

**REPUBLIC OF KENYA**

**COMPETENCY BASED MODULAR CURRICULUM**

**FOR**

**MECHANICAL PRODUCTION TECHNICIAN**

**KNQF LEVEL 6**

**PROGRAMME ISCED CODE: 0715 554A**

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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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# ABBREVIATIONS & ACRONYMS

CAD Computer Aided Design

CBET Competency Based Education and Training

CNC Computer numerical control

DC Direct Current

DVI Digital Visual Interface

HDMI High-Definition Multimedia Interface

MMAW Manual metal arc welding

PPE Personal Protective Equipment

RAM Random Access Memory

TVET Technical and Vocational Education and Training

TVETA Technical and Vocational Education and Training Authority

USB Universal Serial Bus

# KEY TO ISCED UNIT CODE



# COURSE OVERVIEW

Mechanical Production Level 6 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, lathe operations, milling operations, fabrication of sheet metal parts, grinding operations. forging works, foundry works, control systems, CNC milling machine operations, CNC lathe 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 | 150 | 15 |
| **MODULE II** | | | |
| 0715 351 03A | Lathe Operations | 150 | 15 |
| 0715 351 04A | Milling Operations | 150 | 15 |
| **MODULE III** | | | |
| 0031 441 05A | Communication skills | 40 | **4** |
| 0417 441 06A | Work ethics and practices | 40 | **4** |
| 0541 541 07A | Material Science and Metallurgy | 80 | 8 |
| 0541 451 08A | Applied Mathematics | **80** | **8** |
| 0541 451 09A | Mechanical science principles | **80** | **8** |
| 0715 451 10A | Fabricate Sheet Metal Parts | 120 | 12 |
| **MODULE IV** | | | |
| 0413 441 11A | Entrepreneurial skills | 40 | **4** |
| 0611 441 12A | Digital literacy | 40 | **4** |
| 0715 441 13A | Technical Drawing | **80** | **8** |
| 0732 451 14A | Electrical principles | **80** | **8** |
| 0715 451 15A | Grinding Operation | 120 | 12 |
| **MODULE V** | | | |
| 0715 541 16A | Thermo-Fluid Principles | 140 | 14 |
| 0541 541 17A | Engineering Mathematics | 100 | 10 |
| 0715 551 18A | Forging Works | 150 | 15 |
| **MODULE VI** | | | |
| 0732 551 19A | Computer Aided Drawing | 120 | 12 |
| 0715 541 20A | Engineering Mechanics Principles | 80 | 8 |
| 0715 551 21A | Foundry Works | 150 | 15 |
| **MODULE VII** | | | |
| 0713 541 22A | Control Systems | 160 | 16 |
| 0715 551 23A | CNC Milling Machine Operations | 150 | 15 |
| 0715 551 24A | CNC Lathe Operations | 150 | 15 |
| Industrial Training | | 640 | 64 |
| **GRAND TOTAL** | | **3240** | **324** |

**Entry Requirements**

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

1. Kenya Certificate of Secondary Education (KCSE) mean grade C- (Minus).

**Or**

1. Equivalent of KNQF Level 5 in related area

**Trainer qualification**

A trainer for this course must:

1. Have a minimum of KNQF level 7 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 640 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
   2. 30:70 for the units in modules III and IV; and
   3. 40:60 for the units in modules V, VI and VII.
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 TVET Certificate in Mechanical Production Technician KNQF Level 6, 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.

# 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** | | **140** |

**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** |

**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 |

**CONVENTIONAL MILLING MACHINE 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** |

**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 |

**MODULE III**

**COMMUNICATION SKILLS**

**UNIT CODE:** 0031 441 05A

**Duration of Unit:** **40 Hours**

**Relationship with Occupational Standards**

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

**Unit Description**

This unit covers the competencies required to apply communication skills. It involves 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 will 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 |

**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 06A

**Unit Duration: 40 Hours**

**Relationship with Occupational Standards**

**This unit addresses the Unit of Competency**: Apply work ethics and practices.

**Unit Description**

This unit covers competencies required to demonstrate employability skills. It involves 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 this unit of learning, the trainee will be able to:

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

**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 |  |

**MATERIAL SCIENCE AND METALLURGY**

**UNIT CODE:** 0541 541 07A

**Unit Duration: 80 HRS**

Relationship to Occupational Standards

**This unit addresses the Unit of Competency:** Apply Material Science and Metallurgy

**Unit Description**

This unit describes the competences required in order to apply materials and metallurgy. It includes evaluating properties of engineering materials, using iron materials, aluminium and its alloys, copper and its alloys, common non-metallic materials, performing metal testing and corrosion prevention, and applying heat treatment.

**Summary of Learning Outcomes**

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

|  |  |  |
| --- | --- | --- |
| **S/No.** | **Learning Outcome** | **Duration (Hours)** |
|  | Evaluate properties of engineering materials | 10 |
|  | Apply iron materials | 10 |
|  | Apply aluminium and its alloys | 10 |
|  | Apply copper and its alloys | 10 |
|  | Apply heat treatment | 10 |
|  | Perform metal testing | 10 |
|  | Apply common non-metallic materials | 10 |
|  | Apply material corrosion prevention | 10 |
|  | **TOTAL** | **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 and prevention      3. Workplace hazards (Types and prevention/control)         1. Physical         2. Chemical         3. Biological         4. Environmental   2. Types of Engineering Materials      1. Metals and alloys         1. Ferrous metals         2. Non-ferrous metals      2. Ceramics      3. Composites      4. Polymers (plastics)      5. Wood      6. Glass   3. Properties of Engineering Materials      1. Physical properties         1. Color         2. Lustre         3. Opacity         4. Texture      2. Mechanical properties         1. Strength         2. Hardness         3. Ductility         4. Malleability         5. Toughness         6. Rigidity         7. Elasticity         8. Plasticity         9. Brittleness      3. Thermal properties         1. Melting point         2. Specific heat capacity         3. Linear expansivity   4. Forms of Supply of Engineering Materials   (Description and applications)   * + 1. Ingots     2. Bars     3. Plates     4. Pellets     5. Tubes     6. Pipes     7. Sheets     8. Strips     9. Wires     10. Powder   1. Mill Test Certificates      1. Interpretation      2. Usage | * Written tests * Portfolio of Evidence |
| 2.Apply iron materials | * 1. Categories of iron materials:      1. Cast Iron      2. Plain carbon steels      3. Alloy steels      4. Wrought iron   2. Properties, advantages, and disadvantage of      1. Cast Iron      2. Plain carbon steels      3. Alloy steels      4. Wrought iron   3. Applications and Care      1. Cast Iron         1. Grey cast iron         2. white cast iron         3. spheroidal cast iron         4. ductile iron cast iron         5. malleable cast iron      2. Wrought iron      3. Plain carbon steels         1. Low carbon         2. mild steel         3. Medium carbon         4. High carbon         5. Very high carbon      4. Alloy steels         1. Stainless steels         2. Tool steels         3. Heat resisting steels | * Written tests * Portfolio of Evidence |
| 3. Apply aluminium and its alloys | * 1. Aluminium and Aluminium Alloys: Properties, Applications and Care      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. Advantages of aluminium and its alloys in engineering | * Written tests * Portfolio of Evidence |
| 1. Apply copper and its alloys | * 1. Copper and Copper Alloys: Properties, Applications and Care      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. Advantages of copper and its alloys in engineering | * Written tests * Portfolio of Evidence |
| 1. Apply heat treatment | * 1. Definition and Objectives of Heat Treatment   2. Heat Treatment Processes: Description, Advantages, Limitations, and Applications      1. Annealing      2. Normalizing      3. Hardening      4. Quenching      5. Case hardening         1. Carburizing         2. nitriding         3. cyaniding         4. induction hardening         5. flame hardening   3. Heat treatment furnaces   4. General Safety Processes During Heat Treatment |  |
| 1. Perform metal testing | * 1. Metal Inspection Machines, Tools and Equipment: Types, Usage and Care      1. Test Metal surface preparation         1. descaling         2. Polishing         3. Etching      2. Tools         1. Pneumatic tools         2. Gauges         3. Electromagnets      3. Machines         1. Hardness testing machines         2. Tensile testing machines         3. Compressive testing machine         4. Bending testing machine         5. Universal testing machine         6. Ultrasonic testing machine         7. Radiography   2. Consumables      1. Films      2. Ferromagnetic Materials      3. Dyes   3. Non-destructive Metal Test: Types and Applications      1. Visual inspection      2. Ultrasonic inspection      3. Magnetic particle induction      4. Radiography inspection      5. Dye penetrant      6. Eddy current testing   4. Destructive Metal Test Parameters      1. Tensile strength      2. Yield strength      3. Hardness      4. Impact resistance   5. Destructive Metal Tests: Procedure and Applications      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   6. Maintenance of Metal Testing Tools, Machines and Equipment      1. Lubrications      2. Belt adjustments      3. Scheduling      4. Record keeping | * Written tests * Practical’s * Project * Portfolio of Evidence |
| 7. Apply common non-metallic materials | * 1. Properties and Applications of Non-Metallic Materials      1. Composites      2. Polymers (Plastics)      3. Ceramics      4. Wood      5. Glass   2. Handling of materials      1. Storage of materials ,      2. Disposal of Non-Metallic Materials         1. Adopt circular economy         2. Reduce material waste         3. Encourage biodegradable materials         4. Recycle through solar powered recycling units | * Written tests * Portfolio of Evidence |
| 1. Apply material corrosion prevention | * 1. Corrosion Types      1. Galvanic      2. Stress corrosion cracking   2. Methods of Corrosion Prevention      1. Painting      2. Electroplating      3. Galvinizing      4. Cathodic      5. Chromizing | * Written tests * Portfolio of Evidence * Written tests * Portfolio of Evidence |

**Suggested Delivery Methods**

* 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 | 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 30 trainees, approximately 60 sqm | 1 | 1:30 |
|  | Materials Testing Workshop | Standard workshop with work benches and material testing machines and equipment | 1 | 1:30 |
| **C** | **Materials and Supplies** | | | |
|  | Dust coat/ overall | Shields skin and regular clothes from sparks | 30 | 1:1 |
|  | 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 |
|  | Raw materials | Steel, aluminum, copper and cast iron  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 |
| **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 | 1:10 |
|  | 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 |  |  |  |
| **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 |

**APPLIED MATHEMATICS**

**UNIT CODE:** 0541 451 08A

**Unit Duration: 80 Hours**

**Relationship with Occupational Standards**

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

**Unit Description**

This unit describes the competences required in order to apply algebra, apply trigonometric and hyperbolic functions, carry out mensuration and Apply statistics and probability

**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 |

**Suggested Delivery Methods**

* Demonstration
* Group discussions
* 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 30 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 |

**MECHANICAL SCIENCE PRINCIPLES**

**UNIT CODE:** 0541 451 09A

**Unit Duration**: **80 hours**

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

**Unit Description**

This unit describes the competences required in order to apply mechanical science. It includes 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 Outcome** | **Duration (Hrs)** |
|  | Resolve forces | 10 |
|  | Determine effects of loads in mechanical systems. | 20 |
|  | Analyze properties of materials. | 10 |
|  | Determine the nature of friction in mechanical systems | 20 |
|  | Solve problems related to motion. | 20 |
|  | **Total hours** | **80** |

**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 |

**SHEET METAL PARTS FABRICATION**

**UNIT CODE:** 0715 451 10A

**Unit Duration: 120 hours**

**Relationship to Occupational Standards:**

**This unit addresses the unit of competency**: Fabricate Sheet Metal Parts

**Unit Description**

This unit covers the competencies required in fabricating sheet metal parts. It involves preparing working drawing, sheet metal work operation plan and sheet metal work piece, performing sheet metal work operations, inspecting finished work, maintaining sheet metal work tools and equipment.

