visits
* YouTube for teaching/learning and inspiration
* Simulation

**Recommended Resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** |  |  |  |
|  | Textbooks | For reference | 5 pcs | 1:5 |
|  | Installation manuals | For reference | Adequate |  |
|  | Charts | For reference | Adequate |  |
|  | Computer | For instruction | 5 | 1: 5 |
| **B** | **Learning Facilities & Infrastructure** |  |  |  |
|  | Lecture/theory room | 9M × 12M | 1 | 1:25 |
|  | Workshop | 20M × 20M | 1 | 1:25 |
|  | Laboratory | 9M × 12M | 1 | 1:25 |
|  | Work benches | 1.5M × 1.2M | 7 | 1:4 |
|  | Bench Vices |  | 2 | 2:25 |
|  | **Safety** |  |  |  |
|  | Safety goggles |  | 25 pcs | 1:1 |
|  | Leather glove |  | 25 pairs | 1:1 |
|  | Ear muffs |  | 25 pcs | 1:1 |
|  | Overall |  | 25 pcs | 1:1 |
|  | Safety boots |  | 25 pairs | 1:1 |
|  | Dust mask |  | 25 pcs | 1:1 |
|  | Face shield |  | 25 pcs | 1:1 |
| **C** | **Consumable Materials** |  |  |  |
|  | First aid kit | Adequate |  |  |
|  | Cutting oil | Adequate |  |  |
|  | Fire extinguisher | Adequate |  |  |
|  | Ream of Drawing papers | Adequate |  |  |
|  | Cleaning detergents | Enough |  |  |
|  | Cotton wool waste | Enough |  |  |
|  | **Raw material** |  |  |  |
|  | Aluminum round bar | 1 length | 1pc | 1:25 |
|  | Mild steel round bar | 1 length | 1pc | 1:25 |
|  | Nylon / PTFE round bar |  | 1pc |  |
|  | Aluminum plate | 8ft×4ft | 1pc | 1:25 |
|  | Mild steel plate | 8ft×4ft | 1pc | 1:25 |
|  | Brass plate | 8ft×4ft | 1pc | 1:25 |
|  | Nylon / PTFE plate | 8ft×4ft | 1pc | 1:25 |
| **E** | **Tools and Equipment** |  |  |  |
|  | **Measuring Tools** |  |  |  |
|  | Steel rule |  | 25 pcs | 1:1 |
|  | Micrometre screw gauge |  | 5pcs | 1:5 |
|  | Vanier callipers |  | 5 pcs | 1:5 |
|  | Tri square |  | 25 pcs | 1:1 |
|  | Bevel protractor |  | 2pcs | 1:13 |
|  | Combination set |  | 2pcs | 1:13 |
|  | Measuring tapes |  | 5 pcs | 1:5 |
|  | **Marking Out Tools** |  |  |  |
|  | Vanier height gauge |  | 2 pcs | 1:13 |
| 1. \ | Surface plate |  | 2pcs | 1:13 |
|  | Angle plate |  | 2pcs | 1:13 |
|  | Scribers |  | 5 pcs | 1:5 |
|  | Dot punch |  | 5 pcs | 1:5 |
|  | Divider |  | 13pcs | 1:2 |
|  | Center punch |  | 5pcs | 1:5 |
|  | **Cutting Tools** |  |  |  |
|  | Plain milling cutters | set | 2pcs | 1:13 |
|  | Side milling cutters | set | 2pcs | 1:13 |
|  | End milling cutters | set | 2pcs | 1:13 |
|  | Face milling cutters | set | 2pcs | 1:13 |
|  | Surface cutter | set | 2pcs | 1:13 |
|  | Metal slitting cutters | set | 2pcs | 1:13 |
|  | Angle milling cutters | set | 2pcs | 1:13 |
|  | Milling machine |  | 2 pcs | 2:25 |
|  | **Milling inserts** |  |  |  |
|  | Side milling cutter | set | 3 pcs | 1:8 |
|  | Face milling cutter | set | 3pcs | 1:8 |
|  | Surface cutter | set | 3 pcs | 1:8 |
|  | **Finishing machine and materials** |  |  |  |
|  | Buffing machine |  | 3pc | 1:8 |
|  | Emery cloth |  | 1 roll | 1:25 |