**Summary of Learning Outcomes**

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

|  |  |  |
| --- | --- | --- |
| **S/No.** | **Learning Outcome** | **Duration (Hours)** |
|  | Interpret working drawing | 10 |
|  | Prepare sheet metal work operation plan | 10 |
|  | Prepare sheet metal work piece | 30 |
|  | Perform sheet metal work operations | 60 |
|  | Maintain sheet metal work tools and equipment | 10 |
| **TOTAL** | | **120** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Interpret working drawing | * 1. Working drawing interpretation      1. Definition of terms         1. Working drawing         2. Dimensions         3. Tolerance         4. Pattern development      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. drawing symbols and abbreviations   2. Free hand sketching   3. Pattern development      1. Types of pattern layouts         1. Parallel         2. Radial         3. Triangulation | * Written Tests * Practical tests * Portfolio of Evidence |
| 1. Prepare sheet metal work operation plan | * 1. Work plan   2. Sheet metal work operations      1. Cutting      2. Drilling      3. Folding      4. Bending      5. Notching      6. Painting      7. Shearing      8. Punching      9. Stretching      10. Embossing   3. Sheet metal tools and equipment      1. Types      2. Uses      3. Care and storage   4. Types and sizes of Materials      1. Mild steel      2. Galvanized      3. Stainless steel      4. Aluminum      5. Sheet metal gauges | * Written Tests * Practical tests * Portfolio of Evidence |
| 1. Prepare sheet metal work piece | * 1. Workshop safety      1. Rules and regulations      2. Personal protective equipment         1. PPEs         2. Gloves         3. Safety boots         4. Safety glasses         5. Face shields      3. Machine safety      4. Occupational safety and health act, 2007      5. Housekeeping      6. Cleaning      7. Waste management      8. Electrical wiring color coding      9. Danger warning signage      10. Barricades      11. High voltage signage      12. Fire extinguishers      13. Health policy   2. Measuring and marking out   3.3 Produced the pattern | * Written Tests * Practical tests * Project Work * Portfolio of Evidence |
| 1. Perform sheet metal work operations | * 1. Sheet metal work operations   2. Sheet metal joining methods      1. Permanent         1. Welding         2. Brazing         3. Soldering         4. Riveting      2. Temporary         1. Mechanical fasteners   3. Forming techniques      1. Bending      2. Blanking      3. Punching      4. Embossing      5. Drawing      6. Roll forming      7. Stretch forming      8. Pressing   4. Finishing operations      1. Surface grinding      2. Polishing      3. Bluffing      4. Painting      5. Electroplating      6. Deburring      7. Heat treatment      8. Corrosion prevention   5. Inspection tools and equipment      1. Callipers      2. Height gauges      3. Thickness gauge      4. Dial indicators      5. Visual inspection tools         1. Magnifying glass         2. Endoscope         3. LED inspection lights   6. Inspection of:      + 1. Dimension tolerances        2. Surface finish        3. Discrepancies           1. Dents           2. Wrinkles        4. Riveting/welding faults        5. Functionality test   7. Report writing      1. Faults      2. Discrepancies      3. Action taken   8. Recommendation for improvement | * Written Tests * Practical tests * Project Work * Portfolio of Evidence |
| 1. Maintain sheet metal work, tools and equipment | * 1. Types of maintenance      1. Preventive      2. Scheduled      3. Routine   2. Trouble shooting      1. Fault diagnosis   3. Cleaning of sheet metal tools and equipment   4. Maintenance report | * Written Tests * Practical tests * 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 30 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
|  | Textbooks | For reference purpose | 1 | 1:30 |
|  | Charts | For reference purpose | Adequate |  |
| **B** | **Learning Facilities & Infrastructure** | | | |
|  | Lecture/theory room | 9MX12M | 1 | 1:30 |
|  | Workshop | 20MX20M | 1 | 1:30 |
| **C** | **Consumable Materials** | | | |
|  | Filler rods | Per session | 30 | 1:1 |
|  | Flux | Per session | Adequate |  |
|  | Oxygen & acetylene gas | Per session | Set of 2 | 2:30 |
|  | First aid kit | For safety | 1 | 1:30 |
|  | Fire extinguisher | For fire fighting | 1 | 1:30 |
|  | Ream of Drawing papers |  | adequate |  |
|  | Drawing instruments | Per person | 1 set | 1:1 |
|  | Cleaning detergents | Degradants | Adequate |  |
| Floor detergents | Adequate |
| Hand detergents | Adequate |
|  | Cotton wool waste |  | Adequate |  |
| **D .Raw material** | | | | |
|  | Aluminum round bar | Adequate |  |  |
|  | Mild steel bar | Adequate |  |  |
|  | Black sheet | Adequate |  |  |
| **E** | **Testing materials** |  |  |  |
|  | Endoscope | Visual inspection | 3 | 3:30 |
|  | Magnifying glass | Visual inspection | 3 | 3:30 |
| **F** | **Tools and Equipment** |  |  |  |
|  | **Measuring Tools** |  |  |  |
|  | Steel rule | For linear measurement | 10 | 2:5 |
| Micrometre screw gauge | For external measurements | 5 | 1:5 |
| Vernier callipers | For internal measurements | 5 | 1:5 |
| Try square | For right angles measurements | 5 | 1:5 |
| Bevel protractor | For angular measurement | 2 | 2:30 |
| Combination set | For angular measurements | 2 | 2:30 |
| Measuring tapes | For measuring length | 5 | 1:5 |
|  | **Marking Out Tools** |  |  |  |
|  | Vernier height gauge | For height measurement | 2 | 2:30 |
| \ | Surface plate | Reference for dimensional measurement | 2 | 2:30 |
|  | Angle plate | For holding workpiece square to table during marking out | 2 | 2:30 |
|  | Scribers | For marking out | 10 | 2:5 |
|  | Dot punch | For making small marks on workpiece | 10 | 2:5 |
|  | Divider | For length transfer from drawings | 13 | 1:2 |
|  | Centre punch | To mark centres when drilling | 5 | 1:5 |
|  | **Hand Cutting Tools** |  |  |  |
|  | Snips | To cut sheet metal | 10 | 2:5 |
| Rolling machine | To compress metal | 2 | 2:30 |
| Chipping hammer | To remove slug from welds | 30 | 1:1 |
| Punching machine | For embossing sheet material | 2 | 2:30 |
| Hand shearing machine | For cutting metal plates | 1 | 1:30 |
|  | Bending machine | For bedding a workpiece | 2 | 2:30 |
|  | **Power cutting tools** |  |  |  |
|  | Reciprocating saw | For cutting metal | 1 | 1:30 |
| Gas cutting machine | For cutting metal | 2 | 2:30 |
| Guillotine machine | For cutting metal into specific shapes | 1 | 1:30 |
| Band saw | For cutting | 1 | 1:30 |
| Hand grinder | For grinding | 5 | 1:5 |
|  | **Finishing equipment** |  |  |  |
|  | Grinding wheel |  | 12pcs | 1:2 |
| Emery cloth | Coarse | adequate |  |
| Fine | adequate |
| Buffing machine | For polishing metal | 2 | 2:30 |

**MODULE IV**

**ENTREPRENEURIAL SKILLS**

**UNIT CODE:** 0413 441 11A

**Unit Duration: 40 Hours**

**Relationship with occupational standards**

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

**Unit Description:**

This unit covers the competencies required to demonstrate an understanding of entrepreneurship. It involves 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 will be able to:

|  |  |  |
| --- | --- | --- |
| **S/No.** | **Learning Outcome** | **Duration (Hours)** |
|  | Apply financial literacy | 6 |
|  | Apply the entrepreneurial concept | 4 |
|  | Identify entrepreneurship opportunities | 6 |
|  | Apply business legal aspects | 6 |
|  | Innovate Business Strategies | 6 |
|  | Develop business Plan | 12 |
|  | **Total hours** | **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 |  |

**DIGITAL LITERACY**

**UNIT CODE:** 0611 441 12A

**Unit Duration: 40 Hours**

**Relationship with Occupational Standards**

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

**Unit Description**

This unit covers the competencies required to demonstrate digital literacy. It involves 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 will 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 |
|  | **Total Hours** | **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. Remo task      2. Data annotation tech      3. Cloud worker      4. Up work      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 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 |  |

**TECHNICAL DRAWING**

**UNIT CODE:** 0715 541 13A

**Duration of Unit:** 80 hours

**Relationship to Occupational Standards**

**This unit addresses the unit of competency**: Apply technical drawing

**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**

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

|  |  |  |
| --- | --- | --- |
| **S/No.** | **Learning Outcome** | **Duration (Hours)** |
|  | Use technical drawing tools, equipment and materials | 5 |
|  | Produce plane geometry drawings | 10 |
|  | Produce orthographic drawings of components | 15 |
|  | Produce solid geometry drawings | 15 |
|  | Produce Isometric drawings | 15 |
|  | Produce assembly drawings | 20 |
|  | **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 |

**ELECTRICAL PRINCIPLES**

**UNIT CODE:** 0732 551 14A

**Unit Duration:** 80 Hours

**Relationship with Occupational Standards**

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

**Unit Description**

This unit describes the competences required in order to apply electrical and electronics principles. It involves 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 Outcome** | **Duration (Hours)** |
|  | Apply basic concepts of electrical quantities | 10 |
|  | Apply DC and AC circuits | 10 |
|  | Apply the concept of cells and batteries | 10 |
|  | Apply magnetism and electromagnetism | 10 |
|  | Apply basic electrical machines | 20 |
|  | 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. Internal resistance of cells and electromotive force, e.m.f.   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 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/Specifications** | **Quantity** | **Recommended Ratio (Item: Trainee)** |
| **A** | **Learning Materials** | | | |
| 1 | Textbooks | Comprehensive texts on electrical and control principle. | 5 pcs | 1:5 |
| 2 | Charts | Visual aids covering electrical theories and safety protocols | 10 pcs | 1:2.5 |
| 3 | PowerPoint Presentations | For trainer’s use, covering course content and practical applications | 1 | 1:25 |
| **B** | **Learning Facilities & Infrastructure** | | | |
| 1 | Lecture/Theory Room | Equipped with projectors and seating for 25 trainees, ~60 sqm | 1 | 1:25 |
| 2 | Workshop | Hands-on training area with workbenches, tools, and safety equipment, ~80 sqm | 1 | 1:25 |
| 3 | Computer Laboratory | Equipped with testing setups for electrical experiments, ~50 sqm.  Equipped with computers installed with Circuit simulation software. | 25 | 1:1 |
| **C** | **Consumable Materials** | | | |
| 1 | Electrical Wires | Assorted sizes and color-coded (e.g., 1.5mm², 2.5mm², 4mm²) | 5 rolls | 1:5 |
| 2 | Insulation Tapes | For securing connections and insulation, assorted colors | 25 pcs | 1:1 |
| 3 | Breadboard | For prototyping and testing circuits | 5 pcs | 1:5 |
| 4 | Sensors | Assorted types (temperature, pressure, proximity) | 10 pcs | 1:2.5 |
| 5 | Signal generators | For generating AC signals | 5pcs | 1:5 |
| 6 | Transducers | Assorted | 10 pcs | 1:3 |
| 7 | Electronic components | Resistors, transistors, capacitors, relays, transformers. Integrated IC, OPAM. | 100pcs | 4:25 |
| **D** | **Tools and Equipment** | | | |
| 1 | Screwdrivers | Assorted sets for various applications | 2 sets | 1:12.5 |
| 2 | Side Cutters | For cutting wires and cables | 4 pcs | 1:6.25 |
| 3 | Pliers | For gripping and bending wires | 3 pcs | 1:8.33 |
| 4 | Stripping Knives | For stripping insulation from wires | 4 pcs | 1:6.25 |
| 5 | Computers | Equipped with electrical and electronics simulation software | 5 pcs | 1:5 |
| 6 | Multimeters | For measuring voltage, current, and resistance | 5 pcs | 1:5 |
| 7 | Clamp Meters | For measuring current flow in circuits | 5 pcs | 1:5 |
| 8 | Oscilloscope | For observing waveforms and signals | 1 | 1:25 |
| 9 | Voltmeter | For measuring voltage | 1 | 1:25 |
| 10 | Ammeter | For measuring current | 1 | 1:25 |
| 11 | Signal Generator | For generating electrical signals for testing | 1 | 1:25 |
| 12 | Soldering gun | For soldering | 10 | 1:3 |
| 13 | Soldering wire | For making joints in electrical circuits | 10 | 1:3 |
| 14 | PLC | For program practice | 5 | 1:5 |
| 15 | Cells and batteries | For learning | 5 | 1:5 |
|  |  |  |  |  |
| **E** | **PPE (Personal Protective Equipment)** | | | |
| 1 | PPE Sets | Includes helmets, gloves, safety goggles, shoes, and harnesses | 25 sets | 1:1 |
| 2 | Safety Signs and Barriers | For simulating safety zones and hazards | 10 sets | 1:2.5 |
| 3 | Earthing Test Kits | For ground testing and demonstrating earthing procedures | 5 pcs | 1:5 |
| 4 | Electrical Test Benches | For hands-on testing of functionality and circuit design | 5 pcs | 1:5 |
| **F** | **Reference Materials** | | | |
| 1 | Industrial Automation Manuals | Covering principles and practices in automation | 25 pcs | 1:1 |
| 2 | Electrical Standards | Reference on industry standards (e.g., IEEE Guidelines) | 5 pcs | 1:5 |
| 3 | Technical Handbooks | On motors, drives, and wiring systems | 25 pcs | 1:1 |
| 4 | Training Presentations/Slides | Digital format for shared access among trainees | 1 | 1:25 |
| 5 | Multimedia Learning Modules | Digital licenses for videos and tutorials | 25 pcs | 1:1 |
| 6 | Practical Assessment Guides | Worksheets for practical assessments | 25 pcs | 1:1 |

**GRINDING OPERATIONS**

**UNIT CODE :** 0715 451 15A

**Duration of Unit :** **100 Hours**

**Relationship to Occupational Standards:**

**This unit addresses the unit of competency**: Perform Grinding Operations

**Unit Description**

This unit covers the competencies required in performing grinding operations. It involves preparing grinding operation plan, setting up grinding machine, operating grinding machine, inspecting ground component, maintaining grinding machine and tools.

**Summary of Learning Outcomes**

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

|  |  |  |
| --- | --- | --- |
| **S/No.** | **Learning Outcome** | **Duration (Hours)** |
|  | Prepare grinding operation plan. | **10** |
|  | Set up grinding Machine | **20** |
|  | Operate grinding machines. | **80** |
|  | Maintain grinding machine and tools. | **10** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcomes** | **Content** | **Suggested Assessment Method** |
| 1. Prepare grinding operation plan. | * 1. Working drawing interpretation      1. Definition of terms         1. Working drawing         2. Interpretation         3. Dimensions         4. Tolerance      2. Dimensions and Tolerances   2. Types of grinding machines and their parts      1. Portable grinding machine      2. Bench grinding machine      3. Pedestal grinding machine      4. Surface grinding machine      5. Cylindrical grinding machine      6. Precision grinding machine      7. Non-precision grinding machine   3. Grinding wheels      1. Types of grinding wheel         1. Grade         2. Size of the grit         3. Thickness      2. Selection         1. According to the grinding machine      3. Mounting and balancing      4. Maintenance         1. Wheel dressing (diamond dresser)         2. Wheel truing (Huntington, diamond dresser)   4. Workpiece Preparation      1. Measuring and Marking out      2. Cutting   5. Grinding Operations      1. Surface grinding      2. Cylindrical grinding      3. Centreless grinding      4. Internal grinding | * Written Tests * Practical tests * Portfolio of Evidence |
| 1. Set up grinding Machine | * 1. Safety      1. PPE      2. Safe workplace      3. Machine safety         1. Machine Guard         2. Emergency buttons         3. Good Working condition   2. Inspection of Grinding Machine      1. Machine good working condition      2. All the control buttons are functional   3. Mounting of Grinding Wheel      1. Procedure of mounting      2. Grinding wheel alignment      3. Wheel balancing      4. Wheel setting   4. Cutting Fluids      1. Machinable Soluble oils   5. Grinding Machine Parameters      1. Feed and Speed      2. Feed rate | * Written Tests * Practical tests * Portfolio of Evidence |
| 1. Operate grinding machines. | * 1. Clamping the work piece      1. Clamping methods   2. Carry out grinding Operations      1. Cylindrical grinding      2. Centreless grinding      3. Internal grinding      4. Surface grinding   3. Monitoring grinding machine performance      1. Speed      2. Feed      3. alignment | * Written Tests * Practical tests * Project Work * Portfolio of Evidence |
| 1. Maintain grinding machine and tools. | * 1. Assembling of inspection tools and equipment      1. Try Square      2. Spirit level   2. Visual inspection      1. Roughness      2. Proportionalism/eccentricism      3. Chatter      4. Feed lines or spirals on work piece      5. Out-of-round hole distortion   3. Inspection Report   4. Cleaning and lubrication of grinding machine and tools   5. Inspection of grinding discs and tools      1. Wheel loading      2. Chatter      3. glazing   6. Dressing and truing of grinding wheel      1. Wheel truing      2. Wheel dressing   7. Replacement of      1. worn-out wheels      2. cracked discs      3. worn out magnetic brushes   8. Maintenance reports   9. Housekeeping | * Written Tests * Practical tests * Portfolio of Evidence |

**Suggested Delivery Methods**

* Demonstration
* Group discussions
* Practical work by trainee(s)
* Industrials visits
* YouTube for teaching/learning and inspiration.

**Recommended Resources for 30 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** |  |  |  |
|  | Textbook | For reference | 1 pc | 1:30 |
|  | Charts | For illustration | Adequate |  |
| **B** | **Learning Facilities & Infrastructure** |  |  |  |
|  | Lecture/theory room | 9MX12M | 1 | 1:30 |
|  | Workshop | 20MX20M | 1 | 1:30 |
|  | **Holding devices** |  |  |  |
|  | Jigs and fixture |  |  |  |
|  | Work benches | 1.5MX1.2M | 5 | 1:5 |
|  | Bench Vices |  | 5 | 1:5 |
| **C** | **Consumable Materials** |  |  |  |
|  | First aid kit | For safety | 1 | 1:30 |
|  | Fire extinguisher | For firefighting | 1pc | 1:30 |
|  | Ream of Drawing papers | For drawing | Adequate |  |
|  | Drawing instruments | For illustration | 1 set | 1:1 |
|  | Cleaning detergents | For cleaning | Adequate |  |
|  | Grinding paste | For grinding | Adequate |  |
|  | Emery cloth |  | Adequate |  |
|  | Cutting fluid | For cooling | Adequate |  |
|  | Machine oil | For lubrication | Adequate |  |
|  | Cotton wool waste | For cleaning | Adequate |  |
|  | soft brush | To remove chips | 5pcs | 1:5 |
| **D** | **Raw material** |  |  |  |
|  | Aluminum round bar | 1 length | 1pc | 1:30 |
|  | Mild steel bar | 1 length | 1pc | 1:30 |
|  | Brass bar | 1 length | 1pc | 1:30 |
|  | Metal plate | 8ftx4ft | 1pc | 1:30 |
| **E** | **Protective Gears** |  |  |  |
|  | Safety goggles | For safety | 30 pcs | 1:1 |
|  | Leather glove | For safety | 30 pcs | 1:1 |
|  | Helmet | For safety | 30 pcs | 1:1 |
|  | Ear muffs | For safety | 30 pcs | 1:1 |
|  | Overall | For safety | 30 pcs | 1:1 |
|  | Leather apron | For safety | 30 pcs | 1:1 |
|  | Safety boots | For safety | 30 pcs | 1:1 |
|  | Dust mask | For safety | 30 pcs | 1:1 |
|  | Face shield | For safety | 30 pcs | 1:1 |
| **F** | **Tools and Equipment** |  |  |  |
|  | **Measuring Tools** |  |  |  |
|  | Steel rule | For measurement of length | 10 pcs | 2:5 |
|  | Micrometre screw gauge | For external measurement | 5pcs | 1:5 |
|  | Vernier callipers | For internal measurement | 5 pcs | 1:5 |
|  | Combination set | For angular measurements | 2pcs | 2:30 |
|  | Dial gauge indicator | For measuring flatness, roundness | 1pc | 1:30 |
|  | Measuring tape |  | 3pcs | 3:30 |
|  | **Marking Out Tools** | | | |
|  | Vernier height gauge | For height measurement | 2 pcs | 1:13 |
| 1. \ | Surface plate | Reference for dimensional measurement | 2pcs | 1:13 |
|  | Angle plate | For holding workpiece square to the table during marking out | 2pcs | 1:13 |
|  | Scribers | For marking out | 5 pcs | 1:5 |
|  | Divider | For length transfer from drawings | 13pcs | 1:2 |
|  | V block | For holding cylindrical objects | 5 pcs | 1:5 |
| **G** | **Grinding machines** | | | |
|  | Pedestal grinder | For sharpening | 3pcs | 1:8 |
|  | Vertical Surface grinder | For grinding or polishing metal | 3 pcs | 3:30 |
|  | Horizontal surface grinder | For turning metals | 3 pcs | 3:30 |
|  | Hand grinder | For grinding | 8pcs | 3:30 |
|  | Bench grinder | For sharpening | 3 pcs | 3:30 |
|  | Tool grinding | For grinding | 1pcs | 1:30 |
| **H** | **Grinding Cutting Tools** | | | |
|  | Course grinding wheel | For grinding | 3 sets | 3:30 |
|  | Fine grinding wheel | For smoothing | 3 sets | 3:30 |
|  | Diamond dresser |  | 3 sets | 3:30 |
|  | **Power cutting tools** |  |  |  |
|  | Reciprocating saw | For cutting metal | 1pc | 1:30 |
|  | Band saw | For cutting metal |  | 1:30 |
|  | Hand grinder | For grinding | 5pcs | 1:5 |

# MODULE V

## **THERMO-FLUID PRINCIPLES**

**ISCED UNIT CODE:** 0715 541 16A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Apply thermodynamics and fluid mechanics

**Duration of Unit:** **140 hours**

**Unit Description**

This unit describes the competences required in order to apply thermodynamics and fluid mechanics in their work. It includes applying steady flow processes, perfect gas, steam cycles, fuel and combustion. It also includes applying heat transfers and exchangers, fluid mechanics concepts and operating of air compressors and fluid pumps.

**Summary of Learning Outcomes**

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

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcome** | **Course Duration** |
|  | Apply Thermodynamic Processes | 10 |
|  | Apply knowledge of perfect gases | 10 |
|  | Apply knowledge of steam cycle | 10 |
|  | Apply knowledge of fuel combustion | 20 |
|  | Apply heat transfer and heat exchangers in fluid | 20 |
|  | Operate air compressors | 20 |
|  | Apply the knowledge of the flow of fluids | 20 |
|  | Apply the knowledge of viscous flow of fluids | 20 |
|  | Apply dimensional and models analysis fluids | 30 |
|  | Operate fluid pumps | 20 |
| **Total** | | **140** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Apply Thermodynamic Processes | * 1. Basic thermodynamics terms definition      1. work,      2. Power      3. Internal Energy      4. Heat      5. Temperature   2. Laws of Thermodynamics      1. First law of thermodynamics      2. Second law of thermodynamics      3. Zeroth law of thermodynamics   3. Thermodynamic Processes      1. Non-flow Process.      2. Constant Volume Process      3. Constant Pressure Process      4. Hyperbolic Process.      5. Constant Temperature Process      6. Adiabatic Process      7. Polytropic Process.   4. Thermodynamics systems      1. Boundary and surrounding      2. Closed systems      3. Open systems      4. Isolated systems      5. Adiabatic system      6. Homogeneous systems      7. Heterogeneous systems   5. Heating and expansions of gases      1. Determine work done      2. Application of First Law of Thermodynamics      3. Reversible non-flow processes.      4. Irreversible non-flow processes   6. General Laws for Expansion and Compression      1. Define the terms:         1. Expansion         2. compression      2. Apply PVn = Constant for various values of n      3. Curves of pressure against volume for various values of n (index)   7. Application of Steady Flow Energy Equation to:      1. boilers      2. condensers      3. nozzles      4. diffusers      5. compressors      6. turbines | * Written tests |
| 1. Apply knowledge of perfect gases | * 1. Laws of Perfect Gases      1. Boyle's Law      2. Charles' Law      3. Gay-Lussac Law      4. Joule's Law      5. Avogadro's Law   2. General Gas Equation      1. Derive and apply general gas equation PV=nRT   3. Characteristic Equation of Gas      1. Application in engineering calculations   4. Universal Gas Constant      1. Define universal gas constant      2. Apply universal gas constant equation in engineering calculation   5. Specific Heat      1. Constant Volume      2. Constant Pressure | * Written tests |
| 1. Apply knowledge of steam cycle | * 1. Steam cycles      1. Rankine         1. Schematic diagram of a steam engine or turbine plant.         2. Determine Rankine efficiency         3. T-S and h-s graphs         4. Modified Rankine Cycle         5. Work-done using Rankine equations         6. Efficiency of Modified Rankine Cycle         7. Theoretical loss of work per kg of steam due to incomplete expansion         8. Loss in Rankine efficiency due to restricted expansion of steam         9. Enthalpy- entropy chart      2. Carnot         1. Draw schematic diagrams of Carnot engine         2. Carnot Cycle with Steam as Working Substance         3. Performance Criteria for Carnot Cycle      3. Reheat         1. T-S diagram of reheat steam cycle         2. Determine work-done using reheat equations         3. Determine efficiency of reheat cycles      4. Regenerative         1. Ideal regenerative cycle diagram         2. Regenerative Cycle with Single Feed Water Heater         3. Regenerative cycle with single feed water heater diagram         4. Determine work-done by Regenerative cycle         5. Determine Regenerative cycle efficiency         6. Regenerative Cycle with Two Feed Water Heaters and its efficiency   2. Thermodynamics steam turbines      1. Characteristics of steam turbines      2. classification of Steam Turbines      3. Pressure and Velocity of Steam in an Impulse Turbine      4. Velocity Triangles for Moving Blade of an Impulse Turbine      5. Combined Velocity Triangle for Moving Blades      6. Power Produced by an Impulse Turbine | * Written tests |
| 1. Apply knowledge of fuel combustion | * 1. Elements and Compounds of fuel      1. Define of terms         1. Element         2. Compound         3. Atoms         4. Molecules         5. Atomic Mass         6. Molecular Mass      2. Element and symbols table sketches   2. Combustion Equations of Fuels and calculations      1. Balanced Combustion Equations of Solid Fuels      2. Write a balanced Combustion Equations of Gaseous Fuels   3. Conversion analysis of fuels      1. Theoretical or Minimum Volume of Air Required for Complete Combustion      2. Conversion of Volumetric Analysis into Mass Analysis or Gravimetric Analysis      3. Conversion of Mass Analysis into Volumetric Analysis   4. Mass of Carbon in Flue Gases      1. Calculation of mass of carbon, contained in 1 kg of flue or exhaust gases   5. Mass of Flue Gases per kg of Fuel Burnt      1. Calculate the mass of dry flue gases by comparing the mass of carbon present in the flue gases with the mass of carbon in the fuel.   6. Excess Air Supplied calculations      1. Mass of excess air supplied by the mass of unused oxygen, found in the flue gases.      2. Total mass of air supplied   7. Flue Gas Analysis by Ors at Apparatus      1. Components      2. Use of the apparatus      3. Operation      4. Diagram sketches | * Written tests |
| 1. Apply heat transfer and heat exchangers in fluid | * 1. Heat transfer media      1. Heat Transfer methods:         1. Conduction         2. Convection         3. Radiation      2. Newton's Law of Cooling      3. Derivation and application of Fourier's\* Law of Heat Conduction equation   2. Heat Transfer by Conduction   through   * + 1. Slab        1. Thermal Conductivity        2. Temperature Gradient     2. Composite Wall     3. Thick Cylinder     4. Thick Sphere   1. Overall Coefficient of Heat Transfer      1. Heat exchangers | * Written tests |
| 1. Operate air compressors | * 1. Classification of air compressors      1. According to working      2. According to action      3. According to number of stages   2. Single Stage Reciprocating Air Compressor      1. Work done by a Single Stage Reciprocating Air Compressor without Clearance Volume   3. Work done during      1. isothermal compression      2. polytropic compression (pv" = Constant)      3. isentropic compression   4. Power Required to Drive a Single-stage Reciprocating Air Compressor      1. Calculations   5. Work-done by Reciprocating Air Compressor with Clearance Volume      1. Calculations      2. Determine Multistage Compression   6. Power Required to Drive a Two-stage Reciprocating Air Compressor   7. Minimum Work Required for a Two-stage Reciprocating Air Compressor | * Written tests |
| 1. Apply knowledge of flow of fluids | * 1. Types of Fluid Flow      1. Steady and unsteady flows      2. Uniform and non-uniform flows      3. Rotational and irrotational flows      4. Laminar and turbulent flows      5. Compressible and incompressible flows   2. Loss of Energy (or Head) in Pipes      1. Darcy-weisbach formula      2. Chezy’s formula for loss of head due to friction      3. Loss of head due to sudden enlargement      4. Loss of head due to sudden contraction      5. Loss of head due to obstruction in pipe      6. Loss of head at the entrance to pipe      7. Loss of head at the exit of a pipe      8. Loss of head due to bend in the pipe   3. Hydraulic Gradient and Total Energy Lines      1. Pipes in Series or Compound Pipes      2. Pipes in Parallel      3. Power Transmission through Pipes | * Written tests |
| 1. Apply knowledge of viscous flow of fluids | * 1. Flow of viscous flow      1. Flow of Viscous Fluid in Circular Pipes      2. Flow of Viscous Fluid through an Annulus      3. Flow of Viscous Fluid Between Two Parallel Plates         1. One plate moving and other at rest         2. Both plates at rest         3. Both plates moving in opposite directions      4. Kinetic energy correction and momentum      5. Power Absorbed in Viscous Flow      6. Viscous Resistance of Journal Bearings      7. Viscous Resistance of Foot-step      8. Viscous Resistance of Collar Bearing | * Written tests |
| 1. Apply dimensional and models analysis fluids | * 1. Definition of terms      1. Dimensional homogeneity      2. Methods of solving dimensional analysis         1. Rayleigh’s theorem         2. Buckingham π theorem   2. Dimensional analysis similitude      1. Geometric      2. Kinematic      3. Dynamic   3. Dimensionless Numbers      1. Reynold’s Number (Re )      2. Froude’s Number (Fe )      3. Euler’s Number (Eu )      4. Weber’s Number (We )      5. Mach’s Number ( M )   4. Model test analysis and calculations      1. Classification of Models         1. Undistorted Models         2. Distorted Models         3. Scale Ratios for Distorted Models | * Written tests |
| 1. Operate fluid pumps | * 1. Principles of operation of:      1. Reciprocating pumps      2. Centrifugal pumps   2. Derivation of equations for a reciprocating pump      1. Coefficient of discharge      2. percentage slip      3. Work done      4. Acceleration head      5. Friction head      6. Pressure head in the cylinder   3. Application of reciprocating pumps equations to solve problems   4. Derivation of equations for a centrifugal pump      1. Effective head      2. Manometric head      3. efficiency      4. Mechanical efficiency      5. Discharge      6. Torque      7. Work done unit weight      8. Specific speed   5. Application of centrifugal pumps equations to solve problems | * Written tests |

**Suggested Delivery Methods**

* Group discussions
* Demonstration by trainer
* Online videos
* Power point presentation
* Exercises by trainee

**Recommended Resources for 30 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/Specifications** | **Quantity** | **Recommended Ratio (Item: Trainee)** |
| **A** | **Learning Materials** | | | |
|  | Textbooks | * + - 1. Applied Thermodynamics For Engineering Technology (fifth edition) by T.D. Eastop and A. McConkey       2. Engineering Thermodynamics by R.K.Rajput       3. A Textbook Of Fluid Mechanics And Hydraulic Machines by R.K.Rajput       4. A Textbook Of Fluid Mechanics And Hydraulic Machines by R.K Bansal | 30 |  |
|  | 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** | | | |
| 4. | Lecture/Theory Room | Spacious room with seats for 25 trainees, approximately 60 sqm | 1 | 1:30 |
| **C** | **Materials and Supplies** | | | |
|  | Dust coat/ overall | Shields skin and regular clothes from sparks | 30 | 1: |
|  | Fire extinguishers | Protect against fire | 30 | 3 |
|  | First Aid kit | Fully equipped First Aid kit for use in case of accidents | 1 | 1:30 |
|  |  |  |  |  |

## **ENGINEERING MATHEMATICS**

**Unit Code:** 0541 541 17A

**Unit Duration: 100** Hours

**Relationship to Occupational Standards**

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

**Unit Description**

This unit describes the competences required in order to apply engineering mathematics. It enables the learner to; apply complex numbers, perform coordinates geometry, carry out binomial expansion, apply vector theorem, apply matrices and apply Calculus.

**Summary of Learning Outcomes**

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

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcome** | **Duration ( Hours)** |
|  | Apply complex numbers | 10 |
|  | Perform coordinate geometry | 10 |
|  | Carry out binomial expansion | 20 |
|  | Apply Vector Theorem | 40 |
|  | Matrices | 10 |
|  | Apply Calculus | 10 |
| **Total** | | **100** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Apply complex numbers | * 1. Complex geometry      1. Real part      2. Imaginary part      3. Argand diagram      4. Modulus/Magnitude      5. Argument /Angle      6. Conjugate   2. Operations      1. Addition      2. Subtraction      3. Multiplication      4. Division      5. Conversions         1. Polar form to rectangular form         2. Rectangular form to polar form   3. De Moivre’s theorem      1. Expansion of complex numbers      2. Roots of complex numbers      3. Trigonometric identities using complex numbers | * Written tests |
| 1. Perform coordinate geometry | * 1. Cartesian geometry      1. Cartesian plane         1. x and y axes         2. Positive and negative coordinates      2. Gradient         1. Positive         2. Negative         3. Zero         4. Infinite         5. Gradients of parallel line         6. Gradients of perpendicular lines      3. y-intercept   2. Linear equations      1. Straight line      2. Parallel lines      3. Perpendicular lines   3. Graphs of linear equations      1. Straight lines   4. Polar geometry      1. Magnitude      2. Direction      3. Graphs   5. Conversions      1. Linear to polar      2. Polar to linear   6. Solving polar equations | * Written tests |
| 1. Carry out binomial expansion | * 1. Binomial series      1. Powers      2. Coefficients      3. Pascals triangle      4. Expansion   2. Binomial theorem      1. Positive powers of n      2. Negative powers of n      3. Fractional powers of n (roots)      4. Estimation of errors of small changes | * Written tests |
| 1. Apply vector theorem | * 1. Differentiate between vector and scalar quantities      1. Magnitude      2. Direction         1. Positive         2. Negative   2. Operation on vectors      1. Addition      2. Subtraction   3. Resolution of vectors      1. Analysis | * Written tests |
| 1. Apply matrices | * 1. Matrices      1. Types         1. Row         2. Column         3. Square         4. Zero         5. Identity         6. Diagonal   2. Matrices operations of a 2 x 2 and 3 x 3      1. Addition      2. Subtraction      3. Multiplication   3. Inverse of matrices of a 2 x 2 and 3x3      1. Determinant      2. Transpose      3. Adjoint      4. Inverse   4. Simultaneous equations of 2 equations and 3 equations   Inverse method  Cramers rule |  |
| 1. Apply calculus | Differentiation upto third order   * + 1. Functions        1. Linear        2. Trigonometric        3. Logarithmic        4. Exponential     2. Rules        1. Power        2. Product        3. Chain        4. Quotient     3. Applications        1. Stationary points        2. Rates of change   1. Integration      1. Standard integral      2. Definite integral      3. Techniques         1. By parts         2. Substitution         3. Partial fractions      4. Applications         1. Area between and under curves   Volume  6.2.5 Differential equations  6.2.6 Double and triple integrals  6.2.7 Laplace tranforms  6.2.8 Fourier Series |  |

**Suggested Delivery Methods**

* Demonstration
* Group discussions
* Exercises
* 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 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 |
|  | Brooms and cleaning stuff | Hand brooms and mops for cleaning | 10 | 2:5 |
| **D** | **Tools and Equipment** | | | |
|  | Set of Mathematical instruments | For constructions and measurements | 30 | 1:1 |
|  | Firefighting extinguishers | Water, carbon dioxide and chemical powder fire extinguishers for fire fighting | 1 | 1:30 |
| **F** | **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 |

## **FORGING WORKS**

**ISCED UNIT CODE:** 0715 551 18A

**Relationship to Occupational Standards:**

This unit addresses the unit of competency: Perform Forging Works

**Duration of Unit: 150 HRS**

**UNIT DESCRIPTION**:

This unit covers the competencies required in performing forging works. It involves preparing working drawing, preparing forging operation plan, preparing forging workpiece, operating forging equipment, performing forging operations, inspecting forged components and maintaining forging tools and machines.

**Summary of Learning Outcomes**

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

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcome** | **Course Duration** |
|  | Prepare working drawing | 10 |
|  | Prepare forging operation plan | 10 |
|  | Prepare forging workpiece | 10 |
|  | Set up forging tools and equipment | 10 |
|  | Perform forging operations | 80 |
|  | Inspect forged components | 20 |
|  | Maintain forging tools, machines and equipment | 10 |
| **Total** | | **150** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested**  **Assessment**  **Methods** |
| 1. Prepare working drawing | * 1. Interpretation of working drawing.      1. Definition of terms         1. Working drawing         2. Dimensions         3. Tolerance      2. Dimensions and Tolerances      3. Types of dimensions         1. Linear         2. Angular         3. Diametral         4. Radial         5. Geometric         6. Ordinate      4. Types of tolerances         1. Dimensional tolerance         2. Geometric tolerance         3. Surface tolerance         4. Assembly tolerance      5. International drawing standards         1. British Standard (BS)         2. American National and International Standards (ANSI)         3. International organization standards (ISO)         4. drawing symbols and abbreviations   2. Free hand sketching   3. Use of drawing instruments/CAD * Detailed drawing | * Written tests * Practical tests |
| 1. Prepare forging operation plan | * 1. Forging operations      1. Definition of terms         1. Forging         2. Die         3. Punching         4. Preform         5. Flash         6. Swaging         7. Mandrel      2. Cold forging      3. Impact         1. Press         2. Roll         3. Swaging         4. Extrusion         5. Die      4. Hot forging         1. Die         2. Upset         3. Roll         4. Swaging         5. Hollow   2. Tools, equipmentand accessories      1. Hammers      2. Anvil      3. Die      4. Tongs      5. Presses      6. Heating furnace   3. Types of material      1. Ferrous      2. Non-ferrous   4. Forms of Material supply      1. Plates      2. Bars      3. Tubes      4. Rods   5. Defination of operation plan      1. Structure of an operation plan      2. Sequence of forging operations | * Written tests * Practical tests |
| 1. Prepare forging workpiece | * 1. Workshop safety      1. Rules and regulations      2. Personal protective equipment      3. Machine safety      4. Occupational safety and health act, 2007      5. Housekeeping   2. Workpiece preparation      1. Cleaning      2. Measuring      3. marking out      4. cutting      5. heating      6. preforming | * Written tests * Practical tests |
| 1. Set up forging tools and equipment | * 1. Forging tools and equipment      1. Presses         1. Hydraulic press         2. Mechanical press      2. Heating furnace      3. Hammers      4. Dies      5. Rolling mills      6. Trimming machine   2. Forging equipment parameters      1. Force      2. Blank size      3. Power      4. Forging projection area      5. Fillet volume      6. Ideal work of deformation      7. Friction force      8. Interface shear      9. Temperature | * Written tests * Practical tests |
| 1. Perform forging operations | * 1. Forging procedure      1. Material selection      2. Material heating      3. Tool and die set up      4. Placement of material into the die      5. Applying forging force      6. Trimming and flash removal      7. Cooling      8. Finishing   2. Finishing processes      1. Polishing      2. Buffing      3. Machining      4. Heat treatment | * Written tests * Practical tests * projects |
| 1. Inspect forged components | * 1. Inspection of:      1. Dimension tolerances      2. Surface finish      3. Functionality   2. Inspection Tools and equipment      1. Dimensional inspection tools         1. Callipers         2. Micrometre         3. Gauges      2. Surface finish inspection tools         1. Profilometers      3. Visual inspection tools         1. Magnifying glass         2. Endoscope   3. Forging Discrepancies      1. Cracks      2. Scale formations      3. Wrinkles      4. Pits   4. Inspection reports | * Written tests * Practical tests * Project |
| 1. Maintain forging tools, machines and equipment | * 1. Types of maintenance      1. Preventive      2. Scheduled      3. Routine   2. Trouble shooting      1. Fault diagnosis   3. Servicing of forging machine and accessories      1. Inspection      2. Storage      3. Lubrication   4. Maintenance report and logs | * Written tests * Practical tests |

**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 | A comprehensive text book on forging | 1 | 1:1 |
|  | Charts | A comprehensive chart on forging | Adequate |  |
| **B** | **Learning Facilities & Infrastructure** |  |  |  |
|  | Lecture/theory room | 9M×12M | 1 | 1:25 |
|  | Workshop | 20M×20M | 1 | 1:25 |
| **C** | **Consumable Materials** |  |  |  |
|  | First aid kit |  | 1 |  |
|  | Safety Equipment (PPE) |  | 25 sets | 1:1 |
|  | Fire extinguisher |  | 3 |  |
|  | Ream of Drawing papers |  | 1 ream |  |
|  | Drawing instruments |  | 25 | 1:1 |
|  | Lubricants |  | 20 litres |  |
|  | Cleaning detergents | Degreasants. | adequate |  |
| Floor detergents | adequate |
| Hand detergents | adequate |
|  | Cotton wool waste |  | adequate |  |
|  | **Raw material** |  |  |  |
|  | Ferrous | Mild Steel | 20kg | 4:5 |
|  | Non ferrous | aluminium | 10kg | 2:5 |
| **D** | **Testing materials** |  |  |  |
|  | Endoscope | Visual inspection | 5 | 1:5 |
|  | Magnifying glass | Visual inspection | 10 | 2:5 |
|  | Dye penetrant | Non- destructive testing | 10 litres | 2:5 |
|  | Hardness testing machine | Vickers | 1 | 1:25 |
| Rockwell | 1 | 1:25 |
| Brinell | 1 | 1:25 |
| **E** | **Tools and Equipment** |  |  |  |
|  | **Measuring Tools** |  |  |  |
|  | Steel rule |  | 25 | 1:1 |
|  | Micrometre screw gauge |  | 5 | 1:5 |
|  | Vernier callipers |  | 5 | 1:5 |
|  | Tri square |  | 25 | 1:1 |
|  | Bevel protractor |  | 2 | 2:25 |
|  | Combination set |  | 2 | 2:25 |
|  | Measuring tapes |  | 5 | 1:5 |
| **F** | **Marking Out Tools** |  |  |  |
|  | Vernier height gauge |  | 2 | 2:25 |
| 1. \ | Surface plate |  | 2 | 2:25 |
|  | Angle plate |  | 2 | 2:25 |
|  | Scribers |  | 25 | 1:1 |
|  | Dot punch |  | 10 | 2:5 |
|  | Divider |  | 10 | 2:25 |
|  | Centre punch |  | 5 | 1:5 |
| **G** | **Power cutting tools** |  |  |  |
|  | Reciprocating saw |  | 1 | 1:25 |
|  | Pedestal Drilling machine |  | 2 | 2:25 |
|  | Band saw |  | 1 |  |
|  | Hand grinder |  | 2 | 2:25 |
| **H** | **forging tools and equipment** | | | |
|  | Hammers | Sledge | 25 | 1:1 |
|  | Anvil |  | 5 | 1:5 |
|  | Die | Open | 13 | 1:2 |
| Closed | 13 | 1:2 |
|  | Tongs |  | 13 | 1:2 |
|  | Presses | Mechanical | 1 | 1:25 |
| Hydraulic | 1 | 1:25 |
|  | Heating furnace |  | 1 | 1:25 |
| 5 | **Finishing equipment** |  |  |  |
|  | Grinding wheel |  | 12pcs | 1:2 |
|  | Emery cloth | Coarse | Adequate |  |
| Fine | Adequate |
|  | Buffing machine |  | 2 | 2:25 |

# MODULE VI

## **COMPUTER AIDED DRAWING**

**ISCED UNIT CODE:** 0732 551 19A

**UNIT DURATION: 120 HOURS**

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Perform computer aided drawing.

**Unit description**

This unit covers the competences required to perform computer aided drawing.It involves navigating CAD software, producing geometric, pictorial, orthographic and assembly drawings as well as designing mechanical components.

**Summary of Learning Outcomes**

By the end of the Unit of Learning, the trainee will be able to;

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcome** | **Course Duration** |
|  | Navigate CAD software | 10 |
|  | Produce geometric drawings | 10 |
|  | Produce pictorial drawings | 20 |
|  | Produce orthographic drawings. | 20 |
|  | Produce assembly drawings | 30 |
|  | Design mechanical components | 30 |
| **Total** | | **120** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Navigate CAD software | * 1. Overview of CAD      1. Definition and significance of CAD in engineering and design.      2. Historical development of CAD technologies.   2. Computing Equipment and Software      1. Identify hardware requirements for CAD operations.      2. List popular CAD software options (e.g., AutoCAD, SolidWorks, Inventor).   3. Drawing CAD Software      1. Overview of the software interface.      2. Functions and capabilities of CAD tools.   4. CAD Software Templates      1. Explore various templates available for different drawing requirements.   5. Importing CAD Files      1. Process of importing files (DWG, STL, DXF, STEP) into the working space.   6. User Interface Navigation      1. Familiarization with the CAD software interface.      2. Understanding toolbars, menus, and command lines.   7. Setting Up the Drawing Environment      1. Units and measurement settings.      2. Creating a new drawing and saving files.   8. Symbols, Codes, and Standards      1. Identify relevant symbols and codes according to software functionality.   9. Understand and utilize drawing Elements      1. Points      2. Line angles      3. Circles and arcs      4. Planes (horizontal, vertical)      5. Figures and solids      6. Shapes      7. Objects snapping settings      8. Polar tracking settings.      9. Ortho-mode utilization   10. Use editing commands Editing Tools       1. Delete, undo and redo commands       2. Fillet and chamfer commands       3. Trim, extend and break commands       4. Zoom and pan commands       5. Move, copy, and paste commands       6. Rotate and mirror commands       7. Object snapping and grouping commands       8. Dimension and scaling commands | * Written tests * Oral Questioning * Portfolio of evidence |
| 1. Produce geometric drawings | * 1. Setting Drawing Lines      1. Recognize standard drawing line conventions * Dimension lines * Hidden detail lines * Extension lines * Section lines * Break lines * Chain   1. Using drawing lines   2. Constructing Types of Angles      1. Use trigonometry principles to construct acute, obtuse, and right angles.   3. Constructing Geometrical Forms      1. Create circles, rectangles, triangles, and polygons according to standards.   4. Developing Geometric Drawings      1. 2-Dimensional      2. Orthographic      3. Isometric | * Written tests * Oral Questioning * Portfolio of evidence |
| 1. Produce pictorial drawings | * 1. Drawing Symbols and Abbreviations      1. Apply standard drawing symbols and abbreviations in pictorial drawings.   2. Producing Pictorial Drawings      1. Techniques for creating isometric, oblique, cabinet, and cavalier drawings.   3. Saving Pictorial Drawings      1. Procedures for saving drawings in appropriate formats. |  |
| 1. Produce orthographic drawings. | * 1. Fundamentals of Orthographic Projection      1. Definition and importance of orthographic drawing.      2. Differences between orthographic and other drawing types (isometric, perspective).   2. Types of Orthographic Projections      1. First-angle projection.      2. Third-angle projection.   3. Understanding Views      1. Front, top, and side views.      2. Additional views (sectional, auxiliary).   4. First Angle Orthographic Drawings      1. Develop first-angle drawings adhering to standard conventions.   5. Third Angle Orthographic Drawings      1. Create third-angle drawings based on standard practices.   6. Saving Orthographic Drawings      1. Techniques for properly saving orthographic drawings.   7. Dimensioning Orthographic Views   8. Printing orthographic views   9. Creating isometric drawing      1. Choosing isometric cursor      2. Dimensioning isometric drawing      3. Printing isometric drawing   10. Creating 3D model       1. Choosing 3D workspace       2. 3D workspace modifying tool (3D orbit, 3D mirrors, union, extrude, press pull, e.t.c)       3. Rendering       4. Pring 3D models | * Written tests * Oral Questioning * Portfolio of evidence |
| 1. Produce assembly drawings | * 1. Overview of Assembly Drawings      1. Definition and purpose of assembly drawings.      2. Importance in manufacturing and engineering.   2. Types of Assembly Drawings      1. General assembly drawings vs. detailed assembly drawings.      2. Exploded view vs. isometric assembly drawings.   3. Exploding Orthographic Views      1. Techniques for exploding views in accordance with standard conventions.   4. Exploding Pictorial Views      1. Create exploded pictorial views based on drawing specifications.   5. Assembling Views      1. Assemble orthographic and pictorial views accurately.   6. Producing Sectional Views      1. Generate sectional views according to drawing standards.   7. Developing Parts List      1. Creating a parts list based on the drawing schematic. | * Written tests * Oral Questioning * Portfolio of evidence |
| 1. Design mechanical components | * 1. Designing Mechanical Components      1. Apply CAD principles to design mechanical components per work requirements.   2. Applying CAE in Simulation      1. Use computer-aided engineering tools for simulating mechanical designs.   3. Determining Improvements      1. Analyze design results to identify efficiency improvements.   4. Creating a Manufacturing Database      1. Develop a database to support the manufacturing process.   5. Improving Design Documents      1. Make enhancements to design documents based on manufacturing feedback.   6. Practical Activity | * Written tests * Oral Questioning * Portfolio of evidence |

**Suggested Delivery Methods**

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

**Recommended resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/Specifications** | **Quantity** | **Recommended Ratio**  **(Item)** |
| **A** | **Learning Materials** | | | |
| 1 | Textbooks | Comprehensive texts on CAD basics, history, and hardware requirements. | 5 pcs | 1:5 |
| 2 | Charts | Visual aids covering CAD software evolution and industry applications. | 10 pcs | 1:2.5 |
| 3 | PowerPoint Presentations | For trainer’s use, covering CAD definitions, history, and hardware requirements. | 1 | 1:25 |
| **B** | **Learning Facilities & Infrastructure** | | | |
| 1 | Lecture/Theory Room | Equipped with projector, seating for 25 trainees, ~60 sqm. | 1 | 1:25 |
| 2 | Computer Laboratory | Equipped with 25 computers installed with CAD software, ~80 sqm. | 25 | 1:1 |
| 3 | Printer/plotter | For printing CAD drawings | 2 | 1:13 |
| 4 | 3D printer | For printing 3D models | 2 | 1:13 |
| 5 | 3D printer filament | 3D printing material | 2 rolls | 1:13 |
| **C** | **Consumable Materials** | | | |
| 1 | USB Drives | For storing and transferring CAD project files. | 25 pcs | 1:1 |
| 2 | Notebooks | For trainees to take notes during CAD sessions. | 25 pcs | 1:1 |
| **D** | **Tools and Equipment** | | | |
| 1 | Computers | Equipped with CAD software and compatible hardware (e.g., high RAM, graphics support). | 25 pcs | 1:1 |
| 2 | Projector | For displaying CAD software demonstrations and presentations in lecture room. | 1 | 1:25 |
| 3 | External Hard Drives | For backing up CAD files and course materials. | 5 pcs | 1:5 |
| 4 | Drawing Tablets | For CAD software use, supporting stylus input for design precision. | 5 pcs | 1:5 |
| **E** | **Reference Materials** | | | |
| 1 | CAD Software Manuals | Documentation detailing CAD software functionalities and hardware requirements. | 25 pcs | 1:1 |
| 2 | CAD Industry Case Studies | Case studies showcasing CAD applications in engineering and design. | 5 pcs | 1:5 |
| 3 | Practical Assessment Guides | Worksheets for practical assessments on CAD navigation and hardware requirements. | 25 pcs | 1:1 |
| 4 | Training Presentations/Slides | Digital format for shared access among trainees covering CAD course content. | 1 | 1:25 |

## **ENGINEERING MECHANICS PRINCIPLES**

**UNIT CODE: 0715 541 16A**

**Relationship to Occupational Standards**: Apply Engineering Mechanics

**Duration of Unit**: 120 Hours

**Unit Description**

This unit of competency describes the competences required in order to apply engineering mechanics principles. This includes, applying simple mechanisms, designing belts, ropes and chain drives, designing toothed gears and gear trains, designing mechanical rotor dynamic machines, applying stress and strain concepts, determining loading conditions, applying simple bending theory and applying torsion theory in mechanical systems.

**Summary of Learning Outcomes**

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

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcome** | **Duration (Hours)** |
|  | Simple Mechanisms | 10 |
|  | Belts, Ropes and Chain Drives | 10 |
|  | Toothed Gears and Gear Trains | 10 |
|  | Mechanical Rotor Dynamic Machines | 10 |
|  | Stress and Strain Concepts in Mechanical Systems | 10 |
|  | Loading Conditions in Mechanical Systems | 10 |
|  | Simple Bending Theory in Mechanical Systems | 10 |
|  | Torsion Theory in Mechanical Systems | 10 |
| **Total** | | **80** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. simple mechanisms | * 1. Define simple mechanism   2. Components of simple mechanism      1. Link      2. Element   3. Types of mechanisms      1. Single slider mechanism      2. Double slider mechanism | * Written Tests |
| 1. belts, ropes and chain drives | * 1. Definition      1. Belt      2. Rope      3. Chain   2. Belts      1. Material used for belt         + 1. Rubber           2. Cotton           3. Leather      2. Types of belts   2.2.2.1 Flat  2.2.2.2 V belt  2.2.2.3 Circular   * + 1. Configuration of belt drive   2.2.3.1Open   * + - 1. Crossed     1. Design Analysis of Flat and V-Belts   2.2.4.1Velocity ratio   * + - 1. Length of belt       2. Angle of contact       3. Power transmitted   1. Rope Drives      1. Types of rope drives   2. Chain Drives      1. Types of chain drives | * Written Tests |
| 1. toothed gears and gear trains | * 1. Types of Gears      1. Spur      2. Helical      3. Double helical   2. Types of Gear Trains      1. Simple gear train         1. Design calculations      2. Compound gear train         1. Design calculations      3. Reverted gear train         1. Design calculations      4. Epicyclic gear train   3. Lubrication of gears | * Written Tests |
| 1. Design mechanical rotor dynamic machines | * 1. Types of pumps and operation principle      1. Reciprocating pump      2. Centrifugal pump   2. Derivation of equations for      1. Reciprocating pumps      2. Centrifugal pumps   3. Analysis of pumps      1. Discharge      2. Efficiency      3. Power      4. Head      5. Weight per unit   4.4 Types and operation principle of rotary compressors   * + 1. Rotary screw compressors     2. Rotary vane compressors     3. Scroll compressor     4. Rotary lobe   1. Analysis of compressors      1. Inlet and outlet flow      2. Work done      3. Mass flow rate      4. Power requirement      5. Efficiency   2. Compressor Fans and Vanes      1. Structure and functions of compressor fans and vanes      2. Operation principles of fans and vanes in rotary compressors      3. Maintenance of fans and vanes   3. Design Analysis      1. Vane efficiency      2. Fan efficiency      3. Power consumption | * Written Tests |
| 1. Apply stress and strain concepts in mechanical systems | * 1. Define stress and strain   2. Types of simple stresses      1. Direct      2. Shear      3. Ultimate tensile stress      4. Yield stress      5. Breaking stress      6. True stress   3. Analysing stress on      1. Beams      2. Thin cylinders      3. Thin shells   4. Applications of stress and strain concepts      1. Bolts and nuts      2. Shafts | * Written Tests |
| 1. Determine loading conditions in mechanical systems | * 1. Define structure   2. Types of loading      1. Point load      2. Uniformly distributed load      3. Varying load   3. Types of beams      1. Simply supported beams      2. Cantilever beam   4. Overhanging beam |  |
| 1. Apply simple bending theory in mechanical systems | * 1. Engineers Bending Equation   2. Types of Beams      1. Simply supported beams      2. Cantilever beam      3. Overhanging beam   3. Analysis of Beams      1. T-section      2. L-section      3. I-section   4. Types of Shafts      1. Solid      2. Tubular      3. stepped   5. Analysis of shafts      1. Solid      2. Tubular      3. Stepped | * Written Tests |
| 1. Apply torsion theory in mechanical systems | * 1. Define Torsion   2. Torque Analysis   3. Analysis of Shafts      1. Series arranged shafts      2. Parallel arranged shafts   4. Determine angle of twist      1. Engineers’ torsion equation | * Written tests |

**Suggested Delivery Methods**

Group discussions

Demonstration by the trainer

Online video clips

Power point presentation

Exercises by trainee

**Recommended resources for 25 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 |
|  | Brooms and cleaning stuff | Hand brooms and mops for cleaning | 10 | 2:5 |
| **D** | **Tools and Equipment** | | | |
|  | Calculators | For calculations | 30 | 1:1 |
|  | Firefighting extinguishers | Water, carbon dioxide and chemical powder fire extinguishers for fire fighting | 1 | 1:30 |
| **F** | **Reference Materials** | | | |
|  | Training Presentations/Slides | Digital format for shared access among trainees | 1 | 1:30 |

## **FOUNDRY WORKS**

**ISCED UNIT CODE:** 0715 551 21A

**Relationship to Occupational Standards****:**

This unit addresses the unit of competency: Perform Foundry Works

**Duration of Unit: 150 HRS**

**UNIT DESCRIPTION**:

This unit covers the competencies required in performing foundry works. It involves preparing working drawing, preparing casting operation plan, produce moulding patterns, prepare moulding sand, make sand mould, melt casting materials, pour molten melting and inspect casting.

**Summary of Learning Outcomes**

By the end of the unit, the learner should be able to

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcome** | **Course Duration** |
|  | Prepare working drawing | 10 |
|  | Prepare casting operation plan | 10 |
|  | Produce moulding patterns | 20 |
|  | Prepare moulding sand | 30 |
|  | Make sand mould | 30 |
|  | Melt casting materials | 20 |
|  | Carry Out Casting Process | 20 |
|  | Inspect casting | 10 |
| **Total** | | **150** |

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

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Learning Outcome** | **Content** | | **Suggested**  **Assessment**  **Methods** | |
| 1. Prepare working drawing | * 1. Working drawing interpretation      1. International drawing standards         1. British Standard (BS)         2. American National and International Standards (ANSI)         3. International organization standards (ISO)      2. drawing symbols and abbreviations   2. Free hand sketching   3. Detailed drawing | * Written tests * Practical tests | |
| 1. Prepare casting operation plan | * + 1. Definition of terms        1. Foundry        2. Working drawing        3. Dimensions        4. Tolerance        5. Mould        6. Casting        7. Casting sand        8. Pattern        9. Core        10. Skimming        11. Pouring        12. Gating system        13. Sprue        14. Runner        15. Gate        16. Riser        17. Vent        18. Draft        19. Chill        20. Defects   1. Casting Operations and Sequencing      1. Pattern making      2. Mold preparation      3. Core making      4. Mold assembly      5. Pouring      6. Solidification and cooling      7. Mould removal      8. Cleaning and finishing      9. Heat treatment   2. Casting Tools and Equipment:      1. Hand tools      2. Moulding boxes      3. Mechanical tools   3. Materials      1. Ferrous      2. Non ferrous      3. Plastics      4. Glass      5. Ceramics   4. Defination of operation plan      1. Structure of an operation plan      2. Sequence of foundry operations | * Written tests * Practical tests | |
| 1. Produce moulding patterns | * 1. Workshop safety      1. Rules and regulations      2. Personal protective equipment      3. Machine safety      4. Occupational safety and health act, 2007      5. Housekeeping   2. Pattern making Materials      1. Wood      2. Plastic      3. Metals      4. Wax   3. Pattern making tools and equipment      1. Hand tools      2. Measuring tools      3. Power tools   4. Pattern design parameters      1. Dimensional accuracy      2. Shrinkage allowance      3. Draft angles      4. Parting line      5. Gating and risers   5. Pattern construction      1. Pattern shaping      2. Surface finishing      3. Shrinkage allowance      4. Draft angles   6. Pattern assembly      1. Joining pattern components      2. Creating the core      3. Adding gating system   7. Types of Patterns      1. Two piece pattern      2. Multi-piece pattern      3. Match plate pattern      4. Gated patter      5. Skeleton pattern      6. Cope and drag pattern      7. Loose piece pattern | * Written tests * Practical tests * Project | |
| 1. Prepare moulding sand | * 1. Moulding Tools and Equipment      1. Rammers      2. Pattern pullers      3. Spades and shovels      4. Sifters      5. Strickle boards      6. Moulding brushes      7. Core boxes      8. Core venting tools      9. Moulding machines   2. Types of Moulding Sand      1. Green sand mould      2. Dry-sand mould      3. Skin dried sand mould      4. Shell moulds      5. Loam sand mould   3. Moulding Additives      1. Binders      2. Curing agents   4. Moulding Sand Testing | * Written tests * Practical tests * Project | |
| 1. Make sand mould | * 1. Moulding Process      1. Bench moulding      2. Floor moulding      3. Pit moulding      4. Plate moulding      5. Flask less moulding      6. Vacuum moulding      7. Machine moulding   2. Moulding Procedures      1. Flask setup      2. Compacting and setting      3. Mould parting      4. Closing and sealing the mould | * Written tests * Practical tests * Project | |
| 1. Melt casting materials | * 1. Types of furnaces      1. Cupola furnace      2. Induction furnace      3. Crucible furnace      4. Blast furnace      5. Electric furnace   2. Furnace Setup and Charging   3. Furnace Parameters:      1. Temperature      2. Power input      3. Melting time      4. Heat loss and insulation      5. Efficiency and control systems   4. Preheating and fluxing   5. pyrometer      1. Optical pyrometer      2. Radiation/infrared pyrometer   6. Skimming      1. Importance      2. Techniques      3. Equipment | * Written tests * Practical tests * Project | |
| 1. Perform casting | * 1. Pouring tools and equipment      1. Ladle      2. Pouring cups and spouts      3. Furnace tongs   2. Pouring techniques      1. Direct pouring      2. Controlled pouring      3. Back pouring   3. Casting parameters      1. Temperature      2. Pouring speed      3. Pouring height      4. Gating system design      5. Risers   4. Cast removal procedure      1. Solidification and cooling      2. Mould removal      3. Cast ejection      4. Cast cooling      5. Cleaning | * Written tests * Practical tests * Project | |
| 1. Inspect casting | * 1. Inspection tools and equipment      1. Tools for visual inspection      2. Tools for destructive      3. Tools for non-destructive test.   2. Casting Defects      1. Porosity defects      2. Shrinkage defect      3. Warping      4. Sinks      5. Slags inclusions      6. Dross      7. Hot tears      8. Cold shut   3. Heat treatment processes      1. Annealing      2. Normalizing      3. Quenching      4. Tempering      5. Case hardening      6. Stress relieving   4. Finishing Process in Casting      1. Trimming      2. Machining      3. Grinding      4. Fettling      5. Shot blast   5. Inspection Report | * Written tests * Practical tests * Project | |

**Suggested Delivery Methods**

* Demonstration by trainer
* 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** |  |  |  |
| **1** | Textbooks | A comprehensive textbook on foundry | 1pc | 1:25 |
|  | Charts | A comprehensive chart on foundry | Adequate |  |
| **B** | **Learning Facilities & Infrastructure** |  |  |  |
|  | Lecture/theory room | 9M×12M | 1 | 1:25 |
|  | Workshop | 20M×20M | 1 | 1:25 |
| **C** | **Consumable Materials** |  |  |  |
|  | Sand | Green sand mould | Adequate |  |
| Dry-sand mould | Adequate |
| Skin dried sand mould | Adequate |
| Shell moulds | Adequate |
| Loam sand mould | Adequate |
|  | Additives | Green Sand Binder (Bentonite Clay) | Adequate |  |
| Resin Binder (Furan or Phenolic) | Adequate |
| Curing Agent (Hexamethylenetetramine) | Adequate |
| Shell Mould Binder (Sodium Silicate) | Adequate |
| CO₂ Curing Gas | Adequate |
|  | First aid kit |  | 1 | 1:25 |
|  | Core Sand (Silica, Resin-bound) |  | Adequate |  |
|  | Core Binder (Resin) |  | Adequate |  |
|  | Wax (Investment Casting) |  | Adequate |  |
|  | Mould Release Agents |  | Adequate |  |
|  | Safety Equipment (PPE) |  | 25 sets | 1:1 |
|  | Fire extinguisher |  | 3 | 3:25 |
|  | Ream of Drawing papers |  | Adequate |  |
|  | Drawing instruments | For trainer’s use | 1set | 1:25 |
|  | Cleaning detergents | Degradants | Adequate |  |
| Floor detergents | Adequate |
| Hand detergents | Adequate |
|  | Cotton wool waste |  | Adequate |  |
|  | **Raw material** |  |  |  |
|  | Ferrous | Cast iron | 20kg | 4:5 |
|  | Non ferrous | aluminium | 10kg | 2:5 |
|  | Plastics | Resin | 50kg | 2:1 |
|  | Glass | Glass products | 50kg | 2:1 |
|  | Ceramics | Clay based | 20kg | 4:5 |
| **D** | **Testing materials** |  |  |  |
|  | Endoscope | Visual inspection | 5 | 1:5 |
|  | Magnifying glass | Visual inspection | 10 | 2:5 |
|  | Dye penetrant | Non- destructive testing | 10 litres | 2:5 |
|  | Hardness testing machine | Vickers | 1 | 1:25 |
| Rockwell | 1 | 1:25 |
| Brinell | 1 | 1:25 |
|  | **Tools and Equipment** |  |  |  |
|  | **Measuring Tools** |  |  |  |
|  | Steel rule |  | 25 | 1:1 |
|  | Micrometer screw gauge |  | 5 | 1:5 |
|  | Vernier callipers |  | 5 | 1:5 |
|  | Tri square |  | 10 | 2:5 |
|  | Bevel protractor |  | 2 | 2:25 |
|  | Combination set |  | 2 | 2:25 |
|  | Measuring tapes |  | 5 | 1:5 |
| **2** | **Power cutting tools** |  |  |  |
|  | Reciprocating saw |  | 1 | 1:25 |
|  | Pedestal Drilling machine |  | 2 | 2:25 |
|  | Band saw |  | 1 |  |
|  | Hand grinder |  | 2 | 2:25 |
| 3 | **Moulding tools and equipment** | | | |
|  | Rammers |  | 10 | 2:25 |
|  | Pattern pullers |  | 5 sets | 1:5 |
|  | Spades and shovels |  | 10 | 2:5 |
|  | Sifters |  | 5 | 1:5 |
|  | Strickle boards |  | 10 | 2:5 |
|  | Moulding brushes |  | 10 | 2:5 |
|  | Core venting tools | Core boxes | 25 | 1:1 |
| Core rods | 25 | 1:1 |
| 4 | **Pouring tools and equipment** | | | |
|  | Ladle |  | 5 | 1:5 |
|  | Pouring cups and spouts |  | 5 | 1:5 |
|  | Furnace tongs |  | 5 | 1:5 |
|  | Furnace |  | 1 | 1:25 |
| 5 | **Finishing equipment** |  |  |  |
|  | Grinding wheel |  | 12pcs | 1:2 |
|  | Emery cloth | Coarse | Adequate |  |
| Fine | Adequate |
|  | Buffing machine |  | 1 | 1:25 |

# MODULE VII

# ELECTRONICS AND CONTROL PRINCIPLES

**ISCED UNIT CODE:** 0713 541 22A

**UNIT DURATION: 160 HOURS**

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Apply Sensors and Control principles.

**Unit description**

This unit describes the competences required in order to apply Sensors, transducers and Control principles.

**Summary of Learning Outcomes**

By the end of the Unit of Learning, the trainee will be able to;

|  |  |  |
| --- | --- | --- |
| **S/No.** | **Learning Outcome** | **Duration (Hours)** |
|  | Apply Safety requirements for electricity | 10 |
|  | Apply understanding of electronics | 25 |
|  | Perform Single and three phase power supply | 35 |
|  | Apply Sensors and transducers principles | 45 |
|  | Apply Control principles | 45 |
| **Total hours** | | **160** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Apply safety requirements for electricity | * 1. Personal Protective Equipment (PPE)      1. Types of PPE         1. Head protection, insulating gloves, eye protection         2. Usage guidelines and importance   2. Control of Electrical Hazards      1. Identification of Hazards         1. Shocks, explosions, electrocution, burns, fires, electric arcs         2. Risk assessment and management   3. Electric Hazard Prevention      1. Preventative Measures         1. Lockout/Tagout (LOTO) procedures         2. Safe work practices | * Practical * Portfolio of evidence * Third party report * Written tests. |
| 1. Apply understanding of electronics | * 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 D.C circuits.      4. Applications of capacitors in filtering, timing, and energy storage.      5. Inductors: Types, inductance value, and applications.      6. Inductor behavior in D.C 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. | * Practical * Portfolio of evidence * Third party report * Written tests. |
| 1. Perform single and three phase power supply principles | * 1. Overview of Electrical Power Systems      1. Definition and importance of power supply systems      2. Types of power systems: Single-phase vs. three-phase      3. Basic Electrical Concepts         1. Voltage, current, power, and frequency         2. Phase relationships and power factor   2. Single-Phase Power Supply      1. Characteristics of Single-Phase Systems         1. Voltage and current waveforms         2. Applications and limitations of single-phase power         3. Circuit Design and Implementation         4. Basic circuit configurations: Series and parallel         5. Wiring techniques and component selection      2. Measurement Techniques         1. Measuring voltage, current, and power in single-phase circuits         2. Tools and instruments for measurements   3. Three-Phase Power Supply      1. Fundamentals of Three-Phase Systems         1. Characteristics of three-phase power: Star (Y) and Delta (Δ) configurations         2. Advantages of three-phase systems over single-phase      2. Circuit Design and Implementation         1. Wiring and connection techniques for three-phase systems         2. Component selection and configuration      3. Measurement Techniques         1. Measuring line and phase voltages, currents, and power in three-phase circuits         2. Use of power analyzers and other measurement tools   4. Power Calculations and Analysis      1. Power Calculations         1. Active, reactive, and apparent power calculations         2. Understanding the power triangle in both single and three-phase systems      2. Power Factor Correction         1. Importance of power factor in electrical systems         2. Techniques for improving power factor in both types of systems   5. Troubleshooting and Maintenance      1. Common Issues in Power Supply Systems         1. Identifying and diagnosing faults in single and three-phase systems         2. Troubleshooting techniques and best practices | 1. Practical 2. Portfolio of evidence 3. Third party report 4. Written tests. |
| 1. Apply sensors and transducers principles | * 1. Introduction to Sensors and Transducers      1. Definitions and Concepts      2. Differences between sensors and transducers      3. Overview of their roles in measurement and control systems   2. Basic Principles of Operation      1. How sensors and transducers convert physical phenomena into electrical signals      2. Common physical quantities measured (e.g., temperature, pressure, moisture, position, oxygen, light)   3. Types of Sensors      1. Temperature Sensors      2. Thermocouples, thermistors, and infrared sensors         1. Principles of operations         2. Applications and selection criteria      3. Pressure Sensors         1. Strain gauge, piezoelectric, and capacitive pressure sensors         2. Principles of operations         3. Measurement techniques and applications      4. Proximity and Displacement Sensors         1. Inductive, capacitive, and photoelectric sensors         2. Principles of operations         3. Use cases and installation considerations      5. Other Sensor Types         1. Humidity, moisture, oxygen, flow, level, and gas sensors         2. Overview of their principles and applications   4. Types of Transducers      1. Definitionand Functionality         1. Types of transducers (active vs. passive)         2. Examples and applications      2. ElectricalTransducers         1. Strain gauges, load cells, and piezoelectric transducers         2. Principles of operation and usage      3. MechanicalTransducers         1. Overview of mechanical types and their applications         2. Integration into automated systems   5. Hands-on experiments on testing sensors and actuators. | * Practical * Portfolio of evidence * Third party report * Written tests. |
| 1. Apply control principles | * 1. Introduction to Control Systems      1. Definition of terms and Importance of control systems         1. Introduction to control systems in engineering and automation         2. Types of control systems: Open-loop vs. closed-loop      2. Basic Terminology         1. Key terms: feedback, set point, error, actuator, sensor         2. Understanding system dynamics   2. Types of Control Strategies      1. Proportional Control (P Control)         1. Principles and characteristics         2. Applications and limitations      2. Proportional-Integral Control (PI Control)         1. Understanding integral action and its effects         2. Applications in process control      3. Proportional-Integral-Derivative Control (PID Control)         1. Components of PID control and their significance         2. Tuning methods and practical applications      4. Advanced Control Strategies         1. Feedforward control, adaptive control, and fuzzy logic control         2. Overview of model predictive control (MPC)         3. Types of controllers.   3. Introduction to PLCs      1. Overview of PLCs,      2. Applications      3. PLC Hardware         1. PLC components (CPU, I/O modules, power supply) and wiring.         2. PLC Programming Basics Programming languages (Ladder Logic, Function Block, etc.) and         3. Software tools.   4. Ladder Logic Programming      1. Creating basic programs using timers, counters, logic gates, and arithmetic operations.      2. Inputs/Outputs      3. Digital/analog inputs and outputs,      4. Interfacing with sensors and actuators. | * Written tests * Practical |

**Suggested Methods of Instruction**

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

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/Specifications** | **Quantity** | **Recommended Ratio (Item: Trainee)** |
| **A** | **Learning Materials** |  |  |  |
| 1 | Textbooks | Comprehensive texts on electrical and control principle. | 5 pcs | 1:5 |
| 2 | Charts | Visual aids covering electrical theories and safety protocols | 10 pcs | 1:2.5 |
| 3 | PowerPoint Presentations | For trainer’s use, covering course content and practical applications | 1 | 1:25 |
| **B** | **Learning Facilities & Infrastructure** | | | |
| 1 | Lecture/Theory Room | Equipped with projectors and seating for 25 trainees, ~60 sqm | 1 | 1:25 |
| 2 | Workshop | Hands-on training area with workbenches, tools, and safety equipment, ~80 sqm | 1 | 1:25 |
| 3 | Computer Laboratory | Equipped with testing setups for electrical experiments, ~50 sqm.  Equipped with computers installed with Circuit simulation software. | 25 | 1:1 |
| **C** | **Consumable Materials** | | | |
| 1 | Electrical Wires | Assorted sizes and color-coded (e.g., 1.5mm², 2.5mm², 4mm²) | 5 rolls | 1:5 |
| 2 | Insulation Tapes | For securing connections and insulation, assorted colors | 25 pcs | 1:1 |
| 3 | Breadboard | For prototyping and testing circuits | 5 pcs | 1:5 |
| 4 | Sensors | Assorted types (temperature, pressure, proximity) | 10 pcs | 1:2.5 |
| 5 | Signal generators | For generating AC signals | 5pcs | 1:5 |
| 6 | Transducers | Assorted | 10 pcs | 1:3 |
| 7 | Electronic components | Resistors, transistors, capacitors, relays, transformers. Integrated IC, OPAM. | 100pcs | 4:25 |
| **D** | **Tools and Equipment** | | | |
| 1 | Screwdrivers | Assorted sets for various applications | 2 sets | 1:12.5 |
| 2 | Side Cutters | For cutting wires and cables | 4 pcs | 1:6.25 |
| 3 | Pliers | For gripping and bending wires | 3 pcs | 1:8.33 |
| 4 | Stripping Knives | For stripping insulation from wires | 4 pcs | 1:6.25 |
| 5 | Computers | Equipped with electrical and electronics simulation software | 5 pcs | 1:5 |
| 6 | Multimeters | For measuring voltage, current, and resistance | 5 pcs | 1:5 |
| 7 | Clamp Meters | For measuring current flow in circuits | 5 pcs | 1:5 |
| 8 | Oscilloscope | For observing waveforms and signals | 1 | 1:25 |
| 9 | Voltmeter | For measuring voltage | 1 | 1:25 |
| 10 | Ammeter | For measuring current | 1 | 1:25 |
| 11 | Signal Generator | For generating electrical signals for testing | 1 | 1:25 |
| 12 | Soldering gun | For soldering | 10 | 1:3 |
| 13 | Soldering wire | For making joints in electrical circuits | 10 | 1:3 |
| 14 | PLC | For program practice | 5 | 1:5 |
| 15 | Cells and batteries | For learning | 5 | 1:5 |
| **E** | **PPE (Personal Protective Equipment)** | | | |
| 1 | PPE Sets | Includes helmets, gloves, safety goggles, shoes, and harnesses | 25 sets | 1:1 |
| 2 | Safety Signs and Barriers | For simulating safety zones and hazards | 10 sets | 1:2.5 |
| 3 | Earthing Test Kits | For ground testing and demonstrating earthing procedures | 5 pcs | 1:5 |
| 4 | Electrical Test Benches | For hands-on testing of functionality and circuit design | 5 pcs | 1:5 |
| **F** | **Reference Materials** | | | |
| 1 | Industrial Automation Manuals | Covering principles and practices in automation | 25 pcs | 1:1 |
| 2 | Electrical Standards | Reference on industry standards (e.g., IEEE Guidelines) | 5 pcs | 1:5 |
| 3 | Technical Handbooks | On motors, drives, and wiring systems | 25 pcs | 1:1 |
| 4 | Training Presentations/Slides | Digital format for shared access among trainees | 1 | 1:25 |
| 5 | Multimedia Learning Modules | Digital licenses for videos and tutorials | 25 pcs | 1:1 |
| 6 | Practical Assessment Guides | Worksheets for practical assessments | 25 pcs | 1:1 |

## CNC MILLING OPERATIONS

**ISCED UNIT CODE :** 0715 551 23A

**DURATION OF UNIT :** 150 HRS

**Relationship to Occupational Standards:**

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

**Unit Description**

This unit covers the competencies required in operating a CNC Milling machine. It involves preparing working drawing, milling operation plan, performing CNC Milling programming, setting up CNC Milling machine, performing CNC Milling operations, carrying out CNC milling operations and maintaining CNC milling machine and tools

**Summary of Learning Outcomes**

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

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcome** | **Unit Duration** |
|  | Prepare working drawing | 10 |
|  | Prepare CNC milling operation plan | 10 |
|  | Set up CNC milling machine | 20 |
|  | Perform CNC milling programming | 50 |
|  | Carry out CNC milling operations | 40 |
|  | Inspect finished work | 10 |
|  | Maintain CNC milling machines and tools | 10 |
| **Total** | | **150** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcomes** | **Content** | **Suggested Assessment Method** |
| 1. Prepare working drawing | * 1. Working drawing interpretation      1. Definition of terms         1. Working drawing         2. Dimensions         3. Tolerance      2. Dimensions and Tolerances         1. Types of dimensions         2. Linear         3. Angular         4. Diametral         5. Radial         6. Geometric         7. Ordinate         8. Types of tolerances         9. Dimensional tolerance         10. Geometric tolerance         11. Surface tolerance         12. Assembly tolerance      3. International drawing standards         1. British Standard (BS)         2. American National and International Standards (ANSI)      4. International organization of standardization (ISO)      5. drawing symbols and abbreviations   2. Design of component by CAD   3. Safety      1. PPE      2. Safe workplace      3. Machine safety         1. Machine Guard         2. Emergency buttons and 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 | * Written Tests * Practical tests * Project Work * Portfolio of Evidence |
| 1. Prepare CNC milling operation plan. | * 1. Parts of CNC milling machine and uses   2. Types of CNC milling machine   3. CNC Milling Machine Tools      1. Slotting cutter      2. face cutter      3. surface cutter      4. slab cutter      5. angular cutter      6. dove tail cutter      7. slit cutter      8. gear cutter      9. T slot cutter      10. Twist drill   4. The working principle of CNC milling machine   5. CNC Milling Operations      1. Flat Milling      2. Facing      3. 2 D Contour      4. Pocket Milling      5. Slot Milling      6. Chamfer milling      7. Drilling      8. Boring      9. Tapping      10. Threading      11. Smoothing      12. Deburring      13. Engraving      14. 5- axis machining   6. Materials      1. Types         1. Mild steel         2. Brass         3. Aluminium         4. PTFE         5. NYLON      2. Forms of supply         1. Bars         2. Plates         3. Shaft   7. Defination of operation plan      1. Structure of an operation plan      2. Sequence of CNC milling operations | * Written Tests * Practical tests * Project Work * Portfolio of Evidence |
| 1. Set up CNC milling machine | * 1. Machine Referencing      1. X and Y axis      2. Linear Interpolation      3. Work offset      4. Tool setting   2. Tool Setup;      1. Tool mounting      2. Tool holding      3. Tool offset      4. Tool wear compensation   3. Pre-operation inspections   4. Coolant, oil, and hydraulic fluid   5. Clamping devices setup      1. Toggle clamp      2. Screw clamps      3. Step blocks      4. Vacuum tables      5. Vacuum cups      6. Vices      7. Soft jaws Workpiece setup   6. Machine parameters      1. Cutting speed      2. Depth of cut      3. Spindle speed      4. feed rate      5. tool geometry   7. CNC Milling Set up process      1. Install the cutters / tools      2. Securing the workpiece      3. Inputting the design      4. Running a test | * Written Tests * Practical tests * Project Work * Portfolio of Evidence |
| 1. Perform CNC Milling Programming | * 1. Prepare commands      1. G- codes and M- codes      2. APT   2. Set coordinate system      1. Absolute      2. Work offset   3. Input the CNC Milling Programs | * Written Tests * Practical tests * Project Work * Portfolio of Evidence |
| 1. Carry Out CNC milling operations | * 1. CNC Milling operation procedure      1. program loading in the CNC machine      2. Installing the cutter/tool      3. Securing the workpiece      4. Inputting the design      5. Program Simulation      6. Run test the design/ execute      7. Machining      8. Corrective measures   2. Safe Removal of Finished Product   3. Correct Shutdown Procedure | * Written Tests * Practical tests * Project Work * Portfolio of Evidence |
| 1. Inspect finished work. | * 1. Selecting Inspection Tools and Method      1. Magnified glasses      2. borescopes      3. micrometers      4. calipers,      5. coordinate measuring machines(CMM)      6. laser scaners      7. roughness testers      8. profilometers         1. Visual inspection         2. Floor inspection      9. Non destructive testing      10. functional testing      11. hardness testing   2. Inspection of Finished Products      1. Quality control         1. Surface roughness         2. geometrical eccentricity         3. dimensional inspection      2. quality inspection         1. machine vision systems         2. robotic inspection         3. IoT and sensors   3. Post-inspection Adjustments | * Written Tests * Practical tests * Project Work * Portfolio of Evidence |
| 1. Maintain CNC milling machines and tools | * 1. Types of maintenance      1. Preventive      2. Scheduled      3. Routine   2. Trouble shooting      1. Fault diagnosis   3. Servicing of CNC milling machine and accessories      1. Inspection      2. Care and Storage      3. Lubrication   4. Back up and virus checks | * Written Tests * Practical tests * Project Work * Portfolio of Evidence |

**Suggested Delivery Methods**

* Demonstration
* Group discussions
* Practical work by trainee(s)
* Industrials visits
* YouTube for teaching/learning and inspiration.
* simulations

**Recommended Resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** |  |  |  |
|  | Textbooks | For reference | 1 pc | 1:25 |
|  | Installation manuals | For reference | 1 pc | 1:25 |
|  | Charts | For reference | Adequate |  |
| **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 | 5 | 1:5 |
|  | Bench Vises |  | 10 | 2:5 |
|  | **Safety** |  |  |  |
|  | Safety goggles |  | 25 pcs | 1:1 |
|  | Leather glove |  | 25 pcs | 1:1 |
|  | Helmet |  | 25 pcs | 1:1 |
|  | Ear muffs |  | 25 pcs | 1:1 |
|  | Overall |  | 25 pcs | 1:1 |
|  | Safety boots |  | 25 pcs | 1:1 |
|  | Dust mask |  | 25 pcs | 1:1 |
|  | Face shield |  | 25 pcs | 1:1 |
| **C** | **Consumable Materials** |  |  |  |
|  | First aid kit |  | 1 | 1:25 |
|  | Fire extinguisher |  | 1pc | 1:25 |
|  | Ream of Drawing papers |  | Adequate |  |
|  | Drawing instruments |  | 1 set | 1:1 |
|  | Cleaning detergents |  | Adequate |  |
|  | Cutting fluid | For cleaning | Adequate |  |
|  | Machine oil |  | Adequate |  |
|  | Hydraulic oil |  | Adequate |  |
|  | Cotton wool waste |  | Adequate |  |
|  | soft brush |  | 5pcs | 1:5 |
|  | **Raw material** |  |  |  |
|  | Aluminum round bar | 1 length | 1pc | 1:25 |
|  | Mild steel bar | 1 length | 1pc | 1:25 |
|  | Brass bar | 1 length | 1pc | 1:25 |
|  | Metal plate | 8ft×4ft | 1pc | 1:25 |
| **E** | **Tools and Equipment** |  |  |  |
|  | **Measuring Tools** |  |  |  |
|  | Steel rule |  | 25 pcs | 1:1 |
|  | Micrometer screw gauge |  | 5pcs | 1:5 |
|  | Vernier calipers |  | 5 pcs | 1:5 |
|  | Combination set |  | 2pcs | 2:25 |
|  | Dial gauge indicator | Each machine 1pc | 1pc | 1:25 |
|  | **Marking Out Tools** |  |  |  |
|  | Vernier height gauge |  | 2 pcs | 2:25 |
|  | Surface plate |  | 2pcs | 2:25 |
|  | Angle plate |  | 2pcs | 2:25 |
|  | Scribers |  | 5 pcs | 1:5 |
|  | Divider |  | 2:25 | 2:5 |
|  | V block |  | 5 pcs | 1:5 |
|  | CNC milling machine |  | 1pc | 1:25 |
|  | **CNC milling Cutting Tools** |  |  |  |
|  | Twist drill | Assorted | 3 sets | 3:25 |
|  | Surface cutter |  | 3 sets | 3:25 |
|  | Slot cutter |  | 3 sets | 3:25 |
|  | Angular cutter |  | 3 sets | 3:25 |
|  | T slot cutter |  | 3 sets | 3:25 |
|  | Slit cutter |  | 3 sets | 3:25 |
|  | Slab cutter |  | 3 sets | 3:25 |
|  | Gear cutter |  | 3 sets | 3:25 |
|  | Turning tool |  | 3 sets | 3:25 |
|  | Threading tool |  | 3 sets | 3:25 |
|  | Facing tool |  | 3 sets | 3:25 |
|  | Boring |  | 3 sets | 3:25 |
|  | Centre drill |  | 3 sets | 3:25 |
|  | **Power cutting tools** |  |  |  |
|  | Reciprocating saw |  | 1pc | 1:25 |
|  | Band saw |  |  |  |
|  | Hand grinder |  | 5pcs | 1:5 |
|  | **Computer software** |  |  |  |
|  | CAD |  | 1 license | 1:25 |
|  | CAM |  | 1 license | 1:25 |
|  | Solid Works |  | 1 license | 1:25 |
|  | Inventor |  | 1 license | 1:25 |

## CNC LATHE OPERATIONS

**ISCED UNIT CODE:** 0715 551 24A

**Duration of Unit :** 150 HRS

**Relationship to Occupational Standards:** Produce Parts by CNC Lathe

**Unit Description**

This unit covers the competencies required in producing parts by CNC lathe. It involves preparing working drawing and CNC lathe operation plan, setting up CNC lathe machine, programming CNC lathe, performing CNC lathe operations, inspecting finished product and maintaining lathe tools and machines.

**Summary of Learning Outcomes**

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

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcome** | **Course Duration** |
|  | Prepare working drawing | 10 |
|  | Prepare CNC lathe operation plan. | 10 |
|  | Set up CNC lathe machine | 20 |
|  | Program CNC lathe | 50 |
|  | Perform CNC lathe operations | 40 |
|  | Inspect finished product. | 10 |
|  | Maintain lathe tools and machines | 10 |
| **Total** | | **150** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcomes** | **Content** | **Suggested Assessment Method** |
| 1. Prepare working drawing | * 1. Working drawing interpretation      1. Definition of terms         1. Working drawing         2. Dimensions         3. Tolerance      2. Dimensions and Tolerances         1. Types of dimensions         2. Linear         3. Angular         4. Diametral         5. Radial         6. Geometric         7. Ordinate         8. Types of tolerances         9. Dimensional tolerance         10. Geometric tolerance         11. Surface tolerance         12. Assembly tolerance      3. International drawing standards         1. British Standard (BS)         2. American National and International Standards (ANSI)      4. International organization of standardization (ISO)      5. drawing symbols and abbreviations   2. Design of component by CAD   3. 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 | * Observation * Demonstrations * Group discussions * Direct instructions * Oral and written tests |
| 1. Prepare CNC lathe operation plan. | * 1. Parts of CNC machine and uses   2. Types of CNC lathe machine   3. CNC Lathe Machine Tools      1. Knurling tools      2. Thread cutting tools      3. Turning tools      4. Boring tools      5. Parting off tools      6. Drilling bits      7. Chamfering tools      8. Facing tools   4. The working principle of CNC lathe machine   5. CNC Lathe Operations      1. Knurling      2. Threading      3. Turning      4. Facing      5. Boring      6. Taper turning      7. Grooving      8. Parting off      9. Chamfering      10. Sanding      11. Profile   6. Materials      1. Types         1. Mild steel         2. Brass         3. Aluminium         4. Nylon/PTFE      2. Forms of supply         1. Bars         2. Plates         3. Shaft   7. Defination of operation plan      1. Structure of an operation plan      2. Sequence of CNC lathe operations | * Observation * Demonstrations * Group discussions * Direct instructions * Oral and written tests |
| 1. Set up CNC lathe machine | * 1. Machine Referencing      1. X and Y axis      2. Linear Interpolation      3. Work offset      4. Tool setting   2. Tool Setup;      1. Tool mounting      2. Tool holding      3. Tool offset      4. Tool wear compensation   3. Pre-operation inspections   4. Machine coolant, oil, and hydraulic fluid   5. Clamping devices setup      1. Pneumatic chuck      2. Conventional chuck      3. Catch plate      4. Lathe dog      5. Mandrel      6. Collets      7. Faceplate      8. Steady rests   6. Workpiece setup      1. secure the work on the chuck      2. load the tool turret      3. Work offset      4. load the program | * Observation * Demonstrations * Group discussions * Direct instructions * Oral and written tests |
| 1. Program CNC lathe | * 1. Tool Path Geometry and Machine Function   2. CNC Lathe Machine Programs      1. G-code and M -code      2. APT   3. Selecting Machining Parameters      1. Cutting speed      2. Depth of cut      3. Spindle speed      4. feed rate      5. tool geometry   4. Coordinate System Setup      1. Work coordinate system      2. Tool coordinate system   5. Program Generation and Input   6. Simulation of Machining Sequences   7. Post processing the machine      1. Tool Path Data conversion   8. Trial Runs/Program Verification   9. Program Editing and Tool Parameters Correction | * Observation * Demonstrations * Group discussions * Direct instructions * Oral and written tests * Practical |
| 1. Perform CNC lathe operations | * 1. Program Input and Operation Execution   2. Monitoring and Parameter Adjustments   3. Safe Removal of Finished Product   4. Correct Shutdown Procedure | * Observation * Demonstrations * Group discussions * Direct instructions * Oral and written tests * Practical |
| 1. Inspect finished product. | * 1. Selecting Inspection Tools and Method      1. Centralised inspection      2. Visual inspection      3. Floor inspection   2. Inspection of Finished Products      1. Quality control   3. Post-inspection Adjustments | * Observation * Demonstrations * Group discussions * Direct instructions * Oral and written tests * Practical |
| 1. Maintain lathe tools and machines | * 1. Types of maintenance      1. Preventive      2. Scheduled      3. Routine   2. Trouble shooting      1. Fault diagnosis   3. Servicing of CNC lathe machine and accessories      1. Inspection      2. Care and Storage      3. Lubrication | * Observation * Demonstrations * Group discussions * Direct instructions * Oral and written tests * Practical |

**Suggested Delivery Methods**

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

**Recommended Resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** |  |  |  |
|  | Textbooks | For reference purpose | 1 pc | 1:25 |
|  | Installation manuals | For reference purpose | 1pc | 1:25 |
|  | Charts | For reference purpose | Adequate |  |
| **B** | **Learning Facilities & Infrastructure** | | | |
|  | Lecture/theory room | 9M×12M | 1 | 1:25 |
|  | Workshop | 20MX×20M | 1 | 1:25 |
|  | Laboratory | 9M×12M | 1 | 1:25 |
|  | Work benches | 1.5M×1.2M | 7 | 1:4 |
|  | Bench Vises |  | 25 | 1:1 |
| **C** | **Consumable Materials** |  |  |  |
|  | First aid kit | For safety | 1 | 1:25 |
|  | Fire extinguisher | For fire fighting | 1pc | 1:25 |
|  | Ream of Drawing papers | Drawing purpose | Adequate |  |
|  | Drawing instruments | Drawing purpose | 1 set | 1:1 |
|  | Cleaning detergents | For cleaning purpose | Adequate |  |
|  | Cutting fluid | Each machine 5lts | Adequate |  |
|  | Machine oil | Each machine 5lts | Adequate |  |
|  | Hydraulic oil | Each machine 5lts | Adequate |  |
|  | Cotton wool waste | For cleaning | Adequate |  |
|  | soft brush | For cleaning | 6pcs | 1:4 |
|  | **Raw material** |  |  |  |
|  | Aluminum round bar | 1 length | 1pc | 1:25 |
|  | Mild steel bar | 1 length | 1pc | 1:25 |
|  | Brass bar | 1 length | 1pc | 1:25 |
|  | Mild steel plate | 8ftx4ft | 1pc | 1:25 |
| **E** | **Tools and Equipment** |  |  |  |
|  | **Measuring Tools** |  |  |  |
|  | Steel rule |  | 10 pcs | 2:5 |
|  | Micrometer screw gauge |  | 5pcs | 1:5 |
|  | Vanier calipers |  | 5 pcs | 1:5 |
|  | Combination set |  | 2pcs | 2:25 |
|  | Dial gauge indicator | Each machine 1pc | 3pcs | 3:25 |
|  | **Marking Out Tools** |  |  |  |
|  | Vanier height gauge |  | 2 pcs | 2:25 |
| \ | Surface plate |  | 2pcs | 2:25 |
|  | Angle plate |  | 2pcs | 2:25 |
|  | Scribers |  | 5 pcs | 1:5 |
|  | Divider |  | 10pcs | 2:5 |
|  | V block |  | 5 pcs | 1:5 |
|  | CNC lathe machine |  | 1 pc | 1:25 |
|  | **CNC lathe Cutting Tools** |  |  |  |
|  | Twist drill | Assorted | 3 sets | 3:25 |
|  | Turning tool |  | 3 sets | 3:25 |
|  | Threading tool |  | 3 sets | 3:25 |
|  | Facing tool |  | 3 sets | 3:25 |
|  | Knurling |  | 3 sets | 3:25 |
|  | Boring |  | 3 sets | 3:25 |
|  | Grooving |  | 3 sets | 3:25 |
|  | Parting |  | 3 sets | 3:25 |
|  | Reaming |  | 3 sets | 3:25 |
|  | Centre drill |  | 3 sets | 3:25 |
|  | **Power cutting tools** |  |  |  |
|  | Reciprocating saw |  | 1pc | 1:25 |
|  | Band saw |  |  |  |
|  | Hand grinder |  | 2pcs | 2:25 |
|  | **Computer software** |  |  |  |
|  | CAD |  | 1 license | 1:25 |
|  | CAM |  | 1 license | 1:25 |
|  | Solid Works |  | 1 license | 1:25 |
|  | Inventor |  | 1 license | 1:25 